Soil Conservation in Smallholder Farming Systems

A Proposal for: Der Bundesminister für Wirtschaftliche Zusammenarbeit (BMZ)

Special Project Funding

Submitted by: CIAT

Centro Internacional de Agricultura Tropical

August 1992

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Acronyms

BMZ	Der Bundesminister Für Wirtschaftliche Zusammenarbeit
CETEC	Corporación para Estudios Interdisciplinarios y Asesoría Técnica
CIAT	Centro Internacional de Agricultura Tropical
CGIAR	Consultative Group on International Agricultural Research
CVC	Corporación Autónoma Regional del Valle del Cauca
FEDECAFE	Federación Nacional de Cafeteros de Colombia
FUNDAEC	Fundación para la Aplicación y Enseñanza de las Ciencias
GOs	Governmental Organizations
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
INCORA	Instituto Colombiano de la Reforma Agraria
NGOs	Non-Governmental Organizations
PPCI	Programa de Producción de Cultivos en Zonas Indígenas
USLE	Universal Soil Loss Equation

1.0 Summary

Title: Soil conservation and improved production technology in smallholder hillside cassava-based farming systems.

Short Title: Soil Conservation in Smallholder farming systems.

Objectives: The overall objectives of the project are to generate basic knowledge on soil degradation and erosion processes of Andean inceptisols and develop conservation effective cropping systems through on- farm testing and transfer of technology.

Abstract: Current traditional land use in the Andean region, with annual cropping systems, are generally resource demanding and virtually unsustainable. Inappropriate utilization of agricultural land on hillsides is causing erosion and soil degradation which will lead to chronic loss of productivity.

Although cassava production is not normally recommended for hillsides with slopes greater than 10-15%, large slopes are still being cultivated for cassava production since it is one of the few crops that tolerate degraded soils.

The CIAT Cassava Program together with the Institute for Plant Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, FRG, have been searching for solutions to this problem for the past few years. The research findings, both basic and applied, are encouraging and efforts have been recently extended to "on- farm" testing of technology in collaboration with national institutions as well as farmers' communities.

To further strengthen and accelerate these "on-station" and "on-farm" efforts, the current research proposal is recommended. Its duration of 3 years, with possible future extension, requires financial support of approximately US $ 400,000 to achieve the anticipated objectives.

Cooperating Partners: The execution of the proposed project will be carried out jointly by:

- The Centro Internacional de Agricultura Tropical(CIAT), Colombia
- The Institute for Plant Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, FRG.

Names of Principal Scientists:

- Senior staff from the Cassava Program at CIAT (Dr. Rupert Best, Leader, Cassava Program)
- Prof. Dr. Dietrich E. Leihner, Director, Institute for Plant Production in the Tropics and Subtropics, University of Hohenheim.

Names of staff to be financed:

- CIAT staff (Dr. Rupert Best, Leader, Cassava Program)
- German staff:
  - Post-Doctoral Scientist (3 years)
  - One or more Ph.D. students (3 years with the project and 1 year in Germany).

Total Budget: The total budget is US $ 397,080 broken down as follows:

Budget	Year 1	Year 2	Year 3	Total
BMZ	139,400	135,760	121,920	397,080
CIAT	in-kind	in-kind	in-kind	in-kind
Total	**139,400**	**135,760**	**121,920**	**397,080**

2.0 Background and Justification

Soil degradation in tropical hillsides is a threat to agricultural production in many Latin America countries

The decreasing availability of prime land in tropical America is forcing resource-poor small farmers to grow crops on very steep hills with poor soils. The tropical hillsides, once cultivated with annual crops become highly susceptible to erosion caused by heavy rains and their soils are further degraded. Soil degradation is already apparent in large areas in the Andean region and it is a growing threat to agricultural production in many Latin American countries.

CIAT has looked into ways to minimize soil erosion in hillside areas where cassava is an important crop

One of the few crops that is able to survive in these already degraded lands is cassava. Although cassava is not usually recommended for cultivation on hillsides with slopes of more than 10%, it remains a major crop in these areas with steeper slopes. For this reason, CIAT Cassava Program scientists have been actively engaged in soil conservation research on hillsides for several years. They have been also looking for practical solutions to minimize soil erosion in cassava-based production systems in fragile steep lands.

The University of Hohenheim has joined CIAT in this research effort

These research efforts have been strengthened in the past years through a collaborative research project with the University of Hohenheim, Stuttgart, FRG. The project was financed by BMZ and has been executed, by one German Ph.D. student and a post-doctoral scientist in collaboration with the Cassava Physiology section at CIAT, The earlier objectives of the project focused on collecting basic information on the characteristics of erosion processes in two defined locations of the Andean zone of Colombia where cassava has become a major staple and cash crop for small farmers. One of these locations was at the CIAT experimental station, Santander de Quilichao, Cauca Department, with an average slope of 8-10%. The second site was on a private farm near Mondomo, Cauca Department, with an average slope of 15-20%.

Two clearly defined locations of Southern Colombia were selected to collect basic data on the soil erosion process

The basic soil characteristics of these two sites were studied in detail during the primary phase of the project (Ludger Reining, Ph.D. Thesis, Hohenheim University, 1991). Climatic data were also systematically collected and analyzed in relation to soil erosion using the Universal Soil Loss Equation (USLE) which has been previously developed for temperate climate by Wischmeier and Smith (1978).

Application of the USLE in acidic inceptisols in the Andeans, indicated a lack of correlation of various erosivity indices including the R-factor of the USLE with observed soil erosion of the first year.

On the other hand, second ,third and fourth year studies showed significant correlations with almost all tested indices and parameters. Variability and progressive tendencies of the data so far collected suggest longer-term studies before unequivocal conclusions can be drawn on the use of such a model for soil erosion prediction. Causes for the underestimation of erosion by the model have to be explored.

Further studies looked into the effect of cultural practices on soil loss and cassava productivity

As a second major objective of the primary phase of the project, studies were conducted at both sites on the effect of some cultural practices and soil management systems on soil loss as well as cassava productivity. These practices included growing cassava as a sole crop on flat lands which represents, closely, local traditional practices with or without soil preparation (minimum tillage), on contour ridges, with live grass barriers and more recently in association with forage legume species. Data on soil loss, runoff, cassava yield and forage biomass production were collected. Some of the findings were recently reported by Reining (1992) and by CIAT (1987-1991, Cassava Program Report).

Some cultural practices are promising but more research is needed

In summary, some practices were found to be effective in reducing soil erosion and runoff and at the same time maintain cassava productivity. Most notably among these practices are the use of live grass barriers, contour ridges and permanent covers with some less competitive forage legumes species. However, due to difficulties in managing cassava/ forage legume production systems, it is premature to judge the potential of this system at this stage.

On-farm research helped to test and evaluate the potential of some cultural practices

In 1991/1992, the project was extended into "on-farm research" and three different local farmers' communities were selected for participation in evaluating and testing the potential of some of these cultural practices in controlling soil erosion while maintaining crop productivity. These "on-farm" efforts are now gaining momentum together with the collaboration of local non-governmental and semi-official organizations concerned with natural resources management and conservation. Therefore it is hoped, that these efforts would lead to both examine the real interest of the farmers and their views about the tested production systems and to the potential of adoption by farmers of some of the promising technologies.

A new research phase would enhance and accelerate the technology testing efforts

To further enhance and accelerate these "technology-testing" efforts and to generate useful feed-backs to the "on-station" research, a new research proposal is recommended. This would also allow to intensify or bring about activities in this area by locally active institutions and thus strengthen the long-term contribution of the project in the field of applied soil conservation research.

Relationships between soil degradation and productivity also need to be studied

The relation between soil degradation and productivity is another issue which has to be studied in more detail to translate erosion into terms of productivity for economists and policy makers. This can be done with a uniquely sound database on soil development during the past years.

The proposed research is consistent with CIAT's new initiatives on resource management research

In conducting research along these lines, the proposed special project will prepare some of the activities to be developed in the new resources management research initiative of CIAT in a significant way. It will be an example of how a special project can pave the road towards core activities that will be initiated as the "hillside program" (one of the core programs within the framework of Natural Resources Management Research) becomes operational.

The team evaluating Phase I recommended an extension of the project

Both the short term consultant Dr. Rattan Lal from Ohio State University, U.S.A., as well as the report from Dr. Michael Bosh (GTZ Evaluation Team) agreed that the first phase of the project was successful and are recommending a second phase of the project to further improve the data on soil erosion, to collect data on soil dynamics and its impact on productivity and to develop practical conservation effective cropping systems technology.

3.0 Overall Project Objectives

The project has clearly defined goals, specific objectives and outputs

The overall objectives of the project are to generate basic knowledge on soil degradation and erosion processes of Andean inceptisols and develop conservation effective cropping systems by on-farm testing and transfer of technology.

The specific objectives are:

- To better understand the basic processes governing soil erosion focusing on climatic and edaphic components
- To better understand the impact of soil degradation on productivity
- To develop soil conservation effective cropping systems and their economic feasibility
- To conduct on-farm experimentation with different farmers' groups and national institutions (GO'S and NGO's)
- To train scientists and disseminate information.

The expected outputs from fulfilling the above objectives can be summarized as follows:

- Improving the predictability of soil erosion in the tropics by the USLE or a modified USLE
- Characterization of physical and chemical properties of soils as affected by soil erosion and cropping systems
- Identification of the cropping systems and cultural practices most effective in soil conservation, taking into consideration farmers' interests and long-term sustainability aspects from both the economic and environmental points of view

- Identification of national institutions including both public and private organizations which are active in rural development and in natural resources conservation
- Establishing an effective link between researchers, farmers and regional institutions so that useful information and viable technologies are better used and adopted
- Feed-back information from "on-farm" activities to "on-station" research
- Trained national and international scientists and students
- Documentation of basic and applied information on soil conservation, cropping systems and technology development and diffusion.

Outputs will contribute to crop productivity and natural resources preservation

These expected outputs represent the basic components of the project strategy toward fulfilling the stated objectives. They will contribute to improving crop productivity and to the preservation of natural resources in highly populated and fragile mountain areas in Colombia and perhaps in other Latin American countries experiencing the same problems of soil degradation.

Outputs will also strengthen national research capacity

The outputs of the project will further strengthen the capacity of the national institutions involved in research and development in these areas. Moreover, the outcome of the project will contribute to the formation of an effective link between scientists from developed and developing countries and between international and national institutions concerned with alleviating hunger and poverty among the less privileged communities.

4.0 Workplan

The major activities and sub-activities of the project as they relate to the project's outputs are graphically illustrated in Figure 1. The implementation schedule (Gantt Chart) showing the commencement and duration for each main project activity is shown in Appendix A. Figure 2 shows the project organization for the technical reporting and financial management of this project.

German scientists and students will be key participants in this research project

The execution of the project would require at least three years with possible future extension. In collaboration with the Cassava Program at CIAT, German students and scientists will participate intensively in executing the project throughout its duration. The Cassava Program will provide administrative and technical assistance for the project.

The execution of the project will be supervised by the University of Hohenheim

The Institute for Plant Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, FRG, will supervise the execution of the project through the Ph.D. students and the post-doctoral scientist who reside in Colombia.

Relevant Colombian research institutions and farmers' groups will also participate in this project

Colombian graduate students will participate in the execution of the project where they have the opportunity for post-graduate training in soil conservation/crop production research. Colombian institutions concerned with natural resource management (e.g., CVC, Corporacion Autonoma Regional del Valle del Cauca) will actively collaborate in the "on-farm" technology testing and evaluation. Local farmers' communities will participate in the process of "technology-testing" in relation to their short-term (food production and income generation) and long-term (natural resources conservation and improvement) interests.

Figure 1. Work Breakdown Structure of Project

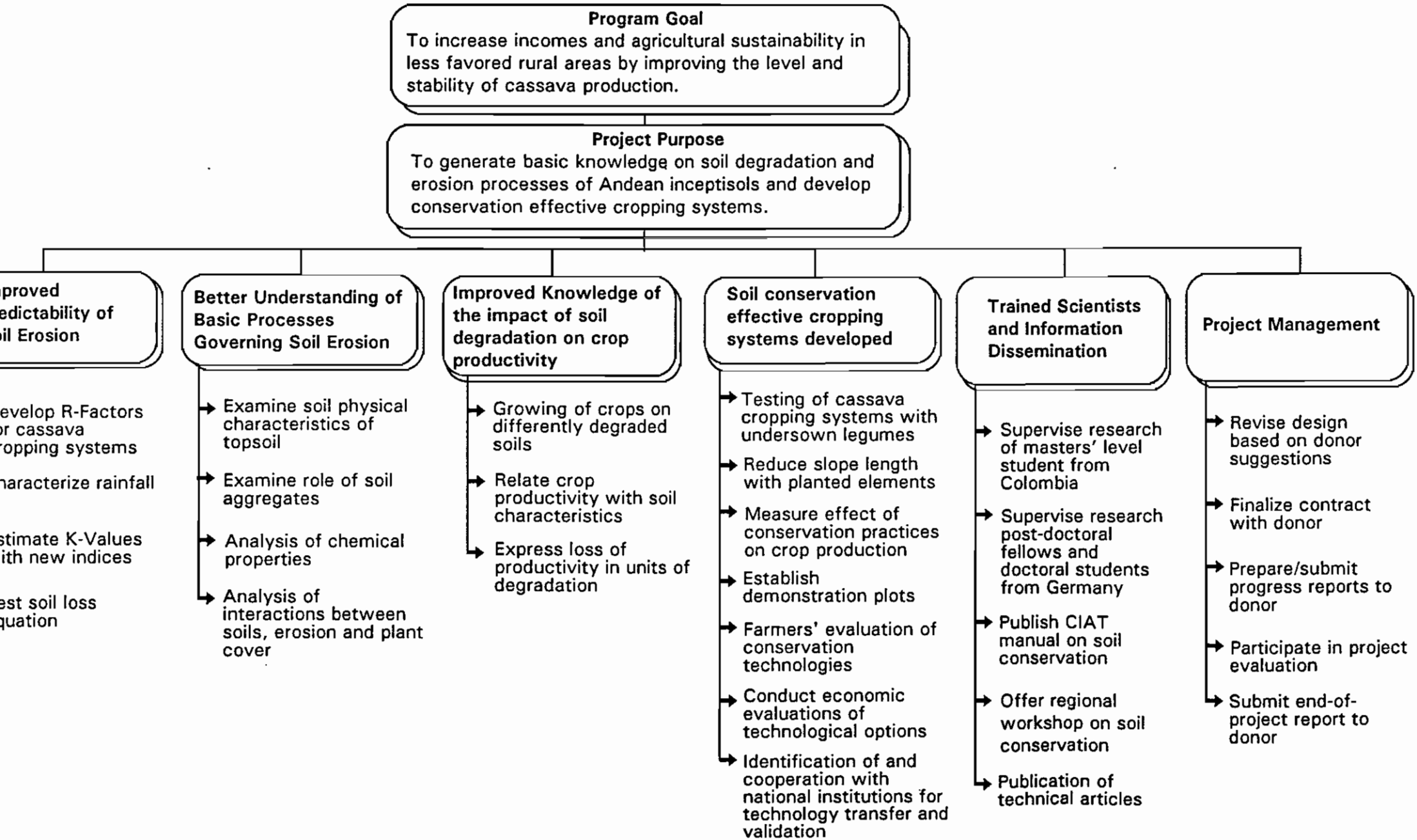
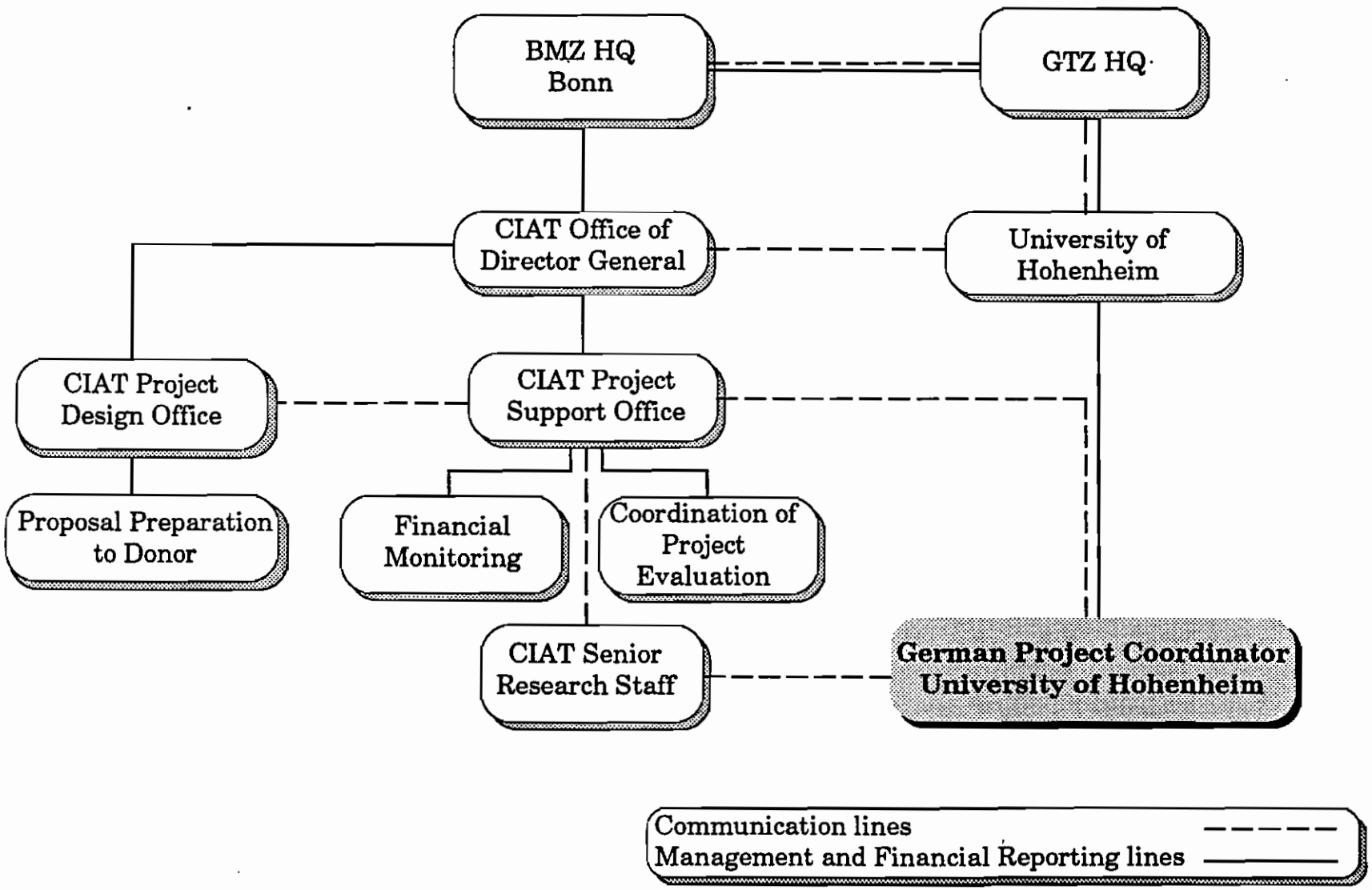


Figure 2. Project Organization Chart



The methodologies and specific "on-station" and "on-farm" research activities to be implemented and conducted during the three years duration are outlined in more detail as follows:

4.1. Basic Processes Governing Soil Erosion

Rainfall and soil data will be collected to improve soil predictability by the use of USLE

The research program under this topic aims at improving the predictability of soil erosion by the universal soil loss equation and to detect physical and chemical changes in soils as a result of soil erosion and cropping systems on a long term basis, considering mainly factors such as:

4.1.1. Rainfall

To fulfill the above objective and specifically improve the precision of the R-factor determination, it is necessary to:

- Continue to record rainfall intensity
- Measure rain drop sizes (D50)
- Generate a relationship between rainfall intensity, drop size and kinetic energy of the rainfall
- Characterize splash processes by splash cup measurements.

4.1.2. Soil

- A continued record of quantity of soil loss is necessary
- Analysis of chemical properties of top soil in all plots once a year is required

- Chemical properties of eroded soil have to be determined after every major rainfall event or for every three events in a mixed representative sample

- The physical properties of the soil have to be determined for each plot. Parameters are: aggregate stability (both through Yoder wet sieving method and raindrop impact method), infiltration rate, bulk density, texture (pipette method), water holding capacity, and soil compaction (penetrometer measurements)

- The rate of soil formation of the two trial sites is still unknown. Since a lysimeter is available at Santander de Quilichao, a determination of the rate of soil formation from solution weathering is possible.

4.2 Agronomic Research

For a better understanding of the impact of soil degradation on productivity, research is necessary on:

4.2.1. Soil Erosion and Crop Productivity

Agronomic research will help to determine the impact of soil erosion on productivity

Around the world, there is very few precise data relating crop productivity to certain degrees of soil erosion. With the history of the standard plots (bare fallow) known since 1986 it will now be possible to grow crops on plots where controlled erosion has taken place. This will allow researchers to establish the crop productivity cost of soil erosion and in the end will quantify the environmental cost of soil degradation processes.

Procedure: Crops (cowpea, peanut and later cassava) will be grown on non-eroded, partially eroded and fully eroded (scalped) soils in order to relate crop yields to the amount of soil loss and other soil parameters normally related to soil degradation.

This research under controlled conditions on-station can be complemented by growing the same crops on differently degraded on-farm sites within the same soil series to establish a similar data set (option for a Colombian M.Sc. thesis).

4.2.2. Crop interactions

Agronomic research will also include studies on crop competition in cassava-based intercropping systems

Research under this topic will help to characterize and to quantify competition situations within cassava-legume, cassava-grass or cassava-contourline systems. Among the large number of factors that could be studied, the project will focus on:

- Rooting patterns in cassava/legume systems
- Nutrient competition
- Water competition.

4.3. Development of Soil Conservation Effective Cropping Systems and Their Economic Evaluation

4.3.1. Diversification of cassava monoculture

In this context, the project will seek the improvement of soil cover and also upgrade soil fertility by using under-sown perennial legumes or rotations with annual legumes or legume/grass mixtures as both an additional plant cover and improved soil fertility

would cater to the principle of achieving an earlier and more extensive soil cover which in turn effectively reduces erosion.

Another way to reduce erosion is by reducing slope lengths. This can be achieved by introducing live barriers formed by grasses, grass/legume associations or multi-species strips (Macrocontour-lines).

4.3.2. Macro-contourline - agroforestry research

The project will look into other soil conserving practices which involve trees and shrub species

In the past, the project has looked at this possibility at the request of one of the farmer's groups it works with (feed-back). This research will be systematically followed-up by aiming at the identification of adapted shrubs and tree species on station. Once a selection of species has been made, this will be on-farm tested to find shrub and tree integration possibilities in soil conserving cropping systems.

4.3.3. An economic evaluation of technological options will be carried out parallel to technology development. This will be done by cooperation with the CIAT cassava economy section.

4.4. On-Farm Experimentation with Different Farmers Groups and Institutions (GO's and NGO's)

On-farm research efforts will involve farmers' groups, GOs and NGOs

4.4.1. Phases of on-farm experimentation

The demonstration of technology options will take place in farmers' fields and on farms operated by local institutions by establishing demonstration plots. The work is done by local farmers themselves

and/or by workers of local institutions yet a minimum of inputs, such as seeds or planting material and technical advice is provided by the project. These demonstration plots are used not only to provide technological options for soil conservation but also other available CIAT technology (new varieties, integrated pest control etc.) The evaluation of these technological options by farmers will be assisted by a Colombian social scientist who will use social aspects of technology adoption as a thesis subject.

On-farm research will provide project scientists with key information on adoption of new technologies

This procedure assures an adequate feedback from on-farm work to scientists as well as identifying of possible constraints and new options.

After a validation of adapted technologies through national institutions and farmers' groups is achieved, the transfer of adapted technology to farmers is facilitated.

4.4.2. Farming communities and institutions involved

- Indigenous community, Toribio

The project will work with the indigenous communities in the target area

The communities of Toribio, San Francisco and Tacueyo are located in the north eastern part of Cauca Department in the Central Cordillera at an average altitude of 1750 m. a.s.l. Average temperature is 17 degrees C, average annual precipitation is 1400 mm. The community comprises 250 families of Paez Indian origin.

Besides communal grazing land, individual plots are assigned to families by the autonomous Indian administration (Cabildo) which also decides on other social and organizational matters. Principal

land use systems are grazing, as well as maize, cassava and bean cropping. Recently, opium poppy has been introduced into the area by drug cartels.

These communities will be assisted by a local research management group

The institution through which the project is working with this indigenous community is PPCI (Programa de Produccion de cultivos en Zonas Indígenas), a collaborative project of indigenous and national organizations. Jorge Rubiano, an agronomist, who was conducting his thesis on an agroecological study of the area is now working with CRC (local resource management institution) and supports the project, strengthening the cooperation with indigenous communities.

- *Mestizo communities of Mondomo and Pescador*

Mestizo communities will also cooperate in the project through local collaborating institutions

The area is located on both sides of the Pan-American highway in the northern Cauca Department around the villages of Mondomo and Pescador. The elevation is 1400 to 1600 m.a.s.l., average annual temperature is 18- 19 degrees C and the annual average precipitation is 1700-2100 mm.

These communities are not directly related to the project, but cooperation exists through the collaborating institutions. FUNDAEC (training courses), FEDECAFE (Grupos de Amistad), IPRA (Farmers' groups from the CIAT- Special Project on Participatory Research) have organized farmers, working with various soil conservation technologies, testing and evaluating them on their own criteria.

The average area of the farms is around 3 to 5 hectares. Extensive grazing, the cultivation of cassava, beans, plantains and some coffee growing

are the dominant forms of land use on predominantly steep hillsides. The region is characterized by a high and constant cassava demand from the local small scale starch processing industries.

- *Black community of Buenos Aires / Cauca.*

The project will work with a small black community in the target area to help to change their environment-degrading cultural practices

The contacts to this community had been established by INCORA (Instituto Colombiano de la Reforma Agraria) in Santander de Quilichao, which bought the land (around 150 hectares) from the former land owner, after members of the community had occupied the land. The community is now working about three years on the farm and, as in Toribio, part of the land is assigned to individual families (9), while other parts are considered communal land.

The largest part of the farm consists of land with steep slopes (20-40%) and some hectares are of flat land along the riverbank with irrigation facilities. (1000 m.a.s.l., acid soils, approx. 1000 mm of annual precipitation). Parts of the farm (including complete micro watersheds) are degraded hillsides. Other parts had been cleared off from forest by the new owners, producing charcoal and planting cassava subsequently. The actual land use can be characterized as a productive exploitation agriculture with no inputs but high environmental costs. Collaboration with the group, trying to change their land use practices, started in September 1991.

Collaborating institutions:

CVC (Corporación Autónoma Regional del Valle del Cauca)

CVC will play an important role in the project due to its relevant infrastructure and influence in the region

CVC is a regional, governmental organization responsible for the management of natural resources (mainly soils and water) in the upper Cauca Valley, including the watersheds of the affluents. CVC creates and provides information in areas of mapping of actual and potential land use and soil maps. Work is also done in the area of rural education and technical assistance on natural resources management and conservation.

A formal agreement has been established with CVC in 1992 to test, multiply and validate soil conservation technology, developed by the project, in different watersheds. One professional of the institution was appointed to develop these activities in cooperation with the project. He is supported by a monthly operating fund of 500-1000 U.S. dollars, paid by the project.

Cooperation with CVC is given priority because of its infrastructure, official mandate and its influence on regional environmental policies.

CETEC (Corporación para Estudios Interdisciplinarios y Asesoría Técnica)

CETEC, a NGO, will conduct field trials involving different cassava cropping systems

CETEC is a non-governmental organization working with rural communities in the northern Cauca Department. Development of small scale, rural, cassava-based industries and of ecologically sound, sustainable farming systems, based on the use of local resources are the main objectives. Studies about the efficiency of new technologies, support of farmers with credits, technical assistance and field days on specific topics form part of their program.

Actually, CETEC cooperates with the project in conducting a field trial on erosion measurement plots with different cassava cropping systems. The trial was set up by the project on farmers' fields in San Antonio/ Cauca.

CETEC is also testing cover legumes and other materials from CIAT on their "Green Farm" in San Antonio. Cooperation with CETEC is informal but so far very uncomplicated and efficient. Working very close to the farmers offers a good perspective for continued testing and transfer of technology.

FUNDAEC (Fundación para la Aplicación y Enseñanza de las Ciencias)

FUNDAEC, a NGO, cooperates with the project in the development of sustainable land use systems

FUNDAEC is a private foundation working throughout Colombia in rural education and development. FUNDAEC gives credits to farmers, participating in specific training courses, as for example, cassava production. Elaborating of extension leaflets and other teaching materials also forms part of their programme.

The NGO is cooperating with the project in the development of sustainable land use systems and taking part in the formal agreement with CVC. Cooperation started in April 1992 and actually Fundaec has set up trials with improved cassava cropping systems and the adoption of soil cover/ forage legumes in Mondomo and Pescador.

FEDECAFE will cooperate with the project in the establishment of new coffee plantations on less eroded sites

FEDECAFE (Federación Nacional de Cafeteros de Colombia)

FEDECAFE is the National, semi-official organization of the Colombian coffee growers working in technical assistance, credit, health, rural

infrastructure, housing and in programs oriented towards diversification of production and the improvement of food security.

FEDECAFE (Regional Office of Santander de Quilichao) is cooperating with the project to find ways to establish new coffee plantations on hillsides with less erosion by integrating live barriers and legumes and also including food crops like plantains, beans and cassava in the initial stage of development. Combining profitability with sustainability is the main objective of the collaborative trials, starting on three sites in September 1992.

INCORA , a GO, is a key collaborator which maintains contacts with farmers' groups in the target area

INCORA (Instituto Colombiano de la Reforma Agraria)

INCORA, the national land reform institution maintains contacts to farmers' groups who received land from the institution through a minimum input in technical and administrative assistance. The farmers' group in Buenos Aires was identified with the help of INCORA and there exists still some contact, concerning the development of this farmers community.

5.0 Training and Dissemination of Information

Colombian and German scientists will be trained throughout the period of the project in the areas of soil conservation

5.1. Training of Colombian Scientists

- Master Thesis (on-going)

  Erodibility (K-factor) of soils in Southern Colombia

- Master Thesis (planned)

  Soil degradation of Andean inceptisols and its relation to crop productivity

- Graduate thesis (on-going)

  Socio-cultural background of soil degradation in the Cauca Department of Colombia around the Salvajina Dam

- Graduate thesis (planned)

  Farmers' evaluation of soil conservation technologies (Rural Sociology)

5.2. Training of German Scientists

- Post-doctoral Training (on-going)

  The long-term engagement by the German post-doctoral fellow will allow him to gain broad-based experience and collect and publish scientific data in resource management, specifically soil conservation research. This will enable him to seek an international scientist position, e.g., within the CGIAR system or to pursue further academic qualifications with a German University (Habilitation).

- Doctoral Thesis (on-going)

  The integration of perennial legumes as soil cover and soil improvement to reduce soil erosion in Andean hillsides

- Doctoral Thesis (on-going)

  To be elaborated on an adjustment of the R-factor to rainfall conditions on Andean hillsides

- Diploma Thesis (on-going)

  Rooting patterns and root interaction in cassava/ grass barrier systems

- Diploma Thesis (planned)

  Competitive effect of soil covering perennial legumes in cassava-based cropping systems.

5.3. Publications and workshops

Outputs will include a publication and a regional workshop

Besides these individual training programs, a CIAT manual on soil conservation in cassava- based cropping systems is planned.

Furthermore, a regional workshop on soil conservation in smallholder hillside farming of Southern Colombia will be organized during the last year of the second project phase (1995).

6.0 Expected Patentable Research Results

CIAT and the collaborating German Institutions: Institute for Plant Production in the Tropics and Subtropics-University of Hohenheim, Stuttgart, FRG, support and abide by the concept of complete access to research results.

The information generated by the project will be made available to all target groups

All generated information and viable technologies achieved by the project will be disseminated and made available to target groups without restriction. In this kind of project, none of the expected outputs would be patentable.

7.0 Budget

Table 1
Proposed Budget 1993 - 1995 (CIAT Component)
(in current US dollars)

Line Item	1993	1994	1995	Total
1. Personnel (*)				
Grad. research Assistant	14,800	15,540	16,300	46,640
Field Technician	9,100	9,555	10,000	28,655
Field Labourers (4)	22,800	23,940	25,140	71,880
Short-Term Consultant	2,500	2,625	2,760	7,885
Secretary (1/2)	5,200	5,540	5,800	16,540
Total Component	54,400	57,200	60,000	171,600
2. Travel				
Local	3,500	3,500	3,000	10,000
International	4,000	4,000	3,000	11,000
Total Travel	7,500	7,500	6,000	21,000
3. Research and Operations				
Supplies and Services	20,000	15,000	10,000	45,000
Laboratory Analysis	13,000	13,000	10,000	36,000
Vehicle Maintenance	3,000	4,000	6,000	13,000
Total Research & Operations	36,000	32,000	26,000	94,000
4. Training and Inter-institutional Cooperation				
Training Res. Assist. & Collaborators Inst.	1,500	1,500	1,000	4,000
Operational Costs CVC-Cooperation	12,000	12,000	6,000	30,000
Cooperative Funds for on-farm Res. Activities	3,600	3,600	3,600	10,800
Total Training and Cooperation	17,100	17,100	10,600	44,800
5. Project management (20%)	22,400	21,960	19,320	63,680
6. Capital				
Supplemental Equipment	2,000			2,000
Grand Total/BMZ Requested Amount for CIAT	139,400	135,760	121,920	397,080

Note: The budget totalling US $ 398,896 for the duration of the project presents estimates of costs to be incurred at CIAT. It is CIAT's understanding that the funds for the personnel budget for the German scientists from the University of Hohenheim will be budgeted under a separate request.

(*) Assumes annual inflation rate of (5%) which is included

Signature

Financial Controller

CIAT

APPENDIX A

CHRONOGRAM OF PROJECT ACTIVITIES BY QUARTER