ENVIRONMENTAL ASSESSMENT (EA) - CASSAVA PROJECT

ALTERNATIVE DEVELOPMENT AND INTEGRATION PROJECT FOR THE PRODUCTIVE CHAIN OF CASSAVA CULTIVATION – DEPARTMENT OF CAUCA, COLOMBIA

C. Ayerbe

Contract Number 527-C-00-01-00091-00
Colombia Alternative Development Project

Chemonics International Inc.
1133 20th Street, NW
Washington, DC 20036
Telephone (202) 955-3300
Fax: (202) 955-7540

November 13, 2003

CONTRACT No CAD-CT-028-04-6
CHEMONICS INTERNATIONAL INC. –ESTUDIOS Y ASESORIAS

ENVIRONMENTAL ASSESSMENT (EA) - CASSAVA PROJECT

ALTERNATIVE DEVELOPMENT AND INTEGRATION PROJECT FOR THE PRODUCTIVE CHAIN OF CASSAVA CULTIVATION – DEPARTMENT OF CAUCA, COLOMBIA

FINAL REPORT

BOGOTÁ D. C., NOVEMBER 13, 2003

TABLE OF CONTENTS

SECTION 1 SUMMARY **6**

1.1 PROJECT LOCATION 6
1.2 PROJECT ACTIVITIES 6
1.3 ENVIRONMENTAL DESCRIPTION 7
1.3.1 Project Area of Influence 7
1.3.2 Geology and Geomorphology 7
1.3.3 Climate 8
1.3.4 Hydrology 8
1.3.5 Water Quality 8
1.3.6 Soil 8
1.3.7 Biotic Characteristics 8
1.3.8 Regional Economic Activities 9
1.3.9 Social Aspects 9
1.3.10 Social Conflicts 10
1.4 IDENTIFICATION of environmental IMPACTS 10
1.4.1 Methodology 10
1.4.2 Results 10
1.4.3 Indirect Impacts – Project Regional Area of Influence 11
1.4.4 Direct Impacts - Project's Area of Influence 12
1.5 environmental Assessment 12
1.5.1 Methodology 12
1.5.2 Results 12
1.6 ENVIRONMENTAL MANAGEMENT PLAN 13
1.7 ENVIRONMENTAL MONITORING AND Follow up PLAN 13
1.8 BUDGET 14
1.9 ANALYSIS of project ALTERNATIVES 14
1.9.1 Methodology 14
1.9.2 Method For Calculation 16

SECTION 2 PURPOSE AND METHODOLOGY **18**

2.1 PURPOSE 18
2.2 METHODOLOGY 18

SECTION 3 ALTERNATIVES INCLUDING THE PROPOSED ACTION **20**

3.1 INTRODUCTION 20
3.2 methodology 20
3.3 Alternative 1 20
3.4 ALTERNATIVE 2 OR NO ACTION ALTERNATIVE 20
3.5 Method for calculation 24
3.6 FINAL results 25

SECTION 4 AFFECTED ENVIRONMENT **26**

4.1 iDENTIFICATION OF ENviRONMENTAL IMPACTS 26
4.1.1 Overview 26
4.1.2 Methodology 26

4.1.3 Impact Identification Matrix 27
4.2 PRESENT ENVIRONMENTAL DESCRIPTION 29
4.2.1 Direct Area of Influence 29
4.3 environmental components 30
4.3.1 Abiotic Component 30
4.3.2 Biotic Components 32
4.3.3 Important Ecosystems 35
4.4 Social Component 36
4.4.1 Indirect Area of Influence or Regional Context 36
4.4.2 Analysis 36
4.5 direct area of influence of the project 38
4.6 PESTICIDE EVALUATION REPORT AND SAFER USE ACTION PLAN, PERSUAP. PESTS AND PESTICIDE PROBLEMS IN CASSAVA CROP. 44
4.6.1. Introduction 44
4.6.2 The Colombia Alternative Development (Cad) Program 44
4.6.3 Spread of Insect Pests and Diseases 45
4.7 Pesticide use today 45
4.8 Pesticide evaluation 46
4.9 Safer use practices 47
4.10 Pest management approaches 47
4.11 CAD Environmental Compliance 50
4.12 PERSUAP 50
4.13 Status of Registration of Pesticides in Colombia and with US-EPA: 22 CFR 216.3 (b)(1)(i)(a) 50
4.14 Basis for Selecting Pesticides: 22 CFR 216.3 (b)(1)(i)(b) 52
4.15 Pesticides in the Context of Integrated Pest Management Programs: 22 CFR 216.3 (b)(1)(i)(c) 53
4.16 Method of Application: 22 CFR 216.3 (b)(1)(i)(d) 53
4.17 Possible toxicological hazards to humans or to the environment: 22 CFR 216.3 (b)(1)(i)(e) 54
4.18 Effectiveness of Pesticides: 22 CFR 216.3 (b)(1)(i)(f) 54
4.19 Compatibility of Pesticides with Target and non-target Organisms: 22 CFR 216.3 (b)(1)(i)(g) 55
4.20 Prevailing Conditions in Areas Subject to Use of Pesticides : 22 CFR 216.3 (b)(1)(i)(h) 55
4.21 Availability and effectiveness of other pesticides and of non-chemical Controls: 22 CFR 216.3 (b)(1)(i)(i) 55
4.22 Capability of Colombian institutions to regulate and control pesticide use: 22 CFR 216.3 (b)(1)(i)(j) 56
4.23 Provisions for Training in SUP and IPM: 22 CFR 216.3 (b)(1)(i)(k) 58
4.24 Effective Monitoring and Pesticide Use: 22 CFR 216.3 (b)(1)(I) 59
(l) 59
4.25 Environmental Compliance 60
4.25.1 Monitoring 60
4.25.2 Long-term sustainability 62
4.26 Training and Best Agricultural Practices Plan (BPA). Recommendations in the Pesticide Evaluation Report and Safe Use Action Plan PERSUAP 63

4.27 Training Plan, Objectives 64
Toxaphene 79

SECTION 5 ENVIRONMENTAL CONSEQUENCES 80

5.1 environmental Assessment MATRIx 80
5.2 Biotic medium 81
5.3 Physical medium 81
5.4 SOCIOECONOMIC medium 83
5.5 ENVIRONMENTAL MANAGEMENT PLAN 85
5.5.1 Overview 85
5.5.2 Methodology 85
5.5.3 Results 86
5.5.4 General Budget 87
5.5.5 Time Schedule (Chronogram) 87
5.6 ENVIRONMENTAL MONITORING AND Follow up PLAN 88
5.6.1 Overview 88
5.6.2 General Objective 88
5.6.3 Specific Objectives 88
5.6.4 Summary of Activities 89

SECTION 6 LIST OF PREPARERS 90

SECTION 7 APPENDIX 91

SECTION 1 SUMMARY

Among the different operational aspects of this project is the Preservation and Improvement of Natural Resources and the Environment. To fulfill this goal, USAID and the Government of Colombia are looking to implement ways for crop substitution programs to cause minimal impacts on the Environment.

Chemonics Colombia hired ESTUDIOS Y ASESORIAS, Consulting Engineers Ltd. of Bogotá, to prepare an environmental assessment of the "Project for development of the productive chain of Cassava crops" in the municipalities of Santander the Quilichao, Caloto, Corinto and Miranda in the department the Cauca, as well a verification of project compliance with USAID and GOC environmental requirements..

The main objective of this study is to analyze the physical, biotic and socioeconomic aspects in the area of influence of Cassava plantations for the purpose of identifying and evaluating the impact of the implementation and operation of the project. The study will establish the relevant environmental monitoring and management measures that will guarantee sustainable development of the project, both during the development phase and upon termination of activities. The objective of the Study include providing people in charge of decision making with a complete exposition of the consequences of the implementation and management of the productive characteristics of Cassava plantations and their repercussions on the environment.

1.1 PROJECT LOCATION

The project is located in the northeast of the department of Cauca, in the border with the department of Valle. Cassava plantations are located in disperse parcels in 22 rural sectors or "Veredas" in the municipalities of Miranda, Corinto, Caloto and Santander de Quilichao. According to the information supplied by Plante, the GOC project implementing agency, 130 ha of Cassava were planted in 2002, in addition to 177 ha planted in 2001. At the time of the visit to the project sites carried out by the consultants, 150 ha had been harvested. Cassava plantations belong to small farmers, planting area averages about 1.0 ha or less. Farmers have very few resources of their own to invest in the cultivation process, other than manual labor. Two different farming systems are being used by project beneficiaries depending on soil topography: one for flat zones and another for sloping and hillside zones; the latter is difficult due to hard terrain characteristics

1.2 PROJECT ACTIVITIES

Cassava crop activities include: soil preparation, lime applications to control soil acidity, planting, fertilization, plague and weed control, (manual and chemical), harvesting and

post-harvest activities, (collection and transport of product to staging areas and markets). Production costs in flat zones are about CP$1,478,000/ha, while in the hillside zones the cost is CP$1,287,000/ha.

The main problems encountered in Cassava cultivation in flat zones are related to soil preparation: furrows are either too low and/or extra raking is necessary, permanent access of domestic animals to the plantation, different mixture of seeds, out of season planting, loss of crops due to root rotting and white fly infestation. Cassava plants in hillside zones showed stress symptoms, probably due to lack of water and/or nutrient deficiency; plants growth was below average; thin stems and yellowish lower leaves; raw soil exposed to erosion and runoffs favored by sloping topography, rain, wind and lack of proper plan covering.

Cassava root processing begins in semi-industrial "*Rallanderías*" or Shredding Plants begin with reception of the roots, followed by washing and skinning; the root is ultimately shredded, and the shredded paste is passed through sieves to retain and collect a sub-product called "*afrecho*". A secondary shredding process is performed next, followed by sedimentation, and transportation of sludge material to the fermentation tanks where it remains for 20 to 30 days. Finally, the product is dried, strained, mashed, and packaged. The product is then taken to industrial starch plants to be washed, further shredded, milled, passed through a centrifuge, pre-dried, vacuum filtered to separate waste, dried and packaged for marketing.

1.3 ENVIRONMENTAL DESCRIPTION

1.3.1 Project Area of Influence

The project is located in the northeastern part of the department of Cauca, and the southeastern zone of the department of Valle del Cauca, have been considered as the project area of influence. However, given the regional nature of the project, the area of influence could be much larger as it encompasses most of the agricultural systems of the entire zone. The direct area of influence is localized in the northern part of the department of Cauca, in the municipalities of Miranda, (specifically the Candaima, Santa Ana and San José *veredas*), Corinto, (including the Corinto Indian reservation), Caloto, (including the Toez Indian reservation), and Santander de Quilichao, (v*ereda* La Arrobleda). All project *veredas* present similar physical and natural environment characteristics.

1.3.2 Geology and Geomorphology

The geology of the northeastern region of the department of Cauca is characterized for dense layers of piroclastic materials, especially volcanic ash, generally covering metamorphic or sedimentary rocks. These rocks are mostly limolitic, sand stones, and conglomerates; porfiritic rocks of intermediate composition with variations of dacite, andecite, and volcanic rocks of the fluvial types as well as lake, alluvial and colluvial

deposits of recent dating. In the geomorphologic aspect, project municipalities feature similar natural spaces, preserved by litology, tectonism and denudative agents.

1.3.3 Climate

The region displays a tropical, humid climate, with average annual temperatures ranging between 24°C in the low lands, (800 m to 1,000 m above sea level, *asl*), and 18°C in the highlands, (1,000 m - 1,500m asl), which causes relative average humidity between 60 and 70%. Precipitation is bimodal, with two humid periods extending from March-May and October-December, separated by dry periods. Average annual precipitation is 1,701 mm.

1.3.4 Hydrology

The municipalities involved in the agricultural project are localized within the Cauca river watershed, and are irrigated by the Guengue, Desbaratado, La Paila, Jagua, Chiquito and Quinamayó rivers, and the Seca, La Bodega y La Quebrada streams. All these currents, within the cultivation area, have slopes below 10% and very low levels during the dry season. They display shallow drainage with mildly sloped valleys. The majority of the rivers have been used for water supply in the highlands, while in the plains they have been used for agriculture, cattle herding, and agroindustrial use.

1.3.5 Water Quality

Hydrological analysis show that water quality of streams in the region is very similar, presenting acceptable conditions for agricultural and cattle related use; however, there are some restrictions in regards to water supply, particularly because of microbiological contents. The results of water quality tests of effluents produced in "*Rallanderías*", indicate that contamination generated by the processing plant present serious pollution problems due to discharge of effluents in nearby watersheds.

1.3.6 Soil

For the most part, the soil in area of influence varied from very superficial to moderately deep; organic matter content is scarce; of an acid nature, and low in phosphorus. Morphologically, soils present a varied topography, from flat to undulating and cracked terrains.

1.3.7 Biotic Characteristics

Within the direct area of influence of the project, Consultants found four life zones, corresponding to the Dry Tropical Forest, (bs-T), Humid pre-mountainous Forest, (bh-PM), Very humid Premontainous Forest, (bmh-PM), and Very humid Premontainous low Forest, (bmh-MB). In accordance to the life zones found in the direct area of influence of the project, habitats for various vegetative species for human use were found, such as

leguminous, food producing, ornamental, and fruit bearing, all of which are characteristic of the tropical dry forest, (bs-T)..

Fauna found in the area of influence of the study is still high. Mammal species found include armadillo, cusumbo, sloth, musaraña, bats, maicero monkeys, tutamonos, coatis, fox, opossum, wild pig, deer, rabbit and squirrel. The bird fauna is also varied, including species such as blue birds, eagles, buchipecoso, woodpeckers, tángaras, cernícalos, cucaracheros, gallineros, pavas and hawks, among others.

Amphibian fauna shows frogs, toads and salamanders; reptiles include coral, patacona and rabo de ají snakes. The endangered indigenous fauna includes guaguas, tigrillos, armadillo, deer, iguanas and some serpents.

1.3.8 Regional Economic Activities

The main economic activity of the project zone is agriculture. This activity is located in the plains near the Cauca river, predominantly in sugar cane plantations, the agro-industrial complex of INCAUCA being the largest sugar mill operation in the region. In hillside areas, where the majority of peasant farmers concentrate; small and medium bean, corn, Cassava, tree tomatoes, vegetables and fruit plantations are predominant. Coca and poppy plantations are found at higher elevations. Cattle is also an important economic resource, albeit of a lesser intensity than agriculture. Peasants rise cattle for milk and also for meat.

1.3.9 Social Aspects

Three ethnic groups live in project area of influence. The black population, located in the Santander de Quilichao area, numbered 33,983 inhabitants in 1999, (41.6%). The Paez Indians accounted for 8,094 inhabitants, (9.9%), located in the Corinto and Caloto municipalities. The “mestizo” population amounted to 39.628 inhabitants, (48.5%), mainly in the Miranda municipality.

According to the information available, (polls conducted by PLANTE), the nuclear family aspects, constituted by age, sex, education, health, public utilities and communal organization of the project population, present the following general profile : The majority of the population is male, with the exception of Santander de Quilichao´s black population; where 15-years old or younger individuals are about 25% of the consulted group; the working age population, (up to 55-years old), represents 52% of total, and 56-years old and above, correspond to 16%. The population involved in the project has access to primary education, with some limitations -kinder garden and secondary education-. There is adequate health coverage for the population in economic strata I and II; the quality of sewerage, telephone and housing services, is mediocre, specially in the rural areas.

1.3.10 Social Conflicts

In Cassava plantations, the main pressure is caused on soil, due to use of chemicals and erosion, due to deforestation and anthropic intervention. Water resources are also affected by cutting down trees for firewood, and inadequate management of domestic waste. In flat areas, the pressure is on subterranean waters due to high volumes required by sugar cane plantations.

In the black community, resolution of conflicts is carried out in a normal manner, through the intervention of older people that serve as mediators. For resolution of greater conflicts the population calls upon the civil legislation at the municipal level. In the Indian community, the Cabildos and the governor of the reservation are the maximum authorities and are responsible for compliance with cabildo's rules and legislation.

In "mestizo" population in the municipality of Miranda, the coexistence rules are established by minor courts, which implies the dialogue among parties towards agreed-to problem solution. If this is not possible, the existent legislature for civilian conflicts is applied.

An important conflict in the area is the pressure of proprietors of sugar cane operations to acquire more land during high demand seasons, since such plantations require larger land extensions. Another conflict, which doesn't involve hillside and highland farmers, is the pressure from armed groups and illicit drug dealers that maintain control over the coca and poppy plantations, and government policies regarding illicit crop spraying in the zone.

1.4 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

1.4.1 Methodology

The methodology followed for purposes of identifying environmental impact is based on a matrix (the Leopold Matrix), which identifies altered environmental factors and relates them to every phase of project activity, within an overall graded impact identification matrix for the productive project. The impact could be adverse when the project activity alters the natural resource negatively, or positive, if it impact is favorable to the environmental resource.

1.4.2 Results

In regards to farming phases, soil preparation and cleaning have the greatest negative values, i.e., the highest potential for environmental impacts. Application of chemicals for plague, disease and weed control activities, are the most significant menace to the environment.

In the farming phase of the project some activities present positive results like, seeding, fertilization, crop collection and transportation, and post-harvest management activities.

In the semi-industrial processing phases, the most adverse activity is management of effluents, followed by the disposal of solid industrial waste, including sub-product management like "mancha", "afrecho", and cleaning processes. These byproducts are biological remnants from cleaning and squeezing of Cassava roots, before it is powdered., They have a high potential for harming the environment if not carefully dealt with and properly treated. Mitigation measures to control negative impacts are presented below.

When reviewing the evaluation matrix horizontally, it is possible to determine that the heaviest impact on soil comes from inadequate management of solid waste, followed by potential landslides in sloping terrain, along with water-caused erosion, soil compaction, soil contamination caused by chemicals, residual effects of insecticides and herbicides, all these cause potential harm on the agrological capacity of the soil.

The greatest impact over water resources, is the inadequate management of solid waste in the cultivation and productive phases is inadequate control and treatment of surplus water and runoff. The impact on air is of a lesser nature, as indicated by minimal solid and gaseous emissions and particle interaction; the biggest problem is caused by particles released during cultivation and processing activities, followed by pollution from burnings and terrain cleaning.

As far as the biotic medium is concerned, the most negative interaction deals with changes in the natural landscape, not too serious since the land has traditionally been used for agricultural purposes; possible affectations to endemic and endangered species may be caused by indiscriminate and uncontrolled use of pesticides. This subject is examined in detail in the PERSUAP presented in Section 4. The rest of the impacts, compared with the impacts on the physical medium, are minor.

In the socioeconomic medium, the interactions reflect the beneficial character of the project, since most of the balances yield positive values. The most significant of them is employment generation, income increase and dietary improvement, participative coexistence and the follow up and control systems that will come with the project.

Detailed analysis of potential environmental impacts in the abiotic, biotic and social spheres is further expanded in greater detail in the following chapters, tables and charts, presented both in Spanish and in English. The mitigation measures are also detailed in chapters below, with text and summarizing charts.

1.4.3 Indirect Impacts – Project Regional Area of Influence

The Project does not and will not present indirect impacts upon the regional area of influence, since no major use of pesticides is expected meaning that migration of particles to other regions will not occur. Also limited uses of water means localized impacts. No roads or infrastructure will be built that would potentially produce regional impacts, and no farming or processing impacts could possibly reach over the Andes or stretch beyond the

direct area of influence of the project.

1.4.4 Direct Impacts - Project's Area of Influence

The direct impacts are discussed in the following chapters, according to abiotic, biotic or social characterization so determined. A good deal of the potentially negative impacts are related to the biotic environment, whilst the abiotic and social impacts are positive. Detailed analysis and evaluation follows.

1.5 ENVIRONMENTAL ASSESSMENT

1.5.1 Methodology

The Environmental Assessment comprises main project activities, as related to major ecological and environmental conditions of the northeastern region of the Department of Cauca, including geographical location, landscape and geology, climate, hydrographic characteristics, social infrastructure, productivity, and land aptitude. The values related to quality and quantity magnitudes are established using environmental quality parameters, related to one another through an environmental qualification indicator (EC).

1.5.2 Results

The results of the environmental assessment's diagnosis and evaluation of potential impacts, are presented in full-length in the text, as a correlation of all the potential affectations that may result from the interaction of each one of the phases of the project, namely: plant nurseries, Cassava farming and product processing, including related environmental components (abiotic, biotic and social). A matrix displaying these realms versus the potential impact is presented below, indicated in each cell of the matrix, a reference to whether or not an impact may occur, that will later have a qualified number associated to the dimension and possibility of occurrence. A synopsis of results of these numerical assessments is presented below.

The resource that present the most potentially adverse environmental alterations is soil, related primarily to the use of agrochemical products, which alter the physical and chemical quality of the soil, producing contamination, and creating residual effects. In descending order, the next adverse effect occurs on water; the activity that compromises the water quality is the physical and chemical contamination generated by Cassava processing, (processing plants), tilling of soil produces sediments that may reach natural water bodies.

The most adverse effects on flora are potential changes in the edaphic community due to use of pesticides. The most adverse effect on air, is the generation of particles due to volatile chemicals or the tilling of the soil during field preparation, and perhaps the increase in noise in the processing phase.

The beneficial impact caused by the project is concentrated in the social environment, where most of the positive qualifying ratings were found. Averaging the negative and positive ratings, it is found that the overall environmental result of the project is beneficial, albeit of low incidence.

Table 1. Summary Environmental Assessment Ratings

AFFECTED ENVIRONMENTAL RESOURCE	PRESENT CONDITION	ALTERNATIVE WITH EMP	ALTERNATIVE WITHOUT EMP
Soil	-4.0	-0.5	-8.1
Water	-3.0	0.1	-6.5
Air	-1.0	1.8	-3.8
Flora	-2.2	0.0	-5.1
Fauna	-0.7	1.2	-3.6
Social	3.3	6.6	-0.2

1.6 ENVIRONMENTAL MANAGEMENT PLAN

The environmental management recommendations that should be kept in mind in Cassava farming, are preventive (to avoid the impact occurrence); corrective, (recommendation of measures that will modify the action produced by the impact and to prevent future occurrence); mitigation or amelioration of the impact, or compensation when the impact is impossible to prevent, correct or mitigate.

The measures established within the environmental management plan to be executed as part of implementation of the Cassava Cultivation and Processing Productive Project, according to the results of the present analysis include: 1) Soil Management: cultural practices of crops, agronomic practices, pesticide and weed control and management, organic and biological agricultural practices, and erosion control; 2) Water Resources Management: water quality control, water control in industrial processes, solid waste disposal, air management and control, and clean technologies for soil preparation; 3) Flora and Fauna Management plant covering management by floristic compensation, fauna migration control, generation of live fences and plantation of plant covering, ecosystem protection and conservation of native ecosystems; 4) Social Management: strengthening of the sense of belonging, environmental education and industrial safety.

1.7 ENVIRONMENTAL MONITORING AND FOLLOW UP PLAN

The environmental monitoring and follow up plan -PSM- is a part of the environmental management plan, (EMP), and constitutes a program activity tool, including impact identification to allow verification, vigilance and evaluation of the actions and activities of the project before, after and during its execution.
The Plan will establish in a detailed manner the indicators and places where monitoring should take place, as well as methodologies recommended in particular for sampling and

verification, including periodicity of sampling, duration, type of analysis, forms of evaluation, costs and financing of the activities. The PSM will include recommendations regarding the form for presenting periodic reports, with argumentation of the periodicity of reporting, and will establish the extent of advances on the following aspects:

- Physical and Chemical Monitoring on Intervened Water Bodies
- Reforestation and Erosion Control programs
- Biological Control programs
- Solid Residue Management programs
- Social Welfare Management programs

1.8 BUDGET

The general budget for the execution of the activities of the Environmental Management Plan, (EMP), is COL$ 707,779,410. The costs include administrative costs, particularly personnel needed to execute and supervise the activities, during three productive cycles.

1.9 ANALYSIS OF PROJECT ALTERNATIVES

As a complement to the evaluation phase of the agricultural project, it is convenient to establish the behavior of the environment into the future, in order to be able to judge its sustainability in time. For this purpose, two alternatives were analyzed to evaluate the character, magnitude and time within which alterations are caused over each one of the environmental elements, considering or not the implementation of the EMP for the productive project. This is an Alternatives Analysis for the continuing realization of the Project, or the option on No Action at all, whereby the project would not be developed. The present chapter deals with the evaluation of performance of the natural resources during the execution of the project with and without the implementation of the measures of the EMP.

1.9.1 Methodology

The same method used in the matrix evaluation was used in preparing the Environmental Assessment of the project, in order to simulate the behavior of impacts identified during the activities of the project, under two different Alternatives Analysis which are described below.

Alternative 1 : This alternative considers the behavior of environmental resources if the productive project is implemented with measures established in the EMP, as indicated in chapter 6.

Alternative 2 or No Action Alternative : This alternative considers future behavior of resources, if the project continues to develop under the same conditions prevailing today, where social objectives and specific environmental measures to ensure project sustainability are not taken.

Once the basic alternatives are known and reviewed, it is possible to project them into a scale to allow for evaluation of objective determination. These parameters are:

- Character: Positive, (Beneficial), or Negative, (Adverse), according to the type of consequences that can be derived in absence of the measure.
- Incidence: It is related to the way in which an action of the EMP realized or not, acts over the resource through the identified impact. It has been valued as High, Medium, or Low.
- Duration: It relates to the time between the application or no application of the measure, and the moment in which the effects can appear on the resource be them adverse or beneficial. This parameter has been valued for three types of periods: Long term, (if greater than three years), Medium term, (if it is between 1 and 3 years), and Low term, (if it is below 1 year).
- Scope: Determines if the action concerns the direct area of the project, (Local), or if it encompasses a larger or regional space, (regional).

The subjective scale defined for purposes of grading criteria is shown below.

Table 2. Scale for quantifying the conditions of the different Alternatives Analysis analyzed

CRITERIA FOR CLASSIFICATION	QUALITATIVE VALUATION	QUANTITATIVE VALUATION
Character of Impact	Positive	+
	Negative	-
Incidence	High	3.0
	Medium	2.0
	Low	1.0
Duration	Short	1.5
	Medium	1.0
	Large	0.5
Scope	Local	0.40
	Extensive	0.60

The definition of criteria was made jointly with the specialists participating in the study at joint meetings, to establish the scales for evaluation of future conditions of the project according to the different environmental resources affected in each of the Alternative's Analysis described. For each alternative, the Assessment results from the addition of the qualifications of the different impacts, to obtain the corresponding measurement of environmental quality, (EC), as follows:

$$EC = I + P + A \qquad \textbf{(1)}$$

Once the EC values are calculated for each alternative, the value of EC to the future is computed by adding these qualifications with those obtained for the present condition of the project, (figure 5.1), as indicated by equations (2) and (3). In order to establish the relation between values of Environmental Qualification, "EC", and Environmental Alteration levels, (EA), the same range of values of EA, which can be related both for positive and negative impacts by entering the amounts of EC as absolute values.

$$EC_{future} = EC_{present} + EC_{with\ EMP} \qquad (2)$$

$$EC_{future} = EC_{present} + EC_{without\ EMP} \qquad (3)$$

1.9.2 Method For Calculation

The addition according to equation (1) applied to the impact of Soil Contamination due to Agrochemicals, (5) Production of Sediments to Water Bodies by Agricultural Activities, (17) Generation of employment, (33) due to project activities are quantified in the following table:

Table 3. Example of Quantification of Identified Impacts

IDENTIFIED IMPACTS		PROJEC WITH EMP								PROJEC WITHOUT EMP								ENVIRONMENTAL QUALIFICATION EC	
		INCIDENCE			DURATION			SCOPE		INCIDENCE			DURATION			SCOPE		WITH EMP	WITHOUT EMP
		3.0	2.0	1.0	0.5	1.0	1.5	0.4	0.6	3.0	2.0	1.0	0.5	1.0	1.5	0.4	0.6		
Soil Contamination due to Agrochemicals (1)	5	**3.0**					**1.5**	**0.4**		**-3.0**					**-1.5**	**-0.4**		**4.9**	**-4.9**
Production of Sediments to Water Bodies by Agricultural Activities (2)	17	3.0				1.0			0.6	-3.0					-1.5		-0.6	4.6	-5.1
Generation of Employment (3)	33		2.0		0.5			0.4		-3.0				-1.0		-0.4		3.9	-4.4

The summary of the assessment is as follows :

Table 4. Final results

AFFECTED ENVIRONMENTAL RESOURCE	PRESENT CONDITION	ALTERNATIVE WITH EMP	ALTERNATIVE WITHOUT EMP
Soil	-4.0	-0.5	-8.1
Water	-3.0	0.1	-6.5
Air	-1.0	1.8	-3.8
Flora	-2.2	0.0	-5.1
Fauna	-0.7	1.2	-3.6
Social	3.3	6.6	-0.2

According to the table above, the environmental resource that is most affected by the actions of the project without the EMP measures is the soil, (-8.1), and even with the measures implanted, it still presents some minor adverse alterations, specially due to the production of sediments caused by the lost of protective vegetative cover. The resource that follows in alteration is water , particularly due to the production of sediments and the contamination due to semi-industrial processing of the Cassava, (-6.5). Flora has a total affectation of –5.1, principally due to loss of vegetative cover in the cultivation zones.

Impacts produced on the Social resources have the lesser impacts when the actions in the EMP are not put to action, due to the very nature of the project, which seeks to mitigate a social problem with the substitution of illicit cultivation through an agricultural activity that allows for the subsistence of the community and an improvement of the living conditions, an objective that can easily been reached even without the implementation of an EMP. All the same, it is evident that the benefits of the EMP, (6.6), are in this aspect of greater

impact, since they constitute a tool to insure sustainability of natural resources and their continued exploitability towards the future.

The main mitigation measures proposed can be found in Section 5 of this document but are summarized in the chart below.

Table 5. Environmental Measures to be Applied to the Cultivation and Processing of Cassava

PROGRAM	INDEX FORM No.	MEASURE
SOIL MANAGEMENT	1	CULTURAL PRACTICES
	2	AGRONOMIC PRACTICES
	3	PESTICIDE AND WEED CONTROL AND MANAGEMENT
	4	WEED CONTROL
	5	ORGANIC AND BIOLOGICAL AGRICULTURAL PRACTICES
	6	EROSION CONTROL
WATER RESOURCES MANAGEMENT	7	WATER QUALITY CONTROL
	8	WATER CONTROL IN INDUSTRIAL CASSAVA PROCESSING
	9	SOIL CONSERVATION BY SOLID WASTE DISPOSAL
AIR MANAGEMENT AND CONTROL	10	CLEAN TECHNOLOGIES FOR SOIL PREPARATION
MANAGEMENT AND CONTROL OF FLORA AND FAUNA	11	VEGETATIVE COVER MANAGEMENT BY FLORISTIC COMPENSATION
	12	FAUNA MIGRATION CONTROL
	13	GENERATION OF LIVE FENCES AND PLANTATION OF VEGETATIVE COVER
ECOSYSTEM PROTECTION	14	CONSERVATION OF NATIVE ECOSYSTEMS
SOCIAL MANAGEMENT	15	STRENGTHENING OF THE SENSE OF
	16	ENVIRONMENTAL EDUCATION
	17	SAFETY

The budget for activities proposed under the Environmental Management Plan, (EMP), include administrative costs, particularly those needed for personnel to execute and supervise the activities. The cost of implementing the complete EMP is estimated at US$252,779 ($707,779,410 Colombian pesos), due to the fact that implementation of the EMP relates to activities of the cultivation and processing phases of the productive cycle of Cassava, which lasts 11 months¸ an identical timeframe applies.

SECTION 2 PURPOSE AND METHODOLOGY

2.1 PURPOSE

The main objective of this study is to analyze the physical, biotic and socioeconomic aspects in the area of influence of Cassava plantations for the purpose of identifying and evaluating the impact of implementation and operation of the project. The study will establish the relevant environmental monitoring and management measures that will guarantee the sustainable development of the project both during its steps as well as after it is abandoned. The final goal of the activities is supplying the people in charge of decision making with full information on the consequences of implementation and management of the productive characteristics of Cassava plantations and their repercussions on the environment.

The scope of the project include the following aspects :

- Elaboration of an environmental diagnosis, including relevant specific aspects of the current operation, and projections for implementation of the plantations in different municipalities.

- Elaboration of an environmental Assessment, according to the methodology of the Leopold Matrix, which will identify the different impacts, valuate the degree of damage and propose adequate environmental management measurements.

- Formulation and description of preventive, mitigating, corrective and/or compensatory measurements required to harmonize the physical, biotic and socioeconomic environment with the cultivation of Cassava. These measurements will include aspects such as objectives, goals, expected results, design criteria, typical blueprints, human resources, execution timetable, budget and responsibilities.

- Elaboration of a biophysical and social monitoring and follow up program, in agreement with the alterations occurred as a result of actions and processes developed during the operation of Cassava cultivation project.

2.2 METHODOLOGY

The study was developed according to the methodology required in Regulation 216 of USAID, considering some Colombian environmental laws, which means including the following aspects:

Identifying areas of direct or indirect influence; technical description of the prospective project; characterization of the environmental base line on the physical, biotic, social, cultural and economic aspects; in situ identification of the potential impacts generated by the project. Contact with the community was maintained during the field work, through direct involvement with the population working in the project, and the participation of community organizations, which were informed in order to maintain a high level of approval for the project.

The work included field activities involving the gathering of primary information and office activities involving processing and analysis of primary and secondary information related to the area of study. The information was applied in the identification and assessment of potential impacts of the project and in the formulation of environmental management and monitoring plans.

SECTION 3 ALTERNATIVES INCLUDING THE PROPOSED ACTION

ALTERNATIVES ANALYSIS OF THE ENVIRONMENTAL ASSESSMENT FOR PURPOSES OF DECISION MAKING PRIOR TO PROJECT START-UP

3.1 INTRODUCTION

As a complement to the project evaluation phase, it is convenient to establish future behavior of the environment, in order to analyze its sustainability in time.

Cassava cultivation produces alteration of the natural resources through impacts identified in this study, analyzed in the Alternatives Analysis, that permit to evaluate into the future the character, magnitude and time of alterations in environmental elements, considering or not the need to implement an Environmental Management Plan for the productive project. This is the same as performing a Diagnostic of Environmental Alternatives for the execution of the EMP.

This chapter deals with the evaluation of performance of the natural resources during the execution of the project with and without the implementation of the measures of the EMP.

3.2 METHODOLOGY

The analysis uses the same method of matrix evaluation that was used to run the environmental Assessment of the project, in order to simulate the behavior into time of the different impacts caused by project activities, under two different Alternatives Analysis which are described in detail below:

3.3 ALTERNATIVE 1

This alternative considers the behavior of environmental resources if the productive project is implemented with measures established in the EMP, as indicated in chapter 6.

3.4 ALTERNATIVE 2 OR NO ACTION ALTERNATIVE

This alternative considers future behavior of resources, if the project continues to develop under the same conditions prevailing today, where social objectives and specific environmental measures to ensure project sustainability are not taken.

Once the basic alternatives are known and reviewed, it is possible to project them into a scale to allow for evaluation of objective determination. These parameters are:

- Character: Positive, (Beneficial), or Negative, (Adverse), according to the type of consequences that can be derived in absence of the measure.
- Incidence: It is related to the way in which an action of the EMP realized or not, acts over the resource through the identified impact. It has been valued as High, Medium, or Low.
- Duration: It relates to the time between the application or no application of the measure, and the moment in which the effects can appear on the resource be them adverse or beneficial. This parameter has been valued for three types of periods: Long term, (if greater than three years), Medium term, (if it is between 1 and 3 years), and Low term, (if it is below 1 year).
- Scope: Determines if the action concerns the direct area of the project, (Local), or if it encompasses a larger or regional space, (regional).

The subjective scale defined for purposes of grading criteria is shown below.

Table 6. Scale for quantifying the conditions of the different Alternatives Analysis analyzed

CRITERIA FOR CLASSIFICATION	QUALITATIVE VALUATION	QUANTITATIVE VALUATION
Character of Impact	Positive	+
	Negative	-
Incidence	High	3.0
	Medium	2.0
	Low	1.0
Duration	Short	1.5
	Medium	1.0
	Large	0.5
Scope	Local	0.40
	Extensive	0.60

The definition of criteria was made jointly with the specialists participating in the study at joint meetings, to establish the scales for evaluation of future conditions of the project according to the different environmental resources affected in each of the Alternative's Analysis described. For each alternative, the Assessment results from the addition of the qualifications of the different impacts, to obtain the corresponding measurement of environmental quality, (EC), as follows:

$$EC = I + P + A \qquad \textbf{(1)}$$

Once the EC values are calculated for each alternative, the value of EC to the future is computed by adding these qualifications with those obtained for the present condition of the project, (figure 5.1), as indicated by equations (2) and (3). In order to establish the relation between values of Environmental Qualification, "EC", and Environmental Alteration levels, (EA), the same range of values of EA were used which can be related both for positive and negative impacts by entering the amounts of EC as absolute values.

$$EC_{future} = EC_{present} + EC_{with\ EMP} \qquad (2)$$

$$EC_{future} = EC_{present} + EC_{without\ EMP} \qquad (3$$

Table 7. Summary evaluation of identified interaction for implementation of EMP of Soil Resources – Productive Cassava Project (Department of Cauca)

	PRESENT CONDITION		ALTERNATIVE WITH EMP		ALTERNATIVE WITHOUT EMP		DESCRIPTION OF QUALIFICATION
	-4.0	**Medium**	-0.5	**Very low**	-8.1	**High**	The soil is one of the environmental resources that is more affected in the present; the implementation of environmental measures in the EMP generate improvement in the soil conditions in the zone bringing about increase productivity of crops; this improvement is not complete, since initial soil conditions had been deteriorated greatly with the project do to uncontrolled use of agrochemicals, pesticides, and herbicides which affected the physicochemical quality and thus fertility. Another impact that presents great incidence in environmental quality of soils correspond to management of waste relative to the process of transformations of Cassava starch produced by the rallanderias. No implementation of EMP for the project will generate considerable increase in the deterioration of this component which will reflect on an acceleration of the process of detriment in the productive capacity of the soils, affecting the crops.

Table 8. Summary evaluation of identified interaction for implementation of EMP of Water Resources – Productive Cassava Project (Department of Cauca)

	PRESENT CONDITION		ALTERNATIVE WITH EMP		ALTERNATIVE WITHOUT EMP		DESCRIPTION OF QUALIFICATION
	-3.0	**Medium low**	0.1	**Very low**	-6.5	**Medium High**	Alternative two without EMP makes the deterioration of water resources more critical, the second most important negative impact after deterioration of soil resources. This situation occurs mostly do to disposal of organic material in the industrial waste water from the Cassava plants. It is worth noting that water treatment proposed in the EMP do not totally control water pollution, although the quality of the waste water will fulfill the existing normativity (Decree 1594/94 for water utilization). Another important impact within this evaluation is related to sediment production during the different processes of cultivation. It is worth noting that sediment production occurs with and without EMP, except that it has lower incidence and importance when applying the control measures proposed.

Table 9. Summary Evaluation of Identified Interaction for Implementation of EMP of Air Resources – Productive Cassava Project (Department of Cauca)

	PRESENT CONDITION		ALTERNATIVE WITH EMP		ALTERNATIVE WITHOUT EMP		DESCRIPTION OF QUALIFICATION
	-1.0	**Low**	1.8	**Low**	-3.8	**Medium Low**	At present this element does not present critical alteration due to the very nature of the project; implementation of EMP will permit the minimization of affectation on this component, since factors like particle generation during cultivation and noise in the industrial phase will be controlled and mitigated. Continuation of the project without implementation of EMP will clearly contribute to deterioration of air quality at each of the cultivation sites and in the environ of processing plant.

Table 10. Summary evaluation of identified interaction for implementation of EMP of Flora Resources – Productive Cassava Project (Department of Cauca)

	PRESENT CONDITION		ALTERNATIVE WITH EMP		ALTERNATIVE WITHOUT EMP		DESCRIPTION OF QUALIFICATION
	-2.2	**Low**	0.0	**Very Low**	-5.1	**Medium**	Cassava cultivation requires the elimination of vegetative cover which initially protected the soil. EMP proposes actions to mitigate this impact by means of cultural and conservation practices. No execution of this measures will reflect on large areas of moderate slope being susceptible to soil loss and decreasing productivity.

Table 11. Summary evaluation of identified interaction for implementation of EMP of Fauna Resources – Productive Cassava Project (Department of Cauca)

	PRESENT CONDITION		ALTERNATIVE WITH EMP		ALTERNATIVE WITHOUT EMP		DESCRIPTION OF QUALIFICATION
	-0.7	**Very low**	1.2	**Low**	-3.6	**Medium low**	Fauna deterioration is reduced to the affectation of the invertebrates present in the first horizons of the soil, which were affected already before the initiation of the Project, since the area was used for cattle grazing. This species were further affected by that agricultural project. Application of EMP measures will diminish the probability that some of these species will disappear. Activities such as the uncontrolled application of agrochemicals will make this probability augment, a condition that could happen if the EMP is not implemented.

Table 12. Summary Evaluation of Identified Interaction for Implementation of EMP of Socioeconomic Resources-Productive Cassava Project (Department of Cauca)

	PRESENT CONDITION		ALTERNATIVE WITH EMP		ALTERNATIVE WITHOUT EMP		DESCRIPTION OF QUALIFICATION
SOCIO ECONOMI	3.3	**Medium low**	6.6	**Medium High**	-0.2	**Very low**	The original concept of the productive project has the objective of improving the quality of life of a marginal social group from the state agrarian politics, which has opted for surviving from illicit activities. The influence of the project in the socioeconomic element is therefore beneficial. The parallel development of the EPM will bring added benefits both to the socioeconomic element and to the environment. Not applying the measurements of the EMP will reflect in the exhaustion of resources an thus on the sustainability of the project in time and the survival of the community.

In order to establish the relation between values of Environmental Qualification, "EC", and Environmental Alteration levels, (EA), the same range of values of EA were used as defined in section 5, as follows :

Table 13. Range of values of EC

Absolute Value of Environmental Quality	Environmental Alteration
>10.0	**Very High**
8.0-10.0	**High**
6.0-8.0	**Medium Heigh**
4.0-6.0	**Medium**
3.0-4.0	**Médium Low**
1.0-3.0	**Low**
<1.0	**Very Low**

The values of the preceding table can be related both for positive and negative impacts by entering the amounts of EC as absolute values.

3.5 METHOD FOR CALCULATION

The addition according to equation (1) applied to the impact of Soil Contamination due to Agrochemicals, (5), Production of Sediments to Water Bodies by Agricultural Activities, (17), and Generation of employment, (33), due to project activities are quantified as in the following table :

Table 14. Example of Quantification of Identified Impacts

IDENTIFIED IMPACTS		PROJEC WITH EMP								PROJEC WITHOUT EMP								ENVIRONMENTAL QUALIFICATION EC	
		INCIDENCE			DURATION			SCOPE		INCIDENCE			DURATION			SCOPE		WITH EMP	WITHOUT EMP
		3.0	2.0	1.0	0.5	1.0	1.5	0.4	0.6	3.0	2.0	1.0	0.5	1.0	1.5	0.4	0.6		
Soil Contamination due to Agrochemicals (1)	5	**3.0**					**1.5**	**0.4**		**-3.0**					**-1.5**	**-0.4**		**4.9**	**-4.9**
Production of Sediments to Water Bodies by Agricultural Activities (2)	17	3.0				1.0			0.6	-3.0					-1.5		-0.6	4.6	-5.1
Generation of Employment (3)	33		2.0		0.5			0.4		-3.0				-1.0		-0.4		3.9	-4.4

3.6 FINAL RESULTS

Table 15. Summary of the Assessment

AFFECTED ENVIRONMENTAL RESOURCE	PRESENT CONDITION	ALTERNATIVE WITH EMP	ALTERNATIVE WITHOUT EMP
Soil	-4.0	-0.5	-8.1
Water	-3.0	0.1	-6.5
Air	-1.0	1.8	-3.8
Flora	-2.2	0.0	-5.1
Fauna	-0.7	1.2	-3.6
Social	3.3	6.6	-0.2

According to the previous table, the environmental resource that is most affected by the actions of the project without the EMP measures is the soil, (-8.1), and even with the measures implanted, it still presents some minor adverse alterations, specially due to the production of sediments caused by the lost of protective vegetative cover. The resource that follows in alteration is water , particularly due to the production of sediments and the contamination due to semi-industrial processing of the Cassava, (-6.5). Flora has a total affectation of –5.1, principally de to loss of vegetative cover in the cultivation zones.

Impacts produced on the Social resources have the lesser impacts when the actions in the EMP are not put to action, due to the very nature of the project, which seeks to mitigate a social problem with the substitution of illicit cultivation through an agricultural activity that allows for the subsistence of the community and an improvement of the living conditions, an objective that can easily been reached even without the implementation of an EMP. All the same, it is evident that the benefits of the EMP, (6.6), are in this aspect of greater impact, since they constitute a tool to insure sustainability of natural resources and their continued exploitability towards the future.

SECTION 4 AFFECTED ENVIRONMENT

4.1 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

4.1.1 Overview

The practice of agriculture suggests the use of techniques and materials that will improve the quality and quantity of harvests. The goal is to achieve better productivity and increase incomes, however, the application of modern practices generate a series of consequences which are mostly positive, but also have some negative ones that could alter, to different degrees, the natural conditions and resources used in the production process.

4.1.2 Methodology

As mentioned before, the methodology followed for the identification and valuation process of environmental impact went according to the recommendations of the terms of reference, using the Leopold[1], technique; this is the first method employed by the Geological Service of the Ministry of the Interior of the United States, since 1971. The original procedure has been augmented and complemented with the Assessment techniques suggested by Chemonics.

The methodology followed for purposes of identifying environmental impact is based on a matrix, which contains the altered environmental factors and relates them with every phase of the project activities. The impact could be adverse when the project activity alters the natural resource negatively and it can be positive if it impacts the resource to its favor. For example, the plague control activity, (G), interacts with the environmental component, Air, in the reference aspect Toxicity by agrochemicals (23). To indicate the intersection between the activities and the reference aspects of the environmental components a color-coding is used, (blue and orange), aside from the text, (A and B), both make reference to the type of alteration that can be generated between them.

There can be activities that don't generate impact on the resources; these have been identified as innocuous and are not contemplated in the matrix, so the cells appear blank. In the stage of environmental Assessment these impacts will not be considered.

With the purpose of establishing in a quantitative manner the magnitude of the interaction that occurs between the project activities and the identified impacts, valuation scales have been established depending on the relevance of each activity in relation to the others of the same phase. The process begins with the counting of positive or beneficial impacts, (B), and negative impacts,

[1] Instituto Tecnológico Geominero de España. Evaluación y Corrección de Impactos Ambientales, Madrid, 1991

(A); the sum of both is affected by the importance given to each activity; then, an arithmetic balance is calculated between the positive and negative results; an overall negative result indicates that for an specific activity the impact is adverse, while a positive one would mean the opposite. This balance is depicted graphically at the bottom of the matrix. The identification analysis was also made for the rows, to find the value of the interaction of the impacts identified for each resource. The value of the interaction would be defined by the following equation:

$$VI = RA * (\sum_{i}^{n} B_i - \sum_{i}^{n} A_i)$$

Where:

VI = *Value of the Interaction*
RA = *Relevance of the activity*
Bi = *Beneficial Effect*
i = *Ordering number of the Impact* (For columns it varies from 1 to 10, for rows from 1 to 5)
Ai = *Adverse Effect*
n = *Total number of identified Impact*

It is worth noting that the Assessment of impacts included those existing previous to the implementation of the productive project. For the environmental assessment, the following criteria were used and classified in another Leopold matrix which includes:

- Nature of Impact: Positive, (beneficial), or Negative (adverse), in relation to consequences of occurrence.
- Type: Direct or indirect; the impact is direct if it occurs by itself, and indirect if it is brought by another medium such as wind rain a vehicle, people, etc.
- Duration: Temporal or Permanent.
- Scope: Local or extensive. Whether it occurs solely in the direct area or not.
- Tendency: Reversible or irreversible, which measures the possibility of controlling or reversing the impact through management measures.
- Synergy: Yes or no. Refers to the chain reaction of other impacts.
- Probability of occurrence: High or low.
- Magnitude: Classifies the impact in relation to other occurrences as high, low or medium.

Recommended management measure: The possibility of recommending the most adequate management measure is considered. The purpose of these measures tends to be to correct, mitigate, compensate or prevent the impact.

4.1.3 Impact Identification Matrix

For the columns where the project activities are located, the scale of importance RA, is in the range from 1 to 10; this values, as it was commented on before was assigned considering the relevance of

the activity in relation to the others. Table 16 below, shows the values of RA for Cassava cultivation:

Table 16. Values of Environmental Relevance for the Activities Involved in Cassava Cultivation

PHASE	NO.	ACTIVITY	DESCRIPTION	RA
ESTABLISHMENT AND MANAGEMENT OF CASSAVA CULTIVATION	A	Cleaning	Consists in the elimination of vegetation in the original field	7
	B	Land Preparation	Consists in the use of equipment to till the soil, loosening it	7
	C	Seeding		3
	D	Fertilization	Application of organic and chemical fertilizers	4
	E	Lime Addition	Lime application to correct soil acidity	5
	F	Weed Control	Application of pre-emergent or post-emergent herbicides	5
	G	Plague Control	Application of agrochemicals, for plague control	5
	H	Management of Sickness	Application of agrochemicals for sickness control	5
PRODUCTIVE PHASE	I	Harvesting	Consists in the extraction of tuberous roots from the soil	7
	J	Gathering and Transport	Gathering of roots and transportation to processing plant	4
	K	Post-Harvest Management	Soil and residue management once Cassava has been extracted	4
FASE DE PROCESAMIENTO INDUSTRIAL DE LA CASSAVA	L	Washing and Cleaning	Removal of soil and peelings from the surface of the roots	5
	M	Shredding	Formation of humid, milky paste	3
	N	Sifting	Process of sifting to remove impurities and large size particles	2
	O	Sedimentation	Separation of humid Cassava starch by sedimentation in channels	2
	P	Drying	Elimination of humidity and toxic compounds by solar radiation	3
	Q	Milling	Trituration of the dry, mass to make flour	3
	R	Management of subproducts	"Mancha" and "Afrecho", Sub products from skinning	6
	S	Management of Effluents	Use of water as a mean to eliminate residues from skinning	10
	T	Disposition of Solid Residues	Management of residues rejected during processing	10
TOTAL				100

Based on this matrix, the activities can be ordered vertically according to the degree of negative affectation that they generate on the different components considered. The order of activities, including cultivation and processing, is categorized in this manner, from the one with the most negative impacts to the one with the least, as follows:

For the productive and cultivation phases, the activities of soil preparation and cleaning are the ones with the greatest negative values, (-84 and –98), followed by plague control, disease control, harvesting and weed control activities, (-70, -70, -65 and –56). The lime addition activity has a balanced interaction, (0); in this phase of the project, some activities with beneficial results do exist. These activities are seeding, fertilization, gathering and transport, and the post harvesting management, (+15, +8, +8 and +12).

In the Cassava semi industrial processing phase, the most adverse activity is the management of effluents, (-120), followed by the disposition of solid residue, (-100). Differing considerably from the previous, is the management of the sub products "mancha" and "afrecho", and cleaning, (-30 and –25). The rest of the activities, skinning, sifting, sedimentation, fermentation, drying and mashing, have an average of –10.

The activities with higher interaction values will require a more complete monitoring and follow up package within the Environmental Management Plan, EMP, in a later phase.

Evaluating the matrix in a horizontal direction, it is possible to determine which environmental components are the most affected by the group of activities developed both for the cultivation and the processing of the Cassava. The order is as follows:

The heaviest impact on the soil, comes from the inadequate management of solid residue, (-45), followed by the landslides in hillside terrain, loss of soil through hydraulic erosion, compacting of the soil, contamination of the soil through chemicals, damage to the geomorphology, residual effect of insecticides and herbicides and the agrological capacity of the soil, (-21, -18, -18, -15, -12 and -12). The adverse interactions of lower impact occur in the recuperation and/or maintenance of soil fertility, soil affectation and availability of soil nutrients, (-6,-3 and -3).

The greatest impact over the water resources, is the inadequate management of solid residue in the cultivation and productive phases (-14), followed by all other identified impacts that affect this resource, (-12 to –5.6). The impact on the Air resources is smaller than in the other ones, as indicated by the interactions, and the biggest impact is caused by particles released during cultivation and processing activities, (-12), followed by pollution through burnings and terrain cleaning, (-8). There is also a big difference in the interaction value for the other identified impacts, (-1.8 to –3.6).

For the biotic medium the most negative interaction deals with changes in the natural landscape,(-10), followed by affectation to endemic and endangered species, (-9). The rest of the impacts are in a range from –5 to –2; compared with the impacts on the physical medium, these are minor.

In the socioeconomic medium, the interactions reflect the beneficial character of the project, since most of the balances yielded positive values. The most significant of them are generation of employment, of income and the betterment of diet, (+80, +52 and +52), the impact of the other values oscillates between +9 and +33 with the exception of participative coexistence and the lack of an environmental follow up and control system, which resulted in a negative interaction value, (-39, –76).

4.2 PRESENT ENVIRONMENTAL DESCRIPTION

4.2.1 Direct Area of Influence

The project is located in the northeastern part of the department of Cauca, and the southeastern zone of the department of Valle del Cauca, have been considered as the project area of influence. However, given the regional nature of the project, the area of influence could be much larger as it encompasses most of the agricultural systems of the entire zone. The direct area of influence is

localized in the northern part of the department of Cauca, in the municipalities of Miranda, (specifically the Candaima, Santa Ana and San José *veredas*), Corinto, (including the Corinto Indian reservation), Caloto, (including the Toez Indian reservation), and Santander de Quilichao, (v*ereda* La Arrobleda). All project *veredas* present similar physical and natural environment characteristics.

4.3 ENVIRONMENTAL COMPONENTS

4.3.1 Abiotic Component

4.3.1.1 Geology and geomorphology

The geology of the northeastern region of the department of Cauca is characterized for its dense layers of piroclastic materials, specially volcanic ash, generally covering metamorphic or sedimentary rocks. These rocks are mostly limolitic, sand stones, and conglomerates; porfiritic rocks of intermediate composition with variations of dacite, andecite, and volcanic rocks of the fluvial types as well as lake, alluvial and coluvial deposits of recent dating.

In the geomorphologic aspect, the municipalities involved in the project occupy a similar natural space, which has been preserved by litology, tectonism and denudative agents. Three different morphogenetic units are present, identified as piedmont alluvial plains, (1,050m - 1,150m msl), Foothills, (1,150m – 1,350m msl), and the mountain unit, (>1,350m msl).

4.3.1.2 Climate

The region displays a tropical, humid climate, with average yearly temperatures between 24oC in the low lands, (800m to 1,000m msl), and 18oC in the highlands, (1,000m - 1,500m msl), which causes a relative average humidity between 60 and 70%. Precipitation has a bimodal behavior, with two humid periods extending between the months of March-May and October-December, separated by dry periods. Average yearly precipitation is 1,701 mm.

4.3.1.3 Hydrology

The region displays a tropical, humid climate, with average annual temperatures ranging between 24°C in the low lands, (800 m to 1,000 m above sea level, *asl*), and 18°C in the highlands, (1,000 m - 1,500m asl), which causes relative average humidity between 60 and 70%. Precipitation is bimodal, with two humid periods extending from March-May and October-December, separated by dry periods. Average annual precipitation is 1,701 mm.

The municipalities involved in the agricultural project are localized within the Cauca river watershed, and are irrigated by the Guengue, Desbaratado, La Paila, Jagua, Chiquito and

Quinamayó rivers, and the Seca, La Bodega y La Quebrada streams. All these currents, within the cultivation area, have slopes below 10% and very low levels during the dry season. They display shallow drainage with mildly sloped valleys. The majority of the rivers have been used for water supply in the highlands, while in the plains they have been used for agriculture, cattle herding, and agroindustrial use.

4.3.1.4 Water Quality

Analysis of results show that the water quality of streams in the region is very similar, and that it presents acceptable conditions for agricultural and cattle related uses; however, there are some restrictions in regard to water supply, particularly because of microbiological content.

Regarding the physical indicators for surface water, it can be annotated that the overall solid content in the samples is low; color is most likely due to dissolved solids and partly to suspended solids, while solids are mostly non existent.

With respect to chemical parameters analyzed for surface waters, it is worth noticing that in all the samples the values registered for each parameter are constant and within the norms. The waters are neutral, free of oils and grease and with a low oxygen demand, both for the organic fraction and the chemical fraction.

The limitations to the use of these waters lie in their contents of fecal Coli bacteria in downstream La Bodega and La Quebrada creeks, which constitute an "inadmissible" factor according with the norms. The bacterial presence in these two currents is explainable given that they run through rice fields, cattle herding fields, and populated areas.

The results of water quality tests of the effluent of the "Rallandería", indicate that the contamination generated by the processing plant causes serious pollution problems in the surface water sources that receive them. The laboratory results of these samples are shown in table 3.3. Figure 3.2 indicates the locations from which the samples were taken, for future monitoring controls.

Table 17. Water Quality Results in the Direct Influence Area of the Project

PARAMETER	UNITS	CONCENTRATION	EFFLUENT CONCENTRATION	PERMISSIBLE LIMITS
Total Solids	mg/L	91 - 116	2714	200 - 500 mg/L
Conductivity	uS/cm	113 - 185	1112	Not considered in norm
PH	Anidathes	7.78 – 8.98	4.25	5 – 9
Total Hardness	mg CaCO3/L	53.1 – 101.4	234	500
Amonia Nitrogen	mg NH4-N/L	0.06 – 0.16	10.38	1
Nitrates	mg NO3-N/L	<0.05	2.41	10
Nitrites	mg NO2-N/L	<0.06	0.046	1
Chloride	mg Cl/L	0.8 – 3.2	12.7	250
Phosphorus Total	mg P/L	0.037 – 0.066	21.2	4 – 15
Ortofosfatos	mg P/L	0.023 – 0.03	16.2	low
Sulfates	mg SO4/L	6.5 – 10.4	2.8	400
Dissolved Oxygen	mg O2/L	8.2 – 8.5	5.9	Good Concentration
DBO5	mg O2/L	1	2300	Strong in the plant
DQO	mg O2/L	1 - 3	3284	1000 (strong in plnst)
Total Coli Bac.	NMP/100 mL	90 - 5000	<2	20000 (maximum)
Fecal Coli Bac.	NMP/100 mL	<2 -2400	<2	2000 (maximum)

4.3.1.5 Soil

For the most part, the soil in this area is from very superficial to moderately deep; it is scarce in organic matter; of an acid nature, and low in phosphorus; morphologically it presents a varied topography, from flat to undulating and cracked.

The soils correspond to the agrological categories I, II, III, IV, V and VI. Agrological category I soil is apt for every kind of plantation in the region; they are flat, deep, and fertile, with good texture, and moisture retention, permeable and with good drainage characteristics. Categories II and III are appropriate for almost all plantations and are of a moderate fertility. Categories IV and V have low fertility and are of an undulated or cracked topography. Category VI soil presents erosion and lack of humidity problems and have strong slopes, limiting their use.

4.3.2 Biotic Components

The description of the biotic component in the direct influence area of the project includes the characterization of the native flora and fauna, the endangered species, as well as the critical, vulnerable, sensible and environmentally important ecosystems that require special treatment for the duration of the operation of the project.

Within the direct influence area of the project the Consultants found four life zones, corresponding to the Dry Tropical Forest, (bs-T), Humid pre-mountainous Forest, (bh-PM), Very humid Premontainous Forest, (bmh-PM), and Very humid Premontainous low Forest, (bmh-MB).

Table 18. Zones of Life in the Area of Direct Influence of the Project

NO.	ZONE OF LIFE	CLIMATIC CHARACTERISTICS
1	Dry Tropical Forest, (bs-T)	Thermal Floor : Warm Altitude : between 0 - 1.000 m.f.s.l. Temperature: Greater than 24°C. Precipitation: between 700 and 2.000 mm., annually.
2	Humid pre-mountainous Forest, (bh-PM)	Thermal Floor : Moderately war-humid Altitude: between 1.000 - 1400 m.f.s.l. Temperature: between 20 - 24 °C. Precipitations: 1.500 – 2.000 mm., annually.
3	Very humid pre-mountainous Forest, (bmh-PM),	Thermal Floor: moderately warm and humid. Altitude: 1.400 - 2.000 m.f.s.l. Temperature : 16°C Precipitations: 1.800 - 3.000 mm, annually.
4	Very humid pre-mountainous low Forest, (bmh-MB)	Thermal Floor: Moderately cold – very humid. Altitude: 2.000 and 2.400 m.f.s.l. Temperature: 12° - 16°C. Precipitation : 2.000 – 4.000 mm., annually.

4.3.2.1 Native Flora

In accordance to the life zones found in the direct influence area of the project, habitats for various vegetative species for human use were found, such as leguminous, food producing, ornamental, and fruit bearing, all of which are characteristic of the tropical dry forest, (bs-T). The species include, "Matarratón", (Gliciridia sepium), "Carbonero", (Leucaena leucodephala), "Guayacan", (Tabeuia spp.), "Saman", (Samanea saman), "Chiminango", (Pithecellobium spp.), "Pitaya", (Acanthocereus pitahaya), and "Mamoncillo", (Melicocus bijugatus), among others. The relicts of natural forest of the zone constitute real on site genetic banks, which are unknown up to date. The area offers the possibility of maintaining insect species that contribute to plague and disease vectors control.

In the geographic valley of the Cauca river, all of the remains correspond to secondary forests some of which are located in plantation or cattle herding areas. The illegal crops, and the sugar cane plantations that have been introduced in the zone, have generated a critical situation in the original vegetative cover.

In the life zone corresponding to the Premontainous humid forest, which occupies part of the Santander the Quilichao municipality, indigenous species include "Guadua", (*Bambusa guadua)*, "Nacederos", (*Trichanthera* gigantea*)*, "Palma de Corozo", (*Aiphanes caryoteafolia)*, "Algodoncillos", (Goethalsia *meyantha)*, "Nogal Cafetero", (*Juglans neotropica)*, "Cámbulo",

(Erythrina poeppigiana), "Chachafruto", *(Erythrina edulis)*, "Balso Blanco", (*Ochroma sp)*, "Guamo", (*Inga sp)*, "Guayacán Rosado", (*Tabebuia rosea)*, "Zurrumbo", (*Trema micrantha),* "Barbe Gallo", (*Warscewiczia coccinea)*.

Species such as Pigs Fern, *(Pteridium aquilinum)*, "Mortiño", *(Miconia sp.)*, "Platanillo", *(Heliconia sp.)*, "Yarumo", *(Cecropia sp.)*, White "Balso", *(Heliocarpus sp.)*, "Cedro", *(Cedrela sp.)*, "Balso", *(Ochroma sp.)* and "Guamo", *(Inga sp.),* are characteristic of the Premontainous very humid forest.

Some of the primary flora species that grow on this pre-mountainous very humid forest are : "Roble", *(Quercus humboldtii)*, "Wax Palm", *(Ceroxylon quindiuense)*, "Guásimo", (*Cordia acuta Pittier*), "Drago", *(Croton magdaleniensis),* "Borrachero", *(Datura arborea)*, "Caucho", *(Ficus sp.),* "Guamo", *(Inga archeri)*, "Gallinazo", *(Lippia hirsuta)*, "Arrayán", *(Myrcia popayanensis),* "Cordoncillo", *(Piper archeri)*, "Limoncillo", *(Siparuma lepidota*), and "Aliso", *(Alnus jorullensis*).

However, some of the species, such as "Roble", "Comico", "Caña Brava", "Guadua", "Iguerón", "Chagualo", "Jigua", "Caña Menuda", "Guásimo and "Poma", each are indigenous to the area, and are beginning to become scarce, whereas foreign species such as Eucalyptus, "Árbol del Paraíso", "Guandalay", and the Pine tree, are more abundant.

Table 19. Extinct or Endangered Species of the Area of Influence of the Project

FAMILY	SCIENTIFIC NAME
ACANTHACEAE	*Dicliptera Conformis*
ACANTHACEAE	*Dicliptera Triane*
ACANTHACEAE	*Justicia Novograntensis*
ACANTHACEAE	*Odontophandllum huilenses*
AMARANDLLIDACEAE	*Eucharis Lehmannii*
ANNONACEAE	*Guatteria Cargathero*
BRANELLIACEAE	*Branellia Almaguerensis*
FAGACEAE	*Quercus Humboldtii, (ROBLE)*
JUGLANDACEAE	*Juglans neotropica (NOGAL)*

SOURCE : CALDERON 1996b. National Report over the status of the biodiversity, Vol I, 1997, Humboldt Institute

4.3.2.2 Native Fauna

Fauna found in the area of influence of the study is still high. Mammal species found include armadillo, cusumbo, sloth, musaraña, bats, maicero monkeys, tutamonos, coatis, fox, opossum, wild pig, deer, rabbit and squirrel. The bird fauna is also varied, including species such as blue birds, eagles, buchipecoso, woodpeckers, tángaras, cernícalos, cucaracheros, gallineros, pavas and hawks, among others.

Amphibian fauna shows frogs, toads and salamanders; reptiles include coral, patacona and rabo de ají snakes. The endangered indigenous fauna includes guaguas, tigrillos, armadillo, deer, iguanas and some serpents.

The threat of extinction is generated by the destruction of the habitats for cultivation purposes and indiscriminate hunting. The contamination of the water sources is also a factor, affecting specially ictiological species such as the Sabaleta, the Bagre, the sardine, the Bocachico and the Viringo, among others.

4.3.3 Important Ecosystems

In the area of direct influence of the project, including Santander de Quilichao, Corinto, Miranda and Caloto municipalities, there are zones with a great biodiversity that hence require careful protection. The description of the situation for each of the municipalities is as follows.

- **Santander de Quilichao**

The priority area that requires protection extends for 1,800 ha, and corresponds to the micro basins that supply the aqueducts in the area. Another zone in need of protection is about 5,000 ha, and is covered in natural or planted forests, commercial or protective, that could revert to their natural state (prior to 1970). The ecosystems that require conservation and protection, because of their fauna and flora, are: The Munchique Mountain, in the upper part of the municipality, which contains a natural park bearing the same name; the relicts of the primary natural forest, within the Llano de San Vicente hacienda and on the Pan-American highway to Cali; the natural parks of "La Chapa" and "Garrapatero"; the "Cueva del Indio" and the "Hacienda Los Mangos", both in the vereda La Corona, and finally, El Azufrado, upstream the Quilichao river in the vereda San Pedro.

- **Corinto**

This municipality contains many water sources that flow into the sub basin of the Palo river. The upper part of the micro basin of the La Paila river, (the source of the aqueduct for the urban area of Corinto), presents vegetative formations or life zones corresponding to fragile ecosystems which have already been intervened by cultivation and stock rising activities, and also by the advance of illegal plantations, (coca, marihuana and, to a lesser extent, poppy), which produce negative effects on the native forest.

Protection zones in this municipality are the micro watershed of the Las Paila river, those of the Rionegro river, as well as the one localized in the headwaters and channels of the Honda, Quebraditas, Carrizales o Cristalina, Pan de Azucar, San Rafael y Quebradaseca creeks.

- **Miranda**

In Miranda, the main ecosystem for protection is the paramo, represented by a surface of 3,070 ha. Another strategic ecosystem in this municipality is the primary protective forest, with a total extension of 4,995 ha, followed by the secondary forest, that occupies 2,137 ha. In zones between 1,800m and 3,000m msl, problems are generated by marihuana, coca and poppy cultivation, which require deforestation and burning in forested areas. This causes an evident increase in environmental problems, such as the perturbation of native flora and fauna, erosion of the soil, and the elimination of the native germoplasm. There is also a constant pressure over the amortiguation zones and the "Páramo" areas, (cold semiarid highlands), which affect the quantity and quality of water significantly.

- **Caloto (Municipality of Toez)**

A strong and uncontrolled human intervention transformed the originally forested ecosystem into planted forests of foreign species, such as the pine, cypress pine and eucalyptus. To revert this situation, there are about 250 ha of forest reserves that are a part of a native reforestation program in charge of the Association of Cabildos Indigenous in North of Cauca, (ACIN).

4.4 SOCIAL COMPONENT

4.4.1 Indirect Area of Influence or Regional Context

The area is constituted by the municipalities of Santander de Quilichao, (predominately black), Corinto and Caloto, (with an Indian majority), and Miranda, whose population is "mestizo".

4.4.2 Analysis

The socioeconomic and cultural aspects of the project consists of two Alternatives Analysis, the regional and the local; the region is conformed by the municipalities where the plantations are located, while the local alternative deals with the specific areas of which the respective peasants are a part of.

- **Rural and Urban Population of the Project**

The rural and urban population of the project is indicated, which includes data from 1993, last census year, and projections until 2005 according to the calculations of the National Administrative Department for Statistics, (DANE).

Table 20. Growth of Population in the Different municipalities in 1993 – 2005
(Inhabitants per Region)

MUNICIPALITY	1993			2000			2005		
	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL	TOTAL	URBAN	RURAL
Stder. Of Quilichao	75819	30812	45007	71730	36193	35537	78301	40895	37406
Corinto	23155	13495	9660	25315	15167	10148	27212	16620	10592
Caloto	34703	3200	31503	40346	4906	35440	45277	6455	38822
Miranda	22266	11331	10935	23461	12368	11093	24523	13247	11276
TOTAL	**155943**	**58838**	**97105**	**160852**	**68634**	**92218**	**175313**	**77217**	**98096**
Percentage	**100.0%**	**37.7%**	**62.3%**	**100.0%**	**42.7%**	**57.3%**	**100.0%**	**44.0%**	**56.0%**

Source : DANE - Colombia Dept. of Cauca

The results found can be summarized as follows :

- It is predicted that the total population of the project will increase from 155,943 to 175,313 inhabitants within the reference period. A 0.98% rate of increase
- The majority of the population inhabits the rural areas. In 1993 this population was represented by 62.27% and it is predicted that in 2005 it will be around 55.95%.
- For the year 2000 it was calculated that the municipality of Santander de Quilichao registered 44.60% of the total population and 52.73% of the urban population.

It is noteworthy note that 54.14% of the total population corresponds to the economically weaker population, which represents a big part of the demand to satisfy the work needs.

- **Public Utilities**

Access to health services by strata I and II of the economic order, which are both the most vulnerable and the most numerous, is handled by the "System de Beneficiaries of the Health Service", (SISBEN), with a 65% coverage. The rest of the population is taken care of by state services. Education coverage for the area is total at primary level, of about 60% at secondary and scarce for technical and superior levels, according to the results found in the Schemes of Territorial Ordering of the municipalities involved.

Regarding domiciliary services, the energy coverage is the most complete. Basic sanitary services, (such as potable water, sewerage and garbage recollection), have an adequate coverage, (85% in average), within the urban areas. The main difficulties reside in that residual waters are poured into the water sources, (rivers and creeks), that run across the municipal areas, and also that there are no landfills to dispose of solid waste, most of which also goes into the rivers.

In the rural area, people apply punctual solutions, such as veredal aqueducts, water intakes from springs and wells; septic tanks, latrines and garbage burnings, to attend to their basic sanitation needs. Actions that generate pollution by inadequate handling of wastes are however frequent, as it

happens for example with the use of wood for cooking, which generates children's health problems in some places.

Access to the telephone service offers alternatives within the urban areas. In the rural zones, however it becomes critical due to the lack of communication possibilities, causing risk situations for the population, (medical attention, insecurity and difficulties for business)

- **Regional Economic Activities**

The main economic activity of the population is agriculture; this activity is performed in the plains near the Cauca river, predominantly in sugar cane plantations, the agro-industrial complex of INCAUCA being the largest operation. In hillside areas, where the majority of peasant farmers concentrate; small and medium bean, corn, Cassava, tree tomatoes, vegetables and fruit plantations are predominant. In the higher parts of the municipalities, coca and poppy plantations are found. Stock rising is also an important resource but with lesser intensity. Peasants rise cattle for milk and also for the consumption of meat.

In Miranda one finds non-industrial exploitation of marble; production has reached 6,000 tons at times of highest construction demand. This activity, due to the low technological level, and the lack of control, produces negative effects for the environment, (deforestation).

The industrial presence is reflected in the Industrial Park of Santander de Quilichao, which was established in accordance with the preferences of law 218 of 1995, (The Paez law), through which factories become tax exempt when they employ the local workforce. The service sector consists of the activities of commercialization, financial services, and the different trading activities, as well as the services supplied by the state in the urban areas.

4.5 DIRECT AREA OF INFLUENCE OF THE PROJECT

- **Social Aspects**

According to the direct information available, (polls made by the project), the nuclear family aspects, constituted by age, sex, education, health, public utilities and communal organization of the project population, exhibit the following general profile : The majority of the population is male, with the exception of Santander de Quilichao´s black population; the population that is 15 years old or younger has a participation of about 25% of the consulted group; the working age population, (up to 55 years old), represents 52% and those 56 or older, 16%; the population involved in the project has access to primary education, with some limitations to kinder garden and secondary education. There is adequate health coverage for the population in estratos I and II and the biggest deficiencies involve sewerage, telephone and housing quality services, specifically within rural areas.

- **Economic Aspects**

The average size of a Cassava plantation is 1.6 Ha. The parcels are small and most of them have a property title. In Corinto and Caloto, where Indians are predominant, the lands are own by the reservation and the distribution of said lands is done by the respective "Cabildo".

Agriculture is represented, aside from Cassava, by small extensions of bean and corn plantations for family support. There is scarce presence of beef cattle, but the presence of corral birds for human consumption is common. Sources of income and employment for the majority of the population come from agriculture and, in a lesser proportion, stock rising.

The scheme of the project contemplates the industrial processing of Cassava to obtain sour starch and industrial products such as foodstuffs, glue, and paper related products. In the area, (Mondomo vereda), there are also "Rallanderías", where only bitter starch is obtained.

The Indian population receives between $100,000 and $150,000 per month in 60% of the cases. In the Miranda municipality the population perceives about $300,000 a month. The black population of the Santander de Quilichao zone makes one minimum salary on the average, although some families receive two minimum salaries.

- **Cultural Aspects**

Three ethnic groups constitute the population of the project. The black population, located in the Santander de Quilichao area, was in 1999 of 33,983 inhabitants, (41.6%). The Paez Indians registered 8,094 inhabitants, (9.9%), located in the Corinto and Caloto municipalities. The "mestizo" population is constituted by 39.628 inhabitants, (48.5%), mainly located in Miranda municipality.

- **Participation Guidelines**

The most significant form of communal participation within the peasants in the project, is through the Planters associations, The Indian Cabildos and the Communal Action Juntas. The State organization with the most participation in the project is the PLANTE, which is, at the same time, operating itself, and the territorial authorities of each municipality, with the support, in some cases, of the Municipal Technical Assistance Units, (UMATAS).

- **Pressure Over Natural Resources and Conflict Resolution**

In Cassava plantations, the main pressure is upon the soil, due to the use of chemicals and the tendency of hillside areas towards erosion if they are deforested or otherwise intervened. The water resources are affected by these circumstances, as it is by the cooking with wood and the inadequate management of domestic refuse. In flat areas, the pressure is on subterranean waters due to the demand required by sugar cane plantations. This resource is also affected by the inadequate management of the gasses expelled by factories near the Pan American Highway.

In the black community, resolution of conflicts is carried out in a normal manner, through the intervention of older people that serve as mediators. For resolution of greater conflicts the population calls upon the civil legislation of the municipal area. In the Indian community, the Cabildos and the governor of the reservation are the maximum authorities and are hence responsible for the following of its rules.

In the case of the "mestizo" population in the municipality of Miranda, the coexistence rules are given by the established civilian norms, which implies the dialog of the parties towards an agreed solution. If this is not possible, the existent legislature for civilian conflicts is applied.

An important conflict in the area is the pressure of proprietors of sugar cane operations to acquire more land during high demand seasons, since such plantations require greater extensions. Another conflict, which doesn't involve hillside and highland cultivators, is the pressure from armed groups and dealers to maintain control over the coca and poppy plantations, and the government reaction to fumigating the zone. The management of this conflict depends directly on decisions from the government.

- **Susceptibility to change and sense of belonging**

Within the project area there are positive expectations regarding the first harvest of Cassava. It is perceived as an economically viable alternative to the effects and risks of illegal cultivations, to which a great portion of the population turned to as a primary source of income. Some of the reasons which justify this reasoning are :

- The population in the project has a first rate road, the Pan-American Highway, which communicates the southern part of the country both with the capital of the Department, of Valle, and the rest o the nation. This favors commercial, cultural and institutional exchange.
- The Indian ethnicity of the Corinto municipality has high hopes for the project because a recent redistribution of the land, authorized both by the national government and the Toez reservation of Caloto, has been strengthened by the application of the Paez law.

Tables below show reported values of interaction both for cultivation activities and for environmental aspects:

Table 21. Values for Interaction Registered for Cultivation Activities

Phase	No.	Activity	Quantification of Environmental Interactions			Value of the Interaction
			A	B	Innocuous	
PHASE OF ESTABLISHMENT AND MANAGEMENT OF CASSAVA CULTIVATION	A	Field Cleaning	22	8	17	-98
	B	Field preparation	20	8	19	-84
	C	Seeding	5	10	32	15
	D	Fertilization	11	13	23	8
	E	Lime Addition	12	12	23	0
	F	Weed Control	24	11	12	-65
	G	Plague Control	22	8	17	-70
	H	Sickness Control	22	8	17	-70
PRODUCTIVE PHASE	I	Harvest	18	10	19	-56
	J	Collect and Transport	7	9	31	8
	K	Postharvest Management	9	12	26	12
PHASE OF INDUSTRIAL PROCESSING OF CASSAVA	L	Washing and Cleaning	7	2	38	-25
	M	Shredding	5	1	41	-12
	N	Sifting	6	1	40	-10
	O	Sedimentation	6	1	40	-10
	P	Drying	4	1	42	-9
	Q	Milling	4	1	42	-9
	R	Subproduct Management	8	3	36	-30
	S	Effluent Management	13	1	33	-120
	T	Disposal of Solid Residues	13	3	31	-100
TOTAL			238	123	579	

Table 22. Values of interaction Registered for Reference Environmental Aspects

Component	No. Impact	Reference Environmental Aspect	Quantification of Environmental Interaction			Interaction Value
			A	B	Innocuous	
Soil	1	Soil Compaction	6	0	14	-18
	2	Physical-Chemical Soil Quality	7	4	9	-9
	3	Soil Loss to Water Erosion	6	0	14	-18
	4	Geomorphologic Affectation	4	0	16	-12
	5	Agrochemical Contamination of Soils	5	0	15	-15
	6	Landslides in sloping land	7	0	13	-21
	7	Residual Effect by plaguecides and herbicides	4	0	16	-12
	8	Affectation of soil Fertility	5	4	11	-3
	9	Availability of Soil Nutrients	5	4	11	-3
	10	Recuperation and/or maintenance of Soil Fertility	5	3	12	-6
	11	Agrologic Capacity of Soils According to Cultivation Practice	5	1	14	-12
	12	Inadequate disposal of Solid Residues	15	0	5	-45
Sub-Total			74	16	150	
Water	13	Physical-Chemical Contamination of Water Sources due to runoff and leaking from Cassava crops	7	0	13	-9.8
	14	Chemical-Chemical Contamination of Water Sources due Cassava Processing	5	0	15	-7
	15	Affectation of drainage patterns	9	0	11	-12.6
	16	Surface Water demand for cultivation	4	0	16	-5.6
	17	Sediment contribution to water bodies from Cultivation Activities	6	0	14	-8.4
	18	Water Contamination due to Poor Disposal of Solid Residues	10	0	10	-14
	19	Surface Water demand for Processing Activities	5	0	15	-7
Sub-Total			46	0	94	
Air	20	Air Pollution due to burning and soil cleaning	8	0	12	-8
	21	Generation of odors due to cultivation and processing activities	9	0	11	-3.6
	22	Particle generation due to cultivation and processing activities	12	0	8	-12
	23	Air Toxicity due to cultivation and processing activities	5	0	15	-3
	24	Increase in noise due to cultivation activities	4	0	16	-2.4
	25	Increase in noise due to processing of Cassava	3	0	17	-1.8
Sub-Total			41	0	79	
	26	Change of vegetative cover due to cultivation	7	2	11	-5

Component	No. Impact	Reference Environmental Aspect	Quantification of Environmental Interaction			Interaction Value
			A	B	Innocuous	
Flora	27	Change in edafic community due to use of plaguecides	2	0	18	-2
	28	Changes in natural Landscape	11	1	8	-10
Sub-Total			20	3	37	
Fauna	29	Alteration of vital signs due to the use of chemicals	5	0	15	-5
	30	Migration of fauna due to cultivation activities	5	0	15	-5
	31	Affectation of Endemic Species	9	0	11	-9
	32	Endangered Species	9	0	11	-9
Sub-Total			28	0	52	
Ecosystems	33	Vulnerable	0	0	20	0
	34	Critical	0	0	20	0
	35	Protected	0	0	20	0
Sub-Total			0	0	60	
Socials	36	Employment	0	20	0	80
	37	Social Value Recuperation	0	3	17	9
	38	Sense of Ownership Strengthening	1	4	15	12
Sub-Total			1	27	32	
Economics	39	Receipts Generation	0	13	7	52
	40	Increment of the Economic Activities	0	6	14	24
Sub-Total			0	19	21	
Cultural	41	Redistribution of the Familiar Occupation	0	9	11	27
	42	Improvement of Cultivation Patterns	0	11	9	33
	43	Social Scenery Modification	6	3	11	-9
	44	Improvement of the Subsistence Allowance	0	13	7	52
	45	Strengthening of the Living Together	0	11	9	33
Sub-Total			6	47	47	
Institutional	46	Missing of a monitoring and control the Environmental Management System	19	0	1	-76
	47	Technical Assistance Support	3	11	6	32
Sub-Total			22	11	7	
TOTAL			238	123	579	

4.6 PESTICIDE EVALUATION REPORT AND SAFER USE ACTION PLAN, PERSUAP. PESTS AND PESTICIDE PROBLEMS IN CASSAVA CROP.

4.6.1. Introduction

Cassava farming poses a certain number of challenges regarding the management of crop pests and pesticides used to control them, which could likewise pose certain environmental risks that need to be dealt with.

The PERSUAP presents a summary of the pests of the Cassava crop and their management, including toxic and eco-toxic analyses for some of the main pesticides used, as well as the existing options for an Integrated Pest Management (IPM) program that allow for a continuous decrease in use of agrochemicals[2].

4.6.2 The Colombia Alternative Development (Cad) Program

The Colombia Alternative Development (CAD) program, funded by USAID in the context of Plan Colombia, supports farmers, farmers' families and farming communities that have been involved in production of illicit crops, such as coca and poppy, to switch voluntarily to licit crop production. Working with communities, community associations, and municipalities in the departments of Bolivar, Cauca, Caqueta, Huila, Nariño, Norte de Santander, Putumayo, and Tolima, the program is creating licit economic opportunities to generate income, improve the quality of life, protect the environment, and support ethnic and cultural values for peaceful coexistence. The program uses an open-bid approach to call for proposals from farmers' organizations in support of basic staple crops ('*cultivos de pan cojer*') as well as 'industrial' crops targeted to internal or external markets, many of them with associated industrial processing and transformation.

So far, most agricultural projects supported by CAD include low-input agricultural systems, ecologically appropriate, with an integrated, if not ecological or organic, approach to crop production and pest management. This is the case of Cassava where grower's research center, Cenipalma, changed 10 years ago the pest management approaches from a very heavy reliance upon pesticides, to the present IPM program based mainly on biological controls (see "Pest in Cassava Farming and Management Guide" in table No. 28). This is the type of alternative development that, by protecting the health of Colombians and their environment not only maximizes the chance of becoming sustainable in the long-term but also through diversifying production systems, increases production and reduce marketing risks.

[2] The detailed requisites for pesticides in Reg. 216.3.(a).10.(b).(1).(i).(a) – (l), being literals (a) through (l) will be presented as numerals 1 to 4.2 plus the subsequent explanatory tables 1 through 8.

<u>Recommendation No.1</u>: CAD should continue with this eco- friendly approach to promote alternative crops, leading into sustainable development, to benefit Colombian eco-environment and health of participant farmers and their families, as well as of consumers.

4.6.3 Spread of Insect Pests and Diseases

CAD is actually taking plant samples from traditional cassava farming areas to be introduced in other zones in Colombia. Although, most of these crops are not of foreign origin in the regions where CAD is operating, or in Colombia for that matter, they are grown in few places.

<u>Recommendation No.2:</u> In order to prevent dissemination of contaminated crop seeds with pathogens, insect pests, and weed propagates, CAD should establish a strict plant sanitation/quarantine system based on international standards and follow the Instituto Colombiano Agropecuario's (ICA) certification procedures and quarantines to control importation/transportation of plant materials into the country as well as from one region to another within Colombia.

4.7 PESTICIDE USE TODAY

There is no clear evidence of abuse or misuse of pesticides in CAD project crops. Two issues of concern, however, need to be mentioned. The first issue relates to the mentality of farmers that will participate in alternative development programs. Illicit crop farmers, such as those dealing with coca and poppy, are used to abundance of inputs to produce highly marketable and economically valuable illicit crops. Due to the extremely high prices paid for coca and poppy, the economic and action thresholds for pest control, as traditionally used in Integrated Pest Management (IPM), are so low that they become totally irrelevant for rationalization of use of pesticides. As such, pesticides as well as other agricultural production inputs are used in large quantities, subject to abuse and misuse. The tendency to use pesticides as the main, or even the sole, resource for pest management is one of the major challenges facing CAD in order to 'rationalize' pest management programs in alternative development farming.

The second issue is distribution of pesticides in Colombia. This is done through large- and medium-size distributors located in Bogotá, Cali, Medellín, and in other major cities in Colombia, continuing through mid- to small-size pesticide dealers located closer to the final users. During the visits carried out by the consultants to distributors, at all levels, we perceived (1) full compliance of Colombia manufacturers and importers with international codes regarding labeling and packaging of pesticides; (2) adequate size of pesticide packages as reported by the final users; (3) good degree of cleanness and organization in all stores visited; (4) no evidence of re-packaging of pesticides; and (5) a relatively good level of knowledge about pesticides, their toxicity and labeling by store attendants. A problem, although not directly observed but heard of in the field, seems to be illegal distribution of smuggled foreign pesticides, including products cancelled and prohibited in

Colombia. Given the general insecurity situation of the rural areas where CAD operates, Colombian authorities are limited in their capacity to fully control this illegal traffic of pesticides.

In summary, due to extremely favorable cost/benefit ratio on the use of pesticides in illicit crops, CAD farmers overuse pesticides in licit crop production as well, without the benefit of rigorous health or environmental analysis. Many of the products used are highly toxic and many are environmental hazards[3]. The well-controlled legal pesticide market is offset by illegal trading of pesticides that are difficult to control. These are major challenges that both, the Government of Colombia (GOC) and CAD, face in promoting environmentally friendly and sustainable alternative development.

<u>Recommendation No.3</u>: CAD should follow a strategy that (a) supports project operators to make farmers, and their families, fully aware of the health hazards of pesticides; (b) supports project operators, civil society and government authorities to make farmers, their families, and the larger Colombian community aware of environmental hazards, and social costs, related to pesticide abuse and misuse; and (c) provide technical assistance to project operators for Safer Use of Pesticides (SUP) and Integrated Pest Management (IPM), based on the principles of economic injury and action levels and thresholds[4].

4.8 PESTICIDE EVALUATION

The review of Cassava pesticides, presently used by farmers, recommended by technical institutions and/or so far requested by project operators for their productive activities are shown in the tables below. Most of these pesticides were cleared based on review of the 12 points of *22 CFR 216.3(b)(1)*. However, some of them do not fully comply with USAID environmental requirements for development projects. As a whole, only 5 active ingredients were selected, to be further studied as possible pesticides to be used in Cassava crop pest management control (see table 29). These pesticides were then subject to more complete risk analyses, discussed and shown in table 30.

<u>Recommendation No.4</u>: Some of the pesticides being presently requested and or purchased by CAD operators are to be *phased out* following the subsequent timeline. (a) In order to allow time for search of alternative products, preferably non-chemical, while still protecting the crops, the insecticides: carbofuran, chlorpyrifos, and profenofos, and the fungicides: chlorothalonil and copper oxychloride should be phased out in the medium term (1-1.5 years); (b) Due to higher than accepted health and environmental risks, and the availability of pest management alternatives to these molecules, the fungicides: benzimidazole, captafol, hexaconazole, kasugamicine and ofurace, and the insecticides: methomyl, cyfluthrin,

[3] More than 30 commercial pesticides are regularly used in Putumayo. Thirty percent of local farmers use paraquat at least once a month and 14% regularly use metamidophos, among other products (US Embassy, 2001).

[4] IPM programs may use economic injury thresholds, e.g. when pest populations reach high numbers causing economically 'significant' damages, and/or action thresholds, e.g. the population density or the damage level require application controls to prevent the pest to reach the economic injury threshold.

cyalothrine (lambda) and cypermethrine should be phased out in the short term (0.5-1 year);(c) highly toxic and easily replaceable insecticides: monocrotophos, metamidophos, aldicarb, isazophos, and methyl parathion and the herbicide: paraquat should be phase out immediately; and finally, (d) no product listed in the prohibited pesticides category in the U.S.A. or in Colombia, should ever be used in this project (see section 5.1.4).

4.9 SAFER USE PRACTICES

Colombia is one of the most advanced countries in Latin America in regards to pesticide registration, regulation and control, as well as in agronomy and associated disciplines. Colombia has adopted state of the art pesticide registration procedures, including international standards and codes for pesticide labeling and a follow-up system to control pesticide manufacturing and distribution, albeit limited by security issues during the past 25 years. Most technicians working in Colombia in pest and pesticide management have solid knowledge and understanding of IPM and safer use of pesticide procedures. However, there is room for improving interventions on Safer Use of Pesticides (SUP). The majority of farmers participating in CAD projects do not use the 'best practices' approach in dealing with SUP: less than 10% use some type of personal body protection in handling and product applications, and 70% of those directly exposed to pesticide spills do nothing, not even cleaning up or decontamination procedures (US Embassy, 2001).

Recommendation No.5: Considering the traditional attitudes and practices of participant farmers regarding use of pesticides, as well as the limited GOC official presence in isolated, and conflictive, areas where CAD is operating, it is recommended that a strong SUP program be implemented. Such program should (a) be based on the pre-existing training offer already available in Colombia; (b) attempt to raise 'awareness' of health and environmental pesticide hazards, as well as to teach 'good practices' on SUP; and (c) include parallel training in 'ecologicgal agriculture' and IPM, to prevent SUP to become a false panacea.

4.10 PEST MANAGEMENT APPROACHES

The majority of Colombian professional agronomists have been either exposed to or trained in, or understand IPM. IPM has become, not only the 'official' approach to pest management at the state-government institutional level (ICA), but also it has taken root in para-statal (Corpoica) institutions, in charge of pest and pesticide R&D, as well as in private R&D organizations. This is the case of grower's associations, such as Cenipalma, Cenicafé, Cenicaña, and Fedecacao. Moreover, Colombia is the headquarters for the well-reputed CIAT, the International Center for Tropical Agricultural Research, that has conducted pioneer research on Integrated Pest Management (IPM) of insect pests and diseases affecting various crops, especially in Cassava. In regards to this PERSUAP, we highlight the availability of IPM programs for CASSAVA, cacao, plantain, sugar-cane and rice crops, and timber plantations.

As shown in the tables below, Colombia is well advanced in the production of bio-inputs for pest management, such as microbial pesticides, entomopathogen fungi, bacteria and viruses, as well as nematodes and parasitic wasps. These bio-inputs are produced and sold in the country by a variety of small, mainly national, industries (see tables below). The important issue, from an IPM perspective, is that these products become readily available, a healthier and environmentally friendly option to use of chemical pesticides. Quoting an expert entomologist and IPM practitioner, "Colombia is better positioned than the U.S.A. in supplying bio-pesticides to agriculture".[5]

Recommendation No. 6: CAD is encouraged to disseminate among project operators the lists of bio-pesticides (Table 1) shown below, and to enterprises producing bio-products (Table 2), in an effort to promote use of bio-pesticides to substitute more toxic and environmentally hazardous chemical pesticides.

As per Reg 216 requirements, as stated previously, in order to avoid transmitting the false idea that pesticides, if used safely, could be the sole solution to pest problems, SUP should not be promoted in isolation but rather within the context of a larger, more comprehensive approach to pest management, i.e., Integrated Pest Management, or IPM. Colombia is well ahead in IPM research and development as well as in IPM training. In addition to pesticide analyses, a considerable amount of effort in the preparation of this PERSUAP has been allocated to the development of IPM matrices that summarize available tactics to manage major crop pests and provide the user with additional references on the subject, as well as main contacts for technical support and management in this section. This is aimed to benefit CAD project operators, providing guidelines in these tables guidance, to avoid the most toxic pesticides as well as providing non-chemical options for pest management.

Recommendation No.7: In spite of the technical level of field technicians working in CAD and CAD project operators, technical support in IPM should be strengthened. This may take the form of (a) crop specific field demonstrations on the use of non-chemical pest control methods; and (b) provision of support to technical staff of the operators for training-of-trainers, as well as training for farmers in specific IPM crop programs.

[5] Dr. Anthony Bellotti, Cassava IPM Leader, CIAT, personal communication.

Table 23. Main Biological Inputs Produced In Colombia*

Entomo-pathogen Fungi	**Fungi Bio-fungicides**	Parasitoids	Predators	**Entomopa-thogen Bacteria**	**Entomopa-thogen Viruses**
Beauveria bassiana	*Trichoderma harzianum*	*Trichogramma exigumm*	*Chrysoperla externa*	*Bacillus thuringiensis*	Nuclear Polyhydrosis Virus (NPV)
Metarhizium anisopliae	*T. lignorum*	*T. pretiosum*	-	-	*Baculovirus ello*
Paecilomyces fumosoroseus	*T. viridae*	*T. atopovirilia*	-	-	-
Nomuraea rilely	*Gliocadium spp.*	-	-	-	-
Paecilomyces lilacinus, minense	-	-	-	-	-
Verticillium lecanii	-	-	-	-	-

- Table courtesy of Dr. A. Bellotti, CIAT.

Table 24. Main Enterprises Producing Biological Inputs in Colombia*

Enterprise	Inputs = Organisms
Agricultura Biológica (Buga-Valle del Cauca)	Entomopathogen fungi, Parasitoids, Predators, Bio-fungicides
Agrobiol (Buga-Valle del Cauca)	Parasitoids
Bioecológicos (Palmira-Valle del Cauca)	Entomopathogen fungi, Parasitoids, Predators, Bio-fertilisers
Biocontrol (Palmira-Valle del Cauca)	Entomopathogen fungi
Productos Biológicos Perkins (Palmira-Valle del Cauca)	Entomopathogen fungi, Parasitoids, Predators
Productos Biológicos El Bolo (Palmira-Valle del Cauca)	Parasitoids
Laverlam (Cali-Valle del Cauca)	Entomopathogen fungi and viruses
Orius (Villavicencio-Meta)	Entomopathogen fungi
Biogarden (Bogotá-Cundinamarca)	Entomopathogen fungi
Biocaribe (Medellín-Antioquía)	Entomopathogen fungi
Live System Technology-LST (Bogotá)	Entomopathogen fungi, Bio-fungicides

* *Table courtesy of Dr. A. Bellotti, CIAT*

4.11 CAD ENVIRONMENTAL COMPLIANCE

CAD is undertaking full compliance of USAID environmental regulations in Colombia. Previous Initial Environmental Examinations (IEE) have been completed for most CAD projects and related activities, as per LAC-IEE-99-38 and LAC-IEE-00-35. A Programmatic Environmental Assessment (PEA) was completed for CAD and approved in June 2003. USAID required CAD to regularize environmental compliance, including preparation of a full study on pesticides used in alternative crops promoted by CAD. To this effect, Chemonics International commissioned the present Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP) for crop projects supported by CAD to date.

4.12 PERSUAP

This PERSUAP has been prepared to achieve the dual purpose of (a) complying with USAID environmental regulations, and (b) providing CAD project operators with practical tools for better and safer management of pests affecting their crops. The PERSUAP not only analyses pest and pesticide issues in crops supported by CAD, but also addresses broader issues related to pest and pesticide management in CAD and in Colombia, such as GOC regulatory and institutional frameworks, agro-ecology of areas of intervention, training and technical capacity strengthening, and provides guidelines for SUP and IPM, as well as identifying project opportunities in Colombia. Future commodities, pests and pesticide products to be considered under CAD, are covered in this document.

During preparation of the PERSUAP, visits were made to the Instituto Colombiano Agropecuario (ICA), the Colombian pesticide authority, and to major Colombian and international technical institutions offering pest management technology and training, such as Cenipalma, Fedecacao, IICA, Corpoica, Centro de Excelencia en Fitoprotección (Aphis, USDA, IICA, ICA, USAID), CONIF; universities (Nacional) and training centers (SENA); private sector (Bayer CropScience, ANDI, BioEcológicos, SEG, pesticide dealers); and environmental consultant companies (Tres Elementos, CAEMA). The consultant traveled to Norte de Santander (Cúcuta) and Putumayo (Puerto Asís), to meet CAD project operators, technical staff and conduct project observations on-site.

4.13 STATUS OF REGISTRATION OF PESTICIDES IN COLOMBIA AND WITH US-EPA: 22 CFR 216.3 (B)(1)(I)(A)

Close to 55 pesticide active ingredients were screened to determine the status of registration with (CA[6], and with the U.S. Environmental Protection Agency (USEPA)[7] The list of pesticides in

[6] Updated "Chemical Pesticide, Bio-inputs and Generics" database obtained courtesy of ICA authorities.

CASSAVA crop farming was compiled from information provided by CAD operators to Chemonics requesting clearance for purchasing pesticides as of June 2003, and other pesticides following the recommendations of Colombian public and private technical institutions[8].

Recommendation No. 8: The list of pesticides to be purchased by CAD operators should be screened by the CAD Natural Resources and Environment (NRE) team, based on pesticide lists included in this PERSUAP. Pesticides not mentioned in this PERSUAP should be subject to a screening process. Products not registered with ICA, Colombia and with US-EPA should not, in principle, be approved (see exceptions discussed below).

Recommendation No.9 : Below is a summary of the Cassava **crop pesticide analysis and recommendations:**

- **Products not registered in the U.S. and Colombia or in PIC[9] list. NOT TO BE USED UNDER ANY CIRCUMSTANCE: captafol, isazofol, methyl parathion and methamidophos.**
- **Products not yet registered in the U.S. or Colombia. Although the first product listed in this category is a microbial product, and the second is a plant extract, both products are NOT TO BE USED UNTIL REGISTERED at least in Colombia: *Baculovirus spodopterae* and *Swingla* (extracts).**
- **Products not registered in Colombia. NOT TO BE USED UNDER ANY CIRCUMSTANCE: endosulfan.**
- **Products not registered with USEPA. NOT TO BE USED UNDER ANY CIRCUMSTANCE: benzimidazole, hexaconazole, kasugamicine, monocrotophos, and ofurace.**
- **Products not registered with USEPA but registered in Colombia, APPROVED TO BE USED: extracts of *Glyricidia sepium*, since the product (*Glyricidia*), the crop (vanilla) and the pest (*Cylsia*), do not exist in the U.S.. *Paecilomices liacinus*, both the crop (heart of palm) and the pest (*Leptopharsa*) do not exist in the U.S.A., and the pesticide is a microbial insecticide with unlikely environmental or health impact; and *Trichogramma pretiosum* and *Verticillium lecanii*, are both microbial insecticides with unlikely environmental or health impacts.**
- **Products that are RUP with USEPA. NOT TO BE USED: aldicarb, cyalothrine (lambda) cyfluthrin, chlorothalonil, chlorpyrifos, copper oxychloride, cypermethrine, methomyl, paraquat, profenofos**
- **Products that are RUP[10] with USEPA. USE ONLY CERTAIN FORMULATIONS to reduce health or environmental risk: carbofuran (pellets/tablet), and picloram (Tordon 101R).**

---

[7] EPA databases were consulted at web sites.

[8] Technical information sources: ICA or Corpoica, Colombia government recommendations, growers' associations, research centers, international research centers and literature references applicable to Colombian conditions, with solid technical and scientific background.

[9] 'PIC List' is the Prior Informed Consent List of the Rotterdam Convention, led by UNEP and FAO, that applies to international shipment of most-hazardous chemicals.

Timelines for implementation of recommendations are shown in Table below:

TABLE 25. SUMMARY OF PESTICIDES TO BE PHASED OUT BY CAD

To be phased out immediately:			To be phased out within 6-12 months		
TECHNICAL NAME	**TRADE NAME**	**USES**	**TECHNICAL NAME**	**TRADE NAME**	**USES**
Monocrotophos	Azodrin	Heart of palm	Benzimidazole	Benomyl+	Requested by operators
Methamidophos	Tamaron	Various crops	Captafol	Difolatan	Cassava
Aldicarb	Temik	Potato	Cyfluthrin	Bulldock	Requested by operators
Isazofos	Miral	Potato	Hexaconazole	Anvil	Requested by operators
Methyl-parathion	Methyl-parathion, etc.	Rice	Methomyl	Lannate	Requested by operators
Paraquat	Gramoxone	Various crops	Kasugamicine	Kasumin	Potato

To be phased out within 12-18 months			To be phased out within 6-12 months		
Technical Name	Trade Name	Uses	Technical Name	Trade Name	Uses
Carbofuran	Furadan	Cassava,Rubber, Plantain, Nurseries	Ofurace	Grolan	Requested by operators
Copper oxychloride	Agrotox	Cassava	Cyalothrine, lambda	Karate, Terminex	Potato
Chlorpyrifos	Lorsban	Plantain, Oil Palm, Cassava, Rubber, Forest Plantations	Cypermethrine	Saat Pop, Agroper, Cipermetrina	Rice
Profenofos	Curacron	Rubber	----------	----------	----------
Chlorothalonil	Bravo	Rubber	----------	----------	----------

4.14 BASIS FOR SELECTING PESTICIDES: 22 CFR 216.3 (B)(1)(I)(B)

The main reason for selecting these pesticides is availability, efficacy and cost. This is typically the case of products such as chlorpyrifos and carbofurán that, although both are RUPs, they are some of the most effective, and cheapest, insecticides and nematocides, as well as preferred products for ant control.

A criterion usually overlooked in the selection of pesticides is pesticide formulation. A simple way to reduce exposure risk to certain pesticides, such as chlorpyrifos, is to switch to formulations like granules or pellets not subject to dangerous spills and drift. The same criteria may be applicable in reducing environmental impacts caused by certain pesticides, such as picloram, an herbicide, by

[10] RUP: Restricted Use Pesticide.

injecting this product in bushy weeds, instead of spraying; this helps in reducing the volume of the product applied on the target and the area impacted. Care must be exercised, however, because granular or pellet formulations, a more attractive method, are toxic to birds. In summary, the potential health and environmental impacts inherent to one or more formulations available in the market should always be considered, checked and analyzed in selecting a pesticide.

Recommendation No. 10*:* CAD should implement training in SUP for operator's technical staff on pesticide selection. Other variables such as product toxicity (using color-coded labels), potential environmental impact, and product formulation should be considered in selecting pesticides, in addition to efficacy, availability and cost.

4.15 PESTICIDES IN THE CONTEXT OF INTEGRATED PEST MANAGEMENT PROGRAMS: 22 CFR 216.3 (B)(1)(I)(C)

USAID's "Integrated Pest Management" policy is the most effective, economical and safest approach to pest control. IPM attempts to control pests economically and environmentally; it emphasizes non-chemical tactics that cause minimal disruption of the ecosystem"[11]. Pesticides should be used as the last resource in pest management after all other options have proven ineffective. Genetic (plant tolerance or resistance), biological (natural enemies), ethological (naturally occurring chemical disrupters), cultural (production practices), and mechanical (physical removal) are preferred tactics to be used before resorting to chemical control (pesticides).

Introduction on IPM possibilities for CASSAVA crops are shown in Table No. 28; including a list of various crop pest problems, management options available, specific pesticides for pests and potential problems and control options. The list also offers technical support offers at the institutional level, as well as individuals and other sources of information, such as literature references and websites.

Recommendation No. 11: No crop should be promoted without first establishing an IPM program. CAD should install at least one IPM demonstration site for each crop in project sites. To this effect, CAD should work with local UMATAS (Municipal Agronomic Technical Assistance Unit) and request technical support of the institutions and individuals listed in pest management proposals.

4.16 METHOD OF APPLICATION: 22 CFR 216.3 (B)(1)(I)(D)

Although a few farmers may have access to stationary-pump spraying systems, a common device in illicit crop zones, most pesticide applications are done with back-pack sprayers. Using sprayers often result in: (a) poor maintenance causing leaks and significant exposure of the applicator to

[11] USAID/AFR Guidance: Preparing PERSUAPs for Pesticide Programs in Africa.

pesticides, and/or (b) inappropriate nozzle settings not responsive to pesticide specifications (insecticides, fungicides or herbicides). Pesticide mixing is also an issue; more often than not, farmers do not follow precautionary measures, high product concentration or undiluted mixes increases the risk of exposure. Often enough, women and children in project areas participate in mixing operations or stay close to mixing sites, or near spraying equipment being cleaned or maintained. Finally, cleaning and disposing of surplus pesticides and product containers should follow strict safety regulations, to minimize human and environmental risks.

Recommendation No.12: CAD SUP program must support three essential components: (a) a comprehensive training program on "best practices" in SUP (see 3.11); (b) insist operators in wearing appropriate[12] protective clothing and equipment (gloves, masks, boots, etc.); and (c) maintenance and repair of spray equipment.

4.17 POSSIBLE TOXICOLOGICAL HAZARDS TO HUMANS OR TO THE ENVIRONMENT: 22 CFR 216.3 (B)(1)(I)(E)

A pesticide risk analysis was done on 9 products that passed the first screening test (see Table 31). This analysis included identifying acute and chronic toxicity of selected pesticides on humans, eco-toxicity and potential for water contamination. As a result, recommendations were drawn in regards to general and specific mitigation activities to be conducted in order to prevent and/or reduce the potential health and/or environmental impact hazard of pesticides used in program activities. These mitigation activities are all included within the comprehensive risk-mitigation SUP and IPM programs.

Recommendation No. 13: CAD should socialize and share with project operators the results of the risk analysis of the pesticides and assure full implementation of mitigation measures recommended.

4.18 EFFECTIVENESS OF PESTICIDES: 22 CFR 216.3 (B)(1)(I)(F)

Recommendations for pesticide and other pest management tactics to be used in project crops have been drafted and/or double-checked with authorized agricultural R&D institutions in Colombia. Additionally, technical literature references and relevant websites were consulted. It should be noted that CAD has access to many institutions that can provide technical information and support, as well as training in pest and pesticide management.

[12] This means adequate for local climatic conditions (temperature and humidity) and possible adaptations using local materials (plastic bottle masks, plastic bags-gloves, etc.) instead of imported clothing.

4.19 COMPATIBILITY OF PESTICIDES WITH TARGET AND NON-TARGET ORGANISMS: 22 CFR 216.3 (B)(1)(I)(G)

The pesticide risk analyses mentioned above, discuses the main risks inherent to use of pesticides on non-target organisms and the environment, as well as potential impacts on target organisms, such as the likelihood of encouraging development of pest resistance. Information on main direct mitigation measures to prevent and reduce the potential impact of pesticides to non-target organisms is also provided. General approaches to prevent and mitigate health and environmental impacts of pest management activities are discussed elsewhere in this PERSUAP, as well as SUP and IPM.

4.20 PREVAILING CONDITIONS IN AREAS SUBJECT TO USE OF PESTICIDES : 22 CFR 216.3 (B)(1)(I)(H)

Large portions of Colombia are plains, located below 500 meters above sea level (m.a.s.l.). The country could be roughly divided into six great geographical regions: the Andean zone, including three mountain ranges and the "inter-Andean" valleys; two coastal regions, the Caribbean and the Pacific; the plains of Antioquia; the Amazonian forests; and finally, the insular region.

CAD is being implemented in southeastern Colombia, in the Departments of Putumayo, Huila, Cauca, Nariño, Caquetá, and in the department of Norte de Santander, in northeastern Colombia. Illicit crops, coca and poppy, abound in these departments.

Colombia's climate is tropical with weather patterns strongly influenced by the Andes. They are normally classified as: (a) hot zones covering close to 84% of the territory, reaching up to 1,000 m.a.s.l. with average temperature of 24º C; (b) temperate zones, at altitudes between 1,000 to 2000 m.a.s.l., with average temperature of 17.5º C; and (c) cold zones, with average temperature of 12º C, and altitudes of 2,000-3,000 and over m.a.s.l..

Ecologically, Putumayo, Caquetá, Norte de Santander, and Huila have predominant pre-mountainous humid forests (Bh-pm) with close to 1,000-2,000 mm/yr, 18-24˚C, to low mountainous forest (Bh-mb) 2,000-2,500 m.a.s.l. 12-18˚C. Cauca, Nariño and Tolima have predominance of pre-mountainous to mountainous forests with a variable levels of humidity and temperate to cold climate.

4.21 AVAILABILITY AND EFFECTIVENESS OF OTHER PESTICIDES AND OF NON-CHEMICAL CONTROLS: 22 CFR 216.3 (B)(1)(I)(I)

The use of pesticides in CAD projects will be inserted into comprehensive IPM programs. The "Decision Making Tree for IPM & a Guideline for SUP", discussed above, should help in making decisions in regards to pesticide use. Matrices shown in this section present available pesticide options and pest management tactics for crops and pests in question. There are, however, some

problems with certain recalcitrant pests, such as ants, that are ubiquitous and pose a serious threat to certain crops, such as young trees, rubber, Cassava and heart of palm. Ants are not easy to control, and tend to draw to some of the most toxic chemicals, such as carbofuran and chlorpyrifos. Non chemical options are being suggested and proposed in the pest and pest management matrices for some of the crops.

EXAMPLE OF A NON-CHEMICAL APPROACH TO RECALCITRANT PESTS: THE CASE OF ANTS

- Attractive baits
- Nest destruction early in development stages
- Prevention of the emergence of winged ants with covers
- Applying cal to change pH and destroy the fungi that is used as a food by ants
- Seeding castor bean (*Ricinus communis*) in rotation or inter-cropped (inhibits ants)
- Plough-in green manure (organic matter attracts them away from crop)
- Irrigation
- Mulching with *Melia azedirach* materials (inhibit ants)

4.22 CAPABILITY OF COLOMBIAN INSTITUTIONS TO REGULATE AND CONTROL PESTICIDE USE: 22 CFR 216.3 (B)(1)(I)(J)

As stated above, Colombia is one of the most advanced countries in Latin America with respect to pesticide registration, regulation, and control. Colombia has very modern registration procedures, applies international standards and codes for pesticide labeling and has a system to follow up and control pesticide manufacturers and distributors that is only limited by the insecurity situation that the country has been living in for the past 25 years. The Instituto Colombiano Agropecuario, ICA, in charge of pesticide regulation, has taken more than 30 actions to ban hazardous pesticides or groups of pesticides, among which DDT, methyl bromide, canfechlor, captafol, all organochlorides, and toxaphene. Moreover, ICA requires that all Class IA and IB pesticides sold in the country have a back up 'prescription' written by a professional agronomist. Undoubtedly, the widespread insecurity in the majority of the rural territory of the country, and more specifically in the areas where CAD is active, limits the enforcing capacity of the GOC institutions. Although, the degree and effectiveness of controls in these areas is somehow limited and less than desirable, during the preparation of this PERSUAP we had first hand evidence of on going inspections to pesticide dealers in the Department of Putumayo, one of the most affected by the conflict.

Colombia pesticide regulations fits within its larger environmental framework, as per law 99 of 1993, "Fundamentals of the Colombian Environmental Policy". This law created the Ministry of

Environment and the National Environmental System and established the "Environmental License" further regulated by decrees 1728 of 2002 and 1180 of 2003.

The modernization of Colombia's legislation related to pesticides begins with a major law, No. 09, approved by the National Congress in January 1979, regulating "hazardous substances, pesticides, and pyrotechnic articles". This law was followed by decree No. 1843, from 1991, that further "regulates the use and management of pesticides". This decree defined and clarified terms and elements for the registration of pesticides, such as "efficacy", "contamination", "fumigation", "residue limits", "risk" and "toxicity", and officially adopted the four-classes WHO hazard classification of pesticides[13]. The same decree further regulated the manufacture and distribution of pesticides in the country.

More recently, Colombia has fully adopted the regional norms that derive from the actions taken by the 'Andean Community" (Comunidad Andina, CAN), to which Colombia is a signatory. The CAN, a result of the integration of Bolivia, Colombia, Ecuador, Peru and Venezuela, began activities in 1997 and in 1998, the 'Andean Norm for the Registration and Control of Chemical Pesticides for Agricultural Use" (Decision 436) was enacted. In this regulation, the five Andean countries committed themselves to a normative towards a common system for registration, control and use of pesticides. CAN decision No.436 established, among other things, (a) the requirements for pesticide registration; (b) norms for labeling and packaging; (c) maximum residue tolerances; and (d) norms for product efficacy research. Later, according to resolution 532, of August 2001, CAN adopted the 'Technical Manual for the Registration and Control of Chemical Pesticides for Agricultural Use", which was fully developed and published in June 2002, in Resolution 630. This is very comprehensive manual, including detailed instructions to register chemical pesticides, with all the information requirements on the technical as well as the formulated material, as they relate to efficacy, human and eco-toxicology, residues, labeling, packaging, risks and the environmental management plan. Finally, ICA, as the GOC institution in charge of registration and control of pesticides, fully executes the application of the CAN decrees internally to Colombia, in its resolution No. 00770 of March 2003.

Given this comprehensive and detailed pesticide regulation framework, again, the capacity of Colombia to regulate and control pesticides is only restricted by the general situation of the country, with somewhat weak institutional presence in certain isolated areas. This scenario, however, does not preclude, as we reported above, that ICA authorities are still enforcing some pesticide rules and regulations.

[13] The WHO classification: IA (extremely hazardous), IB (highly hazardous), II (moderately hazardous), III (slightly hazardous), and 'U' (improbable of presenting an acute risk in normal use). The LD_{50} used for chronic toxicity is either oral (O) o dermal (D). Colombia uses the same classification but classes are numbered I-IV.

4.23 PROVISIONS FOR TRAINING IN SUP AND IPM: 22 CFR 216.3 (B)(1)(I)(K)

CAD supported SUP training program should focus on risk reduction rather than on safe use of pesticides. In other words, instead of sending the message that pesticides could be used safely, the main goal of the training program should be to reduce the risk of farmers and their families by the careful analysis, and management, of the variables that affect the components of risk:

Risk = toxicity x exposure

This means that the "safer use", through risk reduction, begins before the "use" of the product, during its selection and preparation, and continues well after its use, in the field where the product is applied[14].

SUP training could be sub-contracted from Bayer CropScience or from Servicio Nacional de Aprendizaje-Asociación Nacional de Industriales (SENA-ANDI). The former, a chemical company, runs a program called "Agrovida" that focuses on SUP for farmers or farmer's families. Since women and children are in the higher vulnerability group, and women are often involved in storing pesticides as well as in cleaning farmer's clothes, they are an audience of extreme importance to be reached with messages of risk reduction. The second is a joint program between a GOC agency, SENA, and the Association of Industrialists, offerings two options, a two-day user targeted training course, and a 5-day training-of-trainers event. CAD should consider training a few 'trainers', from the operators' staff, in each one of the regions where it operates.
The contents of the training program may need to be adjusted to attend to various audiences, but nevertheless, it should include the themes listed in the training program attached, such as risk management, toxicology, labels, transporting, storage, mixing, spraying, cleaning, discarding, container management, applicators protection, etc.

<u>Recommendation No. 14:</u> Training on SUP should (a) focus on risk reduction; (b) reach the various important audiences: pesticide dealers, farmers, farmer families (women and children), staff of CAD project operators (trainers); (c) use already available training offers in Colombia, such as the 'Agrovida' program, by Bayer CropScience, for farmers and their families (women and children), and/or that of SENA-ANDI joint training program for farmers and trainers.

As stated previously, in order not to transmit the false idea that pesticides, used safely, could be the sole solution to pest problems, SUP should not be promoted in isolation but rather in the context of a larger, more comprehensive approach to pest management, i.e., the Integrated Pest Management, or IPM. Moreover, training in ecological and organic agricultural concepts and practices may always

[14] For more details see in section 5.3 the Power Point presentation "A Practical Guide: Reducing Pesticide Risk", in Spanish.

help CAD project operators to better understand, and even search for and experiment with, non-chemical options for pest control

<u>Recommendation No. 15</u>: CAD should promote a holistic agro-ecological approach, not only to pest management but also to crop producers. Training facilities, as well as technical support, in topics such as IPM, organic or ecological agriculture, are available in Colombia from various institutions. A list of possible technical partners that CAD could resort to in the search for technical support follows.

Table 26. Technical Agreements For Cad

Institution	Crop	The Topics
CIAT	Cassava, dry-beans, vanilla	Pest & crop management
Fedecacao	Cacao	Pest & crop management
Cenicaña	Sugar-cane	Pest & crop management
Cenipalma	Palm oil, heart of palm	Pest & crop management
Centro de Excelencia en Fitoprotección (CEF)	Tree tomato, lulo, passion fruit, tomatoes, Amazonian fruits	Quarantine, pest management, pest risk analyses
Corpoica	Various	IPM in general; training
CONIF	Forest plantations, nurseries	Pest & crop management
IICA	Various	Ecological agriculture
IPGRI	Various	Quarantine & plant introductions
ICA	Various	Pesticides: registration & control; training
SENA	Various	IPM & organic agriculture; SUP; training
ANDI	Various	SUP training
Bayer CropScience	Various	SUP training: Agrovida
SGS / BioTrópico	Various	Certifications

4.24 EFFECTIVE MONITORING AND PESTICIDE USE: 22 CFR 216.3 (B)(1)(I) (L)

CAD is working with farmers associations and enterprises that have a relatively good level of organization. Most have well-trained field technicians monitoring pest management problems and the effectiveness of pest management methods being used, on a regular basis. Open and regular reporting lines exist within CAD project operators and Chemonics to communicate issues such as new pest appearances as well as failures of standard methods being used. Moreover, Chemonics Natural Resources and Environment Group has the capacity for, and it is taking a lead role in, monitoring the most significant environment related variables of the project, including the effectiveness of pesticides.

4.25 ENVIRONMENTAL COMPLIANCE

4.25.1 Monitoring

A set of compliance indicators and PERSUAP recommendations grouped by major themes is being proposed, as shown in the table below.

Table 27. Monitoring Plan for PERSUAP Recommendations

Monitoring Theme	Recommendation	Indicator/s	Special Requirements
Sustainable alternative development	1	♦ Poly-cropping promoted & adopted by farmers ♦ System approach to alternative development in place, promoted & being implemented	Re-asses promotion of crops versus systems
Phytosanitary system for movement of plant materials	2	♦ ICA certification in place for internal movement of plant materials ♦ Quarantine in place for foreign materials	Establish links with ICA
Safer Use of Pesticides: hazard awareness, pesticide phase out, pesticide screening, training program, equipment support, risk analysis	3, 4, 5, 8, 9, 10, 12, 13	♦ Operators aware of color band meaning in products & using info for selecting pesticides ♦ Operators pesticide request list regularly checked by CAD-NRE[15] team ♦ Trend for decreased 'red & yellow' band pesticides request lists ♦ No monocrotofos & paraquat by Dec '03 ♦ No methomyl & others by Aug 04 ♦ No chlorpyrifos, carbofuran & others by Aug 05 ♦ SUP KAP changed ♦ Parts & repairs offered for spray equipment	Training programs contracted & courses offered. Financial resources from CAD allocated for training & equipment
Integrated Pest Management: training (IPM, Eco), bio-pesticides, field demos	6, 7, 11, 14	♦ Ecological agriculture & IPM training contracted, offered, finished & KAP[16] monitored ♦ IPM demo fields installed & monitored for all crops ♦ Operators aware of & using bio-pesticides ♦ Operators using a wide range of pest management practices (more than 3 per pest)	Training programs contracted & courses offered. Financial resources allocated for IPM demos
Sustainability of Environmental Compliance	16	♦ Market-led environmental compliance through: organic agriculture, EurepGap, Illicit-to-Licit or other type of certification in place, or ♦ A third party system installed for auditing environmental compliance	Contacts made, bids open, resources allocated to initiate / catalyze both processes

[15] Natural Resources and the Environment
[16] KAP: Knowledge, Attitude and Practices.

4.25.2 LONG-TERM SUSTAINABILITY

Environmental compliance with Regulation 216 provisions, vis-à-vis pesticide issues could be assured through the auditing role of Chemonics NRE group. The group could check the pesticide purchasing lists submitted regularly by CAD project operators to Chemonics for approval and pesticide screening. It may also conduct project operator's field-checks to inspect pesticide storage buildings, follow up selected field operations and check on pesticide selection, mixing and use. [This has already been proposed in Recommendation No. 8]. However, since this monitoring is based mainly on a 'police' approach to compliance, its sustainability is somewhat questionable. Although, an important 'educational' component, on SU and IPM, has been included in this PERSUAP, farmers may 'comply' with environmental regulations only and as long as the policing pressure is maintained. And this will probably happen as long as USAID and Chemonics continue funding and implementing CAD activities. It could very well end-up right after that …

A similar approach, one that promotes a more direct participation and appropriation of environmental compliance issues by the Colombian civic society, is allocating the 'policing' role to a 'third party' such as a local NGO or a consultant. The profile of this auditing may be similar to the NGOs or consultants that Chemonics NRE group has already contracted to do the environmental studies of CAD productive activities. The local, Colombian, NGOs and consultant companies visited have demonstrated the capacity and the interest to undertake such work. Based on the table above (see section 4.1), and on the 16 recommendations of this PERSUAP, CAD could develop a more detailed monitoring plan, agreed to among USAID, Chemonics, and the CAD operators, and assign a third party agency its verification following a system of open bids, as it is normally done in CAD.

A more sustainable path to environmental compliance may be a 'market-led' mechanism. If the market rewards an environmentally sound, clean, ecological or whatever product, then farmers will have to comply with certain production norms in order to be able to access and receive that reward. Third party certification is the key to this and not necessarily has to take the form of purely 'organic' production. Some of the Colombian certifying agencies contacted, such as *Biotrópico,* are working on organic produce certification, with the support of IFOAM, but also certify other producers. Among the latter are the coffee growers associated in COSURCA, exporting 'fair trade' coffee to the U.S. market, through a project funded by USAID and UNDP. Other enterprises, such as the Swiss SGS, are certifying aromatic plant producers for EurepGap norms, as well as Colombian flower exporters. Finally, the fruit growers association ASPROME, based in Cali, is exporting 'organic marmalades' to Europe, certified by Naturland-IFOAM, from fruits produced in a project funded by GTZ, the German Government and the European Community. The certification system is so simple as to work out a detail set of agreed rules, and corresponding indicators to track them, between producers, donors, project implementers and the certifying agency. The rules could easily be those established as environmental compliance requirements in Regulation 216, tracked by indicators such as pesticides registered with Colombia-ICA and US-EPA, no RUP pesticides, no

class IA and IB products, etc. Again, the table in 4.1 and the 16 recommendations could be used as the basis for a framework for certification of USAID environmental compliance.

<u>Recommendation No. 16</u>: CAD is encouraged to seek a sustainable mechanism for pesticide environmental compliance. This could take the form of (a) a third party independent auditing on use and management of pests and pesticides by project operators; and/or (b) a market-lead environmental (vis-à-vis pesticides) compliance mechanism through a third party, independent, certification agency that assures 'organic', 'EurepGap', 'low-intensity pesticide use', 'IPM-based', or agricultural production based on Regulation 216 requirements.

4.26 TRAINING AND BEST AGRICULTURAL PRACTICES PLAN (BPA). RECOMMENDATIONS IN THE PESTICIDE EVALUATION REPORT AND SAFE USE ACTION PLAN PERSUAP[17]

Insect Pest[18] are one of the principal problems affecting agricultural production and crops, decreasing productivity and/or product quality, resulting in important economic losses. Moreover, improper management and abuse of pesticides utilized in plague control may also lead to severe economic losses and negative environmental impacts (air pollution, contamination of soil and water resources) as well as loss of biodiversity and other negative effects. The combination of the negative factors mentioned above also cause the worst of all affectations i.e., the health of agricultural workers, their families and even, the health of consumers of agricultural products, is threatened.

CAD complies fully with USAID's provisions, the grantee agency, established in USAID's regulation 216. CAD has already carried out detailed environmental assessments of productive agricultural and transformation activities that are being or will be supported by the project. Such studies are known as Environmental Assessments (EA) and include, normally, an environmental diagnosis of the project site, a study of potential impacts caused by project activities and an environmental management plan that proposes prevention and mitigation measures of possible environmental impacts caused by development activities.

Specifically, CAD just completed phase 1 of a detailed study on pesticides currently used in more than 20 productive projects, including alternative methods to replace the use of pesticides available in Colombia for agricultural plague management. CAD is presently implementing phase 2 of this study covering almost 40 additional crops. This study, called "Pesticide Evaluation Report and Safer Use Action Plan", or PERSUAP, follows closely the requirements stated in Regulation 216 of the United States Government applicable to each type of pesticide that may or will be used in CAD

[17] Draft No. 3, 29 October 2003

[18] The term Plague utilized through this document refers to its broad generic meaning, including insects, other arthropods and invertebrates, several pathogens, weeds and vertebrates.

projects, planned or recommended, for crop plague management, as called for in 12 sections of Regulation 216, including:

1. Status of registration of pesticides in Colombia and with USEPA;
2. Basis for selection of pesticides for any particular application; why was such pesticide selected?
3. To which extent are pesticides part of Integral Plague Management systems?
4. Methods of application, including availability and use of appropriate equipment for application of pesticides and protective measures;
5. Acute long-range risks to humans and the environment, associated to proposed use of pesticides and available measures to reduce dangers thereof;
6. Efficacy of selected pesticides to meet expected results;
7. Compatibility of pesticides with natural ecosystems within their main objectives or other project objectives proposed;
8. Conditions under which pesticides will be used, including weather, flora, wildlife, geography, hydrology and soils;
9. Availability and effectiveness of other pesticides and/or non-chemical methods to control target plague(s);
10. Capability of operators and project implementers throughout Colombia to regulate or controlling distribution, storage, use and final disposal of pesticides;
11. Provisions for training of pesticide users and operators;
12. Provisions for effective monitoring, use and efficacy of pesticides.

The study mentioned above includes a list of (a) **banned pesticides**, prohibited in Colombia and in The United States (the donor country) or in both countries; (b) **products not approved,** or restricted in The United States, or products potentially harmful to human health or the environment in Colombia. A process of substitution of these products within a 0.5 – 1 year timeframe has been established; and (c) **approved products** that may be utilized in CAD projects. Beyond the strict control measures exerted by CAD on the use of pesticides in CAD projects, there is a commitment to promote the Best Agricultural Practice (BPA) production activities, including Integrated Plague Management (MIP) and Safe Use of Chemical Pesticides (USP), to contribute to sustainable alternative development. With this in mind, CAD developed a far-reaching training plan in support of BPA, MIP and USP.

4.27 TRAINING PLAN, OBJECTIVES

The Training Plan follows-up the application of PERSUAP recommendations. Its general objective is **to develop technical capacity within CAD project operators, at the technical and production levels, to implement clean environmental production systems contributing to minimize hazardous risks on producers and consumers health.** This plan was developed to assure that CAD not only complies with PERSUAP recommendations, but also will meet program indicators and goals listed in the Monitoring Plan, in regards to use of pesticides and agricultural plague management activities carried out by project operators.

Specifically, the Training Plan aims to develop particular and broad technical skills in (a) **safer use of pesticides in agriculture**, such as appropriate approaches: ecological, economical and social; (b) **integrated management of agricultural Pest**, applying appropriate technological, economic and social systems approach; (c) **ecological or organic agricultural production**, if such approach is economically feasible within a production methodology context applicable to protection of the environment and human health. The proposal aims towards offering general training and specific training to technicians to strengthen their capability, thus enabling technicians to offer productive options to participant farmers, including social, economical and environmentally acceptable elements.

Table 28. Pest in Cassava Farming ((*Manihot* spp.)) and Management Guide

General Comments: Cassava farming presents ideal conditions for biological control due to the fact that the duration of the vegetative phases of yucca is rather long (8-14 months). The main considerations in regards to biological control include: (a) high plague resistance levels are not necessary; (b) weather conditions, especially rain, play a key role; (c) in cultural control and agronomic practices, selection and collection of plant material, crop rotation, etc. for planting play a fundamental role; (d) careful application of insecticides should be made only as necessary.

Plague(s)	Control Methods	Plaguicides[i]	Problems
Arthropods:			
Acaros (several species)	Genetic: control of several varieties of plague resistant (cv) species.		Product not available in the market as yet.
	Biologic: development of predators and entomophatogen fungi.		Idem.
White flies (several genus and species)	Genetic: release NATAIMA – 31 a cv species already liberated.		Limited to the warm valley of the upper Magdalena river.
	Cultural: association of Cassava-caupí, planning during rainy season, removal of weeds.		
	Biologic: *Beauveria bassiana*, *Metarhizium anisopilae* and *Verticillium lecanii*		Several product are not accessible to farmers.
	Physical: yellow traps		
Horn worm (*Erinnys ello*)	Biologic: (a) parasitoids, *Trichogramma* sp., and predators, *Chrysopa* sp. and (b) microorganisms, *Bacillus thuringiensis* and Baculovirus		Available from BioCaribe distributors.
	Mechanical: manual collection of larvae.		
	Cultural: turn over soils, cut-off weeds, rotate crops. Physical: black light trap.		
Thrips (several species)	Genetic: several resistant cv. are available based on down (thin hair) and foliar shoots.		Ideal method, albeit not generally available and not well known..
	Cultural: adequate fertile soils and water availability. Avoid early application of pesticides.		
Underground chinche (*Cyrtomenus bergi*)	Cultural: intercalate *Crotalaria* in yucca crop.		*Crotalaria* has low market value, decreases yucca yieds somewhat. *Crotolaria* marketing under development.
	Genetic: HCN varieties are more resistant.		Exploratory.
	Biologic: nematodes and fungi		Exploratory.

[i] Pesticides in this Table are not necessarily recommended for CAD projects. Check pesticide Tables

Plague(s)	Control Methods	Plaguicides	Problems
White chizas (several species and genus)	Biologic: entomophatogen fungi *Metarhizium anisopliae* y *Beauveria basiana*) and bacteria *Bacillus popilliae*		
	Chemical	Clorpirifós and Carbofurán in soil and stakes.	Both are PUR with US-EPA. See recommendation.
Cutters (several species and genus)	Chemical-cultural: poisoned bait or application on affected sites.	Clorpirifós	PUR
Stem borers (*Coelosternus* spp., *Lagochirus araneiformis*, *Chilomima clarkei*)	Cultural: collect and burn crop leftovers. Capture of adult individuals using stake traps. Select stakes to be used in planning.		Difficult chemical control.
	Biologic: *Trichogramma* sp., *Bacillus thuringiensis*		
	Chemical:	Malathion	Apply in holes to minimize negative environmental impact.
Cutter ants (*Atta* spp.)	Cultural: change the ant's nest pH using lime to kill fungi, the queen's food.		
	Chemical: use insufflators on ant's nesting grounds.	Clorpirifós	PUR. See recommendation.
Diseases:			
Bacterial brown rot (*Xanthomonas axonopodis pv.* manihotis)	Genetic: some bacteria are tolerant.		Availability
	Cultural: healthy stakes, rotate yucca with corn, sorghum, corn barriers, adequate soil drainage, remove weeds, fertilize, eradicate sick plants, plant at the end of the rainy season.		
	Chemical: treatment of stakes	Cu Oxichloride , metalaxyl, captan	PUR. See recommendation.
Super enlargement (*Sphaceloma manihoticola*)	Genetic: resistant varieties		Dubious availability
	Cultural: healthy stakes. Rotate with corn, sorghum and similar species, plant during low-rain season.		
	Chemical: treatment of stakes.	Captafol or benomyl	Captafol not registered in Colombia. Do not use this product.

Plague(s)	Control Methods	Pesticides	Problems
Root rot (*Phythophtora* spp.)	Genetic: participative research in resistant varieties.		Availability
	Cultural: select adequate, deep soils. Plant in *caballones* and drain. Eradicate sick plants. Use healthy, clean seeds.		
	Chemical: treat stakes, as necessary.	Metalaxyl	Plant treatment ineffective.
	Physical: Heat treatment for stakes: (49°C during 49 minutes)		
	Biologic: *Trichoderma*		Not available in market, as yet.

Technical assistance sources, training and contacts:

1. CIAT: Dr. Anthony Bellotti, Líder MIP Yuca, a.bellotti@cgiar.org, specialist in entomology and yucca MIP de yucca. Coordinates a program including yucca pathologists and other experts.
2. Corpoica: Dr. Jairo Osorio, Co-ordinador de MIP, Tabaitatá, josorio@corpoica.org.co; works on *Chyllomimma,* weeds, and white fly.
3. CLAYUCA: Dr. Bernardo Ospina, Director, bospina@cgiar.org; CLAYUCA is the Latin American and Caribbean Consortium in Support of Research and Development of Yucca, provides technical assistance and training in many fucca related fields..

Principal Bibliographic References:

1. Ospina, B. and H. Ceballos. (eds) 2002. Cassava in the Third Millenium: Modern Production Systems, Processing, Utilization and Marketing.. Pages 131-268: Part C: Disease and Plague Management. CIAT / CLAYUCA / MAyDR-Colombia / FENAVI.
2. Ospina, B. and H. Ceballos. (eds) 2002. Practical Guide for Yucca Disease, Plague and Nutritional Deficiencies in Cassava. Several authors. CIAT / CLAYUCA / MAyDR-Colombia / FENAVI.
3. Arias, B., C.J. Herrera, A.C. Bellotti, y G.L. Hernandez. 2001. Technical leaflet: Biologic and Microbiologic Control of the Horn Worm in Cassava. (*Erinnys ello*). MAyDR-Colombia / CIAT / BioCaribe S.A.
4. Corpoica, MAyDR, CIAT. 2002. technical leaflet: NATAIMA-31: CassavaVarieties (*Manihot esculenta* Crantz) resistant to white fly (*Aleurotrachelus socialis* Bondar) in the Magdalena River warm valley.
5. CIAT, UMATA, FIDAR, Universidad Nacional. 1998. Technical leaflet: Radical Rot and Withering in Cassava Farming.

Table 29. Basis for the selection of Cassava Pesticides
[Addresses Reg. 216 point (b)]

Pesticide		Uses		Basis for Selection
Technical Name or Active Ingredient	**Trade or Commercial Name in Colombia**	**Crop**	**Pest**	
Captan	Captan, Merpan, Orthocide	Heart of Palm Cassava Nurseries Potato	Various diseases *Xanthomonas* Damping off *Phythophthora*	Cost. Availability. Effectiveness. Wide spectrum of insect pests controlled.
Carbofuran	Furadan, Carbofed, Curater, Furalimor, Fursem, Carbofuran	Cassava Rubber Plantain Nurseries Pastures	White grubs (various species) *Erinnys ello* *Cosmopolites sordidos* Nematodes Mión	Cost. Availability. Effectiveness. Wide spectrum of insect pests controlled.
Chlorpyrifos	Lorsban, Clorpirifós, Clorpiricol, Arriero	Plantain Oil Palm Cassava Rubber, Forest plantations	*Metamasius hemipterus,* defoliant. Sting bugs. *Strategus aloeus* Ants (*Atta* spp.) & stem cutters (various spp.) & white grubs. Erynnis ello.	Cost. Availability. Effectiveness. One of the very few products used for ant control. Wide spectrum of insect pests controlled
Copper oxychlor-ide	Agrotox, Coper-pro, Coperflow, Cuprene, Oxiclor, Oxicloruro de Cu	Cassava	*Xanthomonas axonopodis pv.* Manihotis	Cost. Availability. Effectiveness.
Dicamba	Banvel	Pastures	Weeds	Cost. Availability. Effectiveness.
Di-chloro-fenoxi-acetic acid (2,4-D)	Agritron, Anikil, Artillero,Aminex, Desyerbe, DMA, Agrogen, Formula 40, etc.	Pastures	Weeds	Cost. Availability. Effectiveness.
Gliphosate	Roundup	Cacao Oil palm, Heart of palm, Rubber, Plantain, Forestry plantations	Cacao plants affected by *Rose-llinia pepo* Weeds in general	Effectiveness. Reduced health & environmental impacts. Cost. Availability.

Pesticide		Uses		
Technical Name or Active Ingredient	**Trade or Commercial Name in Colombia**	**Crop**	**Pest**	**Basis for Selection**
Malathion	Inition, Cropthion, Fyfanon, Malathion, Algodonero	Cacao Plantain Cassava	Ants (*Atta* sp.), 'stings bugs'. Defoliants. Stem borers (*Coelosternus,Lagochirus*, *Chilomima*)	Cost. Availability. Effectiveness.
Metalaxyl	Ridomil (only in mixes with mancozeb)	Cacao Cassava Rubber	*Phytophthora* *Phythophtora y Xanthomonas* *Phytophthora palmivora*	Cost. Availability. Effectiveness. Unique product for Phytophthora control.
MCPA	Tiller, Aniten	Pastures	Weeds	Cost. Availability. Effectiveness.
Picloram	Tordon, Closser, Grazón	Cacao Pastures	Diseased cacao plants c/*Rose-llinia pepo* Bushy weeds	Cost. Availability. Effectiveness.
Trichograma pretiosum	Trichogramma	Various	Various	Effectiveness. No health & environmental impacts

Table 30. Cassava Pesticides[i]
Registration, Problem Analysis & Preliminary Decision [Reg. 216 point (a)]

Pesticide			Crop/s	Pest / s	**Type of Problem, if any**	**Recommenda-tions & alternative/s**
Technical Name[ii]	Trade Name[iii]	**Type & Tox Class[iv]**				
Captafol	Difolatan	Fungicide. WHO TC: Ia.	Cassava	*Sphaceloma manihoticola*	**Not registered in Colombia: P y C in 1999. In PIC list.**	**Not to use for any reason.** Use benomyl instead.
Captan	Captan, Merpan, Orthocide	Fungicide. WHO TC: U; Colombia TC: II	Heart of Palm Cassava Nurseries Potato	Various diseases *Xanthomonas* Damping off *Phythophthora*	In 'Bad Actor' list of PAN for possible carcinogenic & acute toxicity	**Aprobado.**
Carbofuran	Furadan, Carbofed, Curater, Furalimor, Fursem, Carbofuran	Insecticide, nematicide. WHO TC IB; Colombia TC I	Cassava Rubber Plantain Nurseries Pastures Potato	White grubs (various species) *Erinnys ello* *Cosmopolites sordidos* Nematodes Mión *Premnotrypes* & others	RUP with USEPA (Except pellets /tablets). In 'Bad Actor' list of PAN: cholin-esterase inhibitor & acute toxicity. Organophosphate In IRED-04 list.	**Should not be used.** Excep pellets/tablets for 24 months maximum. Revise registration status in 2004.

[i] Includes the pesticides being mentioned for the Cassava crop, requested by CAD Project operators and/or recommended as part of pest management programmes for these crops.
[ii] Generic name or active ingredient.
[iii] Name Ander which is sold in Colombia.
[iv] Type of action: fungicide, insecticida, herbicide, etc. As per WHO classification: IA (extremely hazardous), IB (highly hazardous), II (moderately hazardous), III (slightly hazardous), and U (improbable of presenting an acute risk in normal use). The LD_{50} used for chronic toxicity is either oral (O) o dermal (D). WHO TC is that of the active ingredient. Colombia TC is that of the formulated product available in the country.

Pesticide			Crop/s	Pest / s	Type of Problem, if any	Recommenda-tions & alternative/s
Technical Name	Trade Name	**Type & Tox Class**				
Chlorpyrifos (Clorpirifós)	Lorsban, Clorpirifós, Clorpiricol, Arriero	Insecticide, nematicide. WHO TC II; Colombia TC III	Plantain Oil palm Cassava Rubber, Forest plantatio ns Potato	*Metamasius hemipterus,* defoliant. Sting bugs. *Strategus aloeus* Ants (*Atta* spp.) & stem cutters (varias spp.) & white grubs. Erynnis ello. *Premnotrypes & Tecia*	RUP with USEPA In the 'Bad Actor' list of PAN: cholinesterase inhibitor. Organophosphate.	**Should not be used. Stop using formulations EC & WP within 12 months. Elimi-nate all formu-lations within a max of 24 month.** For the time being & to reduce risk, use only granular formulation.
Copper oxychloride (cobre, oxicloruro)	Agrotox, Coper-pro, Coperflow, Cuprene, Oxiclor, Oxicloruro de Cu	Fungicide. WHO TC III; Colombia TC III.	Cassava	*Xanthomonas axonopodis pv.* Manihotis	RUP with USEPA.	**Should not be used. Phase out in 24 months**
Dicamba	Banvel	Herbicide. WHO TC III; Colombia TC III.	Pastures	Weeds	In 'Bad Actor' list of PAN for repro-ductive toxin & possible water contaminant.	**Approved.**
Di-chlorofenoxi-acetic acid - 2,4-D	Agritron, Anikil, Artillero,Aminex, Desyerbe, DMA, Agrogen, Formula 40, etc.	Herbicide. WHO TC II; Colombia TC II ó III	Pastures	Weeds	In RED-2004 list.	**Approved**. But pendieng re-registration with USEPA in 2004.
Dichlorprop (Diclorprop)	Malezafin (with 2,4-D)	Herbicide. WHO TC III; Colombia TC not available.	Pastures	Weeds	In 'Bad Actor' list of PAN for repro-ductive toxin.	Approved.

Pesticide			Crop/s	Pest / s	Type of Problem, if any	Recommenda-tions & alternative/s
Technical Name	Trade Name	**Type & Tox Class**				
Gliphosate (glifosato)	Roundup	Herbicide. WHO TC U; Colombia TC III ó IV	Cacao Oil palm , Heart of palm, Rubber, Plantain, Forestry plantations	Cacao plants affected by *Rosellinia pepo* Weeds in general		**Approved.**
Malathion	Inition, Cropthion, Fyfanon, Malathion, Algodonero	Insecticide. WHO TC III; Colombia TC II-III	Cacao Plantain Cassava	Ants (*Atta* sp.), 'stings bugs'. Defoliants. Stem borers (*Coelosternus,Lagochirus*, *Chilomima*)	In IRED-03 list. In 'Bad Actor' lis of PAN for cholinesteras e inhibitor. Organophosphate.	**Approved.** But pending of re-registration with USEPA in 2003.
Metalaxyl (Metalaxil)	Ridomil (only in mixes with mancozeb)	Fungicide. WHO TC III; Colombia TC III	Cacao, Potato Cassava Rubber	*Phytophthora Phythophtora y Xanthomonas Phytophthora palmivora*	It was in re-registration with US-EPA.	**Approved.** Re-registration approved by USEPA in Sep 1994.
MCPA (only in mixes)	Tiller, Aniten	Herbicide. WHO TC III; Colombia TC not available	Pastures	Weeds	In RED-04 list. In 'Bad Actor" list of PAN for possible acute toxicity.	**Approved.** But pending re-registration with USEPA in 2004.
Picloram	Tordon, Closser, Grazón	Herbicide. WHO TC U; Colombia TC II, III, ó IV	Cacao Pastures	Diseased cacao plants c/*Rosellinia pepo* Bushy weeds	RUP with US-EPA – except Tordon 101R	**Not to be used, in general.** If no substitute available, use only Tordon 101R.

Pesticide			Crop/s	Pest / s	Type of Problem, if any	Recommenda-tions & alternative/s
Technical Name	Trade Name	**Type & Tox Class**				
Trichogramma pretiosum	Trichogramma	Biological antagonist of insects: parasitoid wasp. TC not available.	Various	Various	Registered in Colombia. Not yet with USEPA	**Approved**. Microbial product with unlikely environmental impact

Table 31. Cassava Pesticides – Risk Analysis

Pesticide[i]	Acute Tox Class[ii]	Type	Chronic Toxicity	Eco-toxicity	Groundwater Contamination Potential	Mitigation of risks / Comments[iii]
Captan	WHO: U Colombia II	Fungi-cide	Possible carcinogenic , acute toxicity. Unlikely reproductive effects. Non mutagenic, non teratogenic.	Non toxic to birds & bees. Very high tocity to fish. Moderate toxicity to moluscs, insects & zooplancton.	Low persistence in soils & water bodies. Degrades rapidly in neutral water.	Use with precaution protecting humans.
Carbo-furan	WHO: IB; Colom-bia: I. High acute toxicity	Insec-ticide, nema-ticide	Organophosphate = cholinesterase inhibitor. Liquid formulations pose serious threat to applicators (RUP reason). Highly toxic by ingestion & inhalation & modera-tely by dermal exposure.	Granular formulations pose serious threat to birds & possible other animals (RUP reason). Highly toxic to birds & fish.	High water solubility & so potential for ground water contamination.	RUP. Carbofuran uses should be minimised & carefully controlled to prevent human & envi-ronmental contamination. In IRED-04. Revise registration status in 2004
Chlorpyri-fos	WHO: II; Colom-bia: III	Insec-ticide, nema-ticide	Organophosphate = cholinesterase inhibitor. No other adverse effects except those associated to central nervous system.	May be toxic to some plants, e.g. lettuce. Mod-very toxic to birds & very highly toxic to fish & aquatic organisms	Unlikely to leach & contaminate water.	RUP. There is a 24 hour minimum re-entry time for field treated with it. Applications should be carefully supervised to prevent human & environmental exposure.
Copper oxychlor-ide	WHO: III; Colombia: III	Fungi cide	Acute effects include irritation of eyes & skin. Chronic toxicity includes hepatic cirrhosis & brain damage.	No evidence for adverse effects on the environment.	No evidence for potential for water contamination.	RUP To be used with caution because of its possible human health impacts.
	Acute				**Groundwater**	**Mitigation of risks /**

[i] Technical name or active ingredient

[ii] As per WHO classification: IA (extremely hazardous), IB (highly hazardous), II (moderately hazardous), III (slightly hazardous), and U (unlikely to presenta acute hazard in normal use). The LD_{50} used for acute toxicity is either oral (O) or dermal (D). Colombia uses the same scale but classes numbered I-IV.

[iii] General mitigation tactics to (a) reduce human exposure risks: protective clothing (mask, hat, glasses, long sleeves shirt, long pants, boots, gloves or plastic bags, washing clothing, no food, no drink, no smoking, no re-entry to fields, etc.) and (b) reduce environmental risks (mix exact amounts, no spray close to water dodies, to bee hives, to bird nesting areas, avoid windy days, etc.) are part of a more general SUP.

Pesticide	Tox Class	Type	Chronic Toxicity	Eco-toxicity	Contamination Potential	Comments
Dicamba	WHO: III; Colom-bia: III	Herbi-cide	Reproductive toxin. Otherwise no carcinogenic, mutagenic, or teratogenic effects have been noted.	Practically non-toxic to birds & low toxicity to fish. Not toxic to bees.	Highly soluble in water & does not bind to soil so it is a potential water contaminant	Should be used with care to prevent contamination of water bodies.
Di-chloro-fenoxi-acetic acid (2,4-D)	WHO: III; Colom-bia: II or III	Herbi-cide	Possible carcinogenic & suspected endocrine disrupter. Possible reproductive effects. Acutelly may be a serious eye & skin irritant.	Possible accumulation in the environment with effects on wildlife. Unclear status.	Potential contaminant	In IRED-04. Revise registration status in 2004. Handle with care to avoid skin & eye irritation
Gliphosate	WHO U; Colom-bia: III-	Herbi-cide	No evidence of any carcinogenic, teratogenic, mutagenic effects.	Slightly toxic to birds, non toxic to fish & bees.	Unlikely due to soil adsorption.	
Malathion	WHO III; Colom-bia: II-III	Insecti-cide	Organophosphate = cholinesterase inhibitor. Possible carcinogenic & suspected endocrine disrupter	Highly toxic to honey bees, moderately toxic to birds & variable toxicity to fish	Possible contaminant. It has been detected in well & ground waters.	In IRED-03. Revise registration status in 2003. Malathion should be used with great care in order not to expose workers & prevent water contamination & effects on bees & birds
Metalaxyl	WHO: III; Colom-bia: II	Fungi-cide	Carcinogeneicity still unknown. No other effects on humans.	Practically not toxic to birds, bees & fish	Potential water contaminant	Re-registration approved by USEPA in Sep. 94
MCPA	WHO: III; Colom-bia: not availa-ble	Herbi-cide (in mixes only)	Possible carcinogen. Significant reproductive effects have been observed in rats. Weakly mutagenic.	Not toxic to fish, slightly toxic to bees & moderately toxic to birds	Not likely. It is degraded rapidly by water micro-organisms	In RED-04. Revise registration status in 2004. Protect applicators.

Pesticide	Acute Tox Class	Type	Chronic Toxicity	Eco-toxicity	Groundwater Contamination Potential	Mitigation of risks / Comments
Tricho-grama pretiosum	WHO & Colom-bia: not availa-ble.	Biolo-gical anta-gonist: parasi-tic wasp.	Unlikely to cause any effect. No indication of carcinogenic, teratogenic, reproductive or mutagenic effects.	Bio-product with unlikely environmental impact. No adverse effects in animals. Naturally occurring in soils.	Unlikely contaminant.	Not yet registered with USEPA.

Table 32. BANNED PESTICIDES
Pesticides PIC, Prohibited, Restricted or Cancelled
In Colombia and/or in the USA[1]

Pesticide[2]	PIC[3] List	Registration status in	
		Colombia	United States
Aldrin	Yes	P (1974 in tobacco), C (1988)	No
BHC		P (1974 in tobacco), P (1978 in coffee), P (1993)	No
Methyl Bromide		P except for quarantine (1996)	RUP
Canphechlor		P (1978 in coffee), C (1988), P (2000)	No
Captafol	Yes	P & C (1989)	No
Chlorinated in tobacco		P (1974)	No
Chlordane		P (1974 in tobacco), C (1988), P (1993)	No
Chlordimeform		P (1987), C (1988)	No
DBCP (di-bromo-chloro-propane)		P (1982)	No
DDT		P (1974 in tobacco), P (1978 en café), P except in health (1986), P (1993)	No
Dicofol		P (1993)	Yes
Dieldrin		P (1974 in tobacco), C (1988), P (1993)	C
Dinoseb		P (1987)	C
Dodecachlor (Mirex)		P (1993)	C
2,4,5-T & 2,4,5-TP		C (1979)	C
Endosulfan		P except for coffee borer (1993 & 1997)	RUP
Endrin		P (1974 in tobaco), P (1985)	No
Ethylene di-bromine (EDB)		P (1985)	No
Fonofos		P (1992)	No
Fosfamin		C (1997)	RUP
Mercury Fungicides		C (1974)	No
Heptachloro		P (1974 in tobacco), C (1988) P (1993)	No
Isazofos		C (1996)	No
Leptofos (Phosvel)		C 1977	No
Lindane		P (1978 in coffee), C (1993), P except in health (1993), P (1997)	RUP
Maneb		C (1989), P (1993)	Yes
Metamidophos	Yes	Yes	Yes
Monocrotophos	Yes	Yes	Yes

[1] It is not an inclusive list for the US or PIC. It based on Colombia prohibited products.
[2] Thechnical name
[3] The list of products for "**Previous International Consent**", or **PIC**.

Pesticide	CIP List	Registration status in	
		Colombia	United States
Organochlorines in general		P (1974 in tobacco), P (1978 in coffee)	No
Paraquat		P aerial application (1989)	RUP
Parathion & methyl-parathion	Yes	R only for cotton & rice (1991)	RUP
Pentachlorophenol (PCP)		P (1993)	GUP & RUP (treatment of wood)
Posphamidon	Yes	No	No
TOXAPHENE		P (1975 in tobacco), P (2000)	No
Zineb		P (1993)	No

[1] It is not an inclusive list for the US or PIC. It is based on Colombian prohibited products.
[1] Technical name.
[1] The list of products for '**Previous International Consent**', or '**PIC**' (1998), of the United Nations Environment Programme (UNEP) and the Food and Agriculture Organisation (FAO). FAO leads in relation to pesticides. Alow importing countries to better know the potentially hazardous products that may be sent.
[1] '**P'** = '**Prohibited**' = '**Banned**" = the uses of the product are not permitted in the country, by explicit decision of the regulatory agency. '**R**' = '**Restringido**' = '**Restricted**' = in the sense of the USEPA, it is a pesticide that can only be applied by a certified applicator. '**C**' = '**Cancelado**' = '**Cancelled**' = registration cancelled without a specific prohibition. **No:** not registered.

SECTION 5 ENVIRONMENTAL CONSEQUENCES

5.1 ENVIRONMENTAL ASSESSMENT MATRIX

The Environmental Assessment's analytical matrix is an interdisciplinary tool for an objective judgment regarding the consequences brought about by the impacts derived from the execution of the activities of a project, by means of the identification and evaluation of the modifications introduced on a given set of prefixed environmental indicators.

The quantification defined for these modifications introduced in the environment are evaluated by the criteria on Table 33

Table 33.Quantification for the Different Criteria of Qualification

CRITERIA FOR CLASSIFICATION	QUALITATIVE VALUATION	QUANTITATIVE VALUATION
Character of Impact	POSITIVE	+
	NEGATIVE	-
Type	DIRECT	0.70
	INDIRECT	0.30
Duration	TEMPORAL	0.20
	PERMANENT	0.80
Scope	LOCAL	0.40
	EXTENSIVE	0.60
Tendency	REVERSIBLE	0.30
	IRREVERSIBLE	0.70
Synergy	YES	0.80
	NO	0.20
Probability of occurrence	HIGH	0.50
	MEAN	0.30
	LOW	0.20
Magnitude	HIGH	0.50
	MEAN	0.30
	LOW	0.20

The equation that relates impacts with respect to their value and from which one obtains the Environmental Quality CA is as follows :

$$CA = CI * PB[\alpha(DR * TD * MG) + \beta(SG * AL * TP)]$$

Where :

CA = Environmental Quality
CI = Character of Impact, + or - pending of its adverse or beneficial nature
PB = Probability of occurrence
DR = Duration of the Impact
TD =Tendency
MG = Magnitude
SG = Synergy

AL = Scope
TP = Type
α = Coefficient of importance (For DR, TD y MG = 60)
β = Coefficient of importance (For SG, AL y TP = 40)

In this manner, an "Environmental Categorization, "CA" has been established, involving all of the different criteria for environmental qualification, which can be related to an "Environmental Alteration" level, (EA), as follows :

ENVIRONMENTAL QUALIFICATION CA	ENVIRONMENTAL ALTERATION (EA)
>10.0	**VERY HIGH**
8.0-10.0	**HIGH**
6.0-8.0	**MEAN – HIGH**
4.0-6.0	**MEAN**
3.0-4.0	**MEAN – LOW**
1.0-3.0	**LOW**
<1.0	**VERY LOW**

The values of the preceding table can be related both for positive and negative impacts by entering the value of EC as the absolute value. The most relevant affectations on the environment that can be generated by the project, are indicated in table 4.2 and can be summarized as follows:

5.2 BIOTIC MEDIUM

Without doubt, the impacts of the Cassava cultivation integration project on the biotic medium are, in general, adverse. However, the environmental qualification on most of them is of less than two, which means the project generates an environmental alteration between low and very low.

On the impacts classified as change in the edafic community through the use of insecticides and change in the vegetative cover, the environmental qualification was the highest, (-4.4 and-4.2), which means the environmental alteration is medium.

These impacts are mainly caused during the preparation of the terrain, the plague and weed control phases, (because of the use of insecticides, fungicides and herbicides), and during the post harvesting period. They occur in an indirect manner, locally in the majority of the cases, and are of temporal duration. The impacts on the flora are synergic while those on the fauna are not.

5.3 PHYSICAL MEDIUM

The physical elements are also affected in an adverse manner; the greatest environmental qualification values are related to the chemical an physical affectation of water sources through the exploitation of the Cassava root, (-7.6), followed by the contamination of the soil through chemicals, (-6.6), physical and chemical quality of the soil, (-6.6), residual effect of insecticides and herbicides, (-6.2), impact on the fertility of the soil, (-5.0),

inadequate management of solid residues, (-4.8), and contribution of sediment to the water sources during cultivation activities, (6.0). The Environmental Alteration generated by the project in these areas is between medium and medium high; on the other items, values are less than 4, so the alteration is very low to medium.

In general, within the physical medium, the soil is the resource which is most affected, although the impact is temporary, local, and tends to be reversible; it is of medium magnitude, synergetic and of a high probability of occurrence.

The water resources are affected in a totally adverse manner by the project activities; the probability of occurrence is between medium and low, but the magnitude is low and the effects are of a temporary and reversible nature.

The water resources are also affected by the activities of the productive project due to the possible influx of waters contaminated by the pesticides employed in plague and weed control in the surface currents that drain the plantation area. However it has been classified as having low magnitude, since the application of these substances is manual and plant by plant, which prevents overdoses that would increase the likelihood of the contaminant reaching the water.

The substances that may enter the water bodies are of the organic-phosphorated type, (chemical organic compounds derived from phosphoric acid, which are not persistent in the medium and are destroyed by hydrolysis, leaving no ostensible residues nor any long term ones), carbamates, (a new family of organic insecticides, after the chlorated and the phosphorated, which are found in different forms under different groups of carbamic derivatives, conferring each substance a different function; the ditiocarbamates are fungicides; the fenilcarbamates herbicides, and the metilcarbamates insecticides), and piretrines, (extracted from the flower pelitre, "*Chrysantemum cinaerifolium*", which has been known for some time but only since the 1930´s has been commercialized; it is still used for the control of flies and mosquitoes, although they are very toxic in the aquatic medium).

The first two, in the organic families, have toxicity degrees between high and moderate, (I and II); the volumes that will reach the water are minimal; the main advantage of carbamates is their lower toxicity to humans and domestic animals.

These impacts are adverse and repeat themselves in a cyclic manner, since they occur when the respective pesticides are applied. They can be mitigated building barriers that will prevent the direct influx of these substances to the water. It would also be worthwhile for the agronomists and technicians of the project to test biological pesticides, which would eliminate the toxicity and residual nature of the products now in use. Within the project population itself there are people that use biological methods for plague control, that are slowly becoming more widespread with the rest of the cultivators regardless of the fact that they are substances developed from individual personal knowledge of the cultivators and their ancestral customs.

The impacts affecting the air are adverse, but the magnitude in which they act is low. These impacts are, in general temporary, local, non synergetic and with tendency to be reversible, however the probability of occurrence is high.

5.4 SOCIOECONOMIC MEDIUM

The impacts over the socioeconomic medium are, in general, positive with the exception of the lack of a follow up and environmental control system, which is adverse with an environmental qualification of -3.3, showing a medium low environmental alteration.

The beneficial impacts generated by the project that are most significant are related to the improvement of family diet, (+5.7), generation of employment, (+5.4), generation of income, (5.4), distribution of family work, (+5.4), and increase in overall economic activity, (+5.0), thus, the environmental alteration is considered medium high. The other impacts over this medium have environmental qualification values between +1 and +3.2. In this group, it is important to notice that technical assistance, (2.0), has a low environmental qualification because of the low level of present coverage among the cultivators. In this respect, several of the activities of the EMP involve, as an important activity, training and technical assistance from the project towards the agricultures.

In general, all of the impacts generated and identified by the productive project have a future projection that is beneficial, and applies mostly to the direct area of influence; they are of a temporary duration, moderate to high magnitude, and have a large probability of occurrence if the operating conditions of the project are maintained. Coverage of the impacts is local, although some effects can be produced outside of the project area, particularly those related to marketing and transportation of the products. Towards the future, the impacts are synergic because they are prime motivators of social welfare.

Analyzing the duration parameter, it would be expected that the impulse given to the project by the PNDA, would make the farmers organize in a way that would permit them to cultivate Cassava not only as a subsistence crop, but also in one that has semi-industrial or industrial characteristics and could give them profits within an acceptable economic range, to improve their way of life and dissuade them from dedicating themselves to illicit crop cultivation in the higher zones, while protecting the environment

In table 34, a summary is presented of all the values of environmental qualification and alteration for each one of the resources identified, for the project of cultivation and processing of Cassava. In order to determine the value of environmental qualification of each one of the resources, an arithmetic mean of the values obtained for CA in each one of the impacts identified was.

Table 34. Summary of the Values of Environmental Quality Obtained for each one of the Resources

RESOURCE	ABSOLUTE BEHAVIOR	ENVIRONMENTAL ALTERATION (AA)
Soil	-4.8	MEAN
Water	-3.4	MEAN TO LOW
Air	-1.2	LOW
Flora	-3.0	LOW
Fauna	-0.9	VERY LOW
Social	+5.1	MEAN

As it can be inferred from the average of the different AC values reported in the list of the identified impacts, the resource that presents the most adverse environmental alteration, (EA), is the soil, (-4.0), related primarily to the use of agrochemical products, which alter the physical – Chemical quality of the soil, contaminate it, and create a residual effect. Because of this, the EMP has considered the control and management of these impacts by means of Form No. 1, Cultural Practice; Form No.2 Agronomical Cultivation Practice; Form No. 3 Management and control of Plaguecides and Herbicides; and Form No.4, management and control of weeds.

In descending order, the next adverse effect occurs on the water, (-2.70). The activity that compromises the water quality is the physical and chemical contamination generated by the Cassava processing, (Processing Plant or Rallanderia). Among the project activities, the tilling of the soil produces sediments that reach the natural water bodies. In order to mitigate the environmental effects of these activities, a number of actions have been proposed in Index Form 8, "Control and Use of Water in Semi-Industrial Activities Related to Cassava Processing", and in Index Form 1, "Cultural Practices".

The most adverse effects on Flora, (-2.2), occur because of the change in edaphic community due to the use of Plaguecides; to prevent this, the Consultants have proposed the measures included in Index Forms 2, "Agronomic Cultivation Practices", and No. 3, "management of Plaguecides and Herbicides".

The most adverse effect on Air, (-1.0), is the generation of particles due to the tilling of the soil during field preparation activities, and the increase in noise during the processing phase. These impacts are controlled by the recommendations included in Index Form 1, "Cultural Practices", and No. 10, "Implementation of Clean Technologies for Field Preparation".

Other effects of lower consequence have also been included in the formulation of the EMP, in order to provide an integral environmental management of the physical and biological resources affected at present by the project activities.

The beneficial alteration of the project is concentrated in the social environment, were most of the positive CA ratings were. The average of the CA values was 3.3, corresponding to a medium low alteration. In order to complement the beneficial aspects of the project, some measures are proposed in Index Forms 15, "Strengthening of the Sense of Belonging"; No.

16, “Environmental Education”, and No. 17, “Industrial Safety”. Averaging negative and positive CA ratings, it is found that the overall environmental result of the project is beneficial, albeit of low incidence.

Finally, it can be said that, although the different activities in the “Productive Chain Project for Cassava Cultivation in the Department of Cauca”, are producing impacts in the environment, these impacts can be mitigated, as well as the beneficial aspects enhanced, once an EMP is effectively implemented, diminishing the CA values of negative ratings to cero and augmenting the beneficial CA values to better the conditions for the community and for the environment.

5.5 ENVIRONMENTAL MANAGEMENT PLAN

5.5.1 Overview

Although the adverse impacts or affectations generated by the integration of the chain of cultivation of the Cassava plant project in the department of Cauca don’t have the dimensions that this cultivation would have in an ecosystem untouched by man, this portion of the report shows the actions, and mechanisms focused to control, mitigate, prevent, correct or compensate the impacts that the cultivations might have on the environment.

The environmental management recommendations that should be kept in mind in the development of the cultivation can be preventive, (to avoid the impact from happening), corrective, (recommendation of measurements that will modify the action that the impact produces and to prevent it in the future), mitigating or ameliorating of the impact, or compensating when the impact is impossible to prevent, correct or mitigate.

5.5.2 Methodology

Each program or mitigation measure contains in detail the specific factors that can generate environmental effects, the mitigating measures provided, and strategies to monitor the activities. In general, each measurement has the following contents:

- Type of Measures

Establishes the nature of the mitigating measure insofar as prevention, mitigation or compensation are concerned, depending on the magnitude of the impact.

- Objective

Define the final goal pursued by the measurement, to be expected from the execution of the program.

- Impacts to Control

Consists of an enumeration of the different impacts and/or environmental effects that have to be mitigated when the measurements are executed.

- Spatial Coverage or localization

Defines the space where the measure or program is to be applied.

- Designs

Contains the technical considerations and designs over which the measure is conceived.

- Description

Corresponds to the description of the actions to be carried out in each of the activities for purposes of diminish, mitigate or keep the predicted effects from happening.

- Schedule

Indicates the moment when the proper measures are to be implemented.

- Costs

Define the costs of the resources necessary for the implementation of the measurement.

With the aim of being consequent with the proceedings involved in the environmental identification and evaluation, the measurements or management forms have been grouped according to the environmental component they affect.

5.5.3 Results

Table 35 summarizes all the measurements established within the environmental management plan to be executed throughout the development of the Cassava Cultivation and Processing Productive Project, according to the results of the present analysis:

Table 35. Environmental Measures to be Applied to the Cultivation and Processing of Cassava

PROGRAM	INDEX FORM No.	MEASUREMENT
SOIL MANAGEMENT	1	CULTURAL PRACTICES
	2	AGRONOMIC PRACTICES
	3	PESTICIDE AND WEED CONTROL AND MANAGEMENT
	4	WEED CONTROL
	5	ORGANIC AND BIOLOGICAL AGRICULTURAL PRACTICES
	6	EROSION CONTROL
WATER RESOURCES MANAGEMENT	7	WATER QUALITY CONTROL
	8	WATER CONTROL IN INDUSTRIAL CASSAVA PROCESSING
	9	SOIL CONSERVATION BY SOLID WASTE DISPOSAL
AIR MANAGEMENT AND CONTROL	10	CLEAN TECHNOLOGIES FOR SOIL PREPARATION
MANAGEMENT AND CONTROL OF FLORA AND FAUNA	11	VEGETATIVE COVER MANAGEMENT BY FLORISTIC COMPENSATION
	12	FAUNA MIGRATION CONTROL
	13	GENERATION OF LIVE FENCES AND PLANTATION OF VEGETATIVE COVER
ECOSYSTEM PROTECTION	14	CONSERVATION OF NATIVE ECOSYSTEMS
SOCIAL MANAGEMENT	15	STRENGTHENING OF THE SENSE OF BELONGING
	16	ENVIRONMENTAL EDUCATION
	17	INDUSTRIAL SAFETY

5.5.4 General Budget

The general budget for the execution of the activities pf the Environmental Management Plan, (EMP), are presented in table below. Among the costs considered, the Consultants have included the Administrative costs, particularly those needed for personnel to execute and supervise the activities.

5.5.5 Time Schedule (Chronogram)

The execution of EMP task is related to the activities of the cultivation and processing phases of the productive cycle of Cassava cultivation, which lasts 11 months¸ for the second and third cycles of cultivation, the same chronogram could be implemented with slight adjustment.

5.6 ENVIRONMENTAL MONITORING AND FOLLOW UP PLAN

5.6.1 Overview

The environmental monitoring and follow up plan (PSM in Spanish) is a part of the environmental management plan –EMP- and constitutes a tool in which the detailed programs, from the activity of impact identification, are consigned, to allow verification, vigilance and evaluation of the actions and activities of the project before, after and during its execution.

The environmental monitoring and follow up program will also have as an objective to obtain the environmental information necessary to determine and describe the behavior of the plantations and their processing; to give elements of judgment, and to ease the making of decisions about predictable an unpredictable situations alike; It will also serve to minimize the adverse character of environmental effects and guarantee the technical soundness of the analysis and solution of eventual conflicts between peasants, the operator of the project and the environmental control authority with respect to the interpretation of environmental topics related to the cultivation and processing of the Cassava plant.

5.6.2 General Objective

The general objective of the EMFP, is to provide the Environmental Authority, the Community, the Chemonics Foundation and USAID, with a technical basis for verification of the correct development of the project.

5.6.3 Specific Objectives

The EMFP will establish the activities that are necessary to implement the EMP as well as those responsibilities that are necessary for verification, vigilance and evaluation of the activities of the Plan.

The Plan will establish in a detailed manner the indicators and the places where the monitoring should take place, as well as the methodologies recommended in particular for sampling and verification, including periodicity of sampling, duration, type of analysis, forms of evaluation, costs and financing of the activities. The sampling points, will be established taking as a basis those that were used for the Environmental Assessment in the EIA, in order to increase the confidence on the results and run comparative evaluations.

The Plan will include recommendations regarding the form for presenting periodic reports, with argumentation of the periodicity of reporting, and will establish the extent of advances on the following aspects :

- Physical and Chemical Monitoring on Intervened Water Bodies
- Revegetation and Erosion Control programs

- Biological Control programs
- Solid Residue Management programs
- Social Welfare Management programs

The present report should present the Chemonics Foundation – USAID, and the Environmental Authority a proposal for implementation of an EMP and an EMFP, considering the following aspects :

- Environmental Components to Monitor
- Impacts to Monitor
- Scheduling of Check ups
- Types of Monitoring Measures

5.6.4 Summary of Activities

For the purpose of making the Monitoring and Follow up Plan a project activity of easy execution and verification by the Environmental authority and the USAID, it has been determined to present it as a chart that includes all aspects of the Project that will have to be controlled and followed up within the Plan, referred to each of the activities proposed in the EMP; Figure 6.1. illustrates the preceding statement.

SECTION 6 LIST OF PREPARERS

The work group for the present project consisted of the following professionals :

- **RAQUEL DUQUE R.** Civil Ing., M. Sc. en Environmental Engineering and Water Resources. Coordinator of the Study.
- **JORGE CAICEDO B.** Economist, specialist in Economic Development and the Transportation and in Cultural management. In charge of socioeconomic aspects of the project.
- **GLORIA BASTO** Agronomist. In charge of technical aspects of the project, soil utilization, soil production, etc.
- **MARIA TERESA ORTIZ** Biologist. In charge of biological aspects of the project, (flora, fauna), water quality and of the formulation of environmental management alternatives.
- **FABIAN CERON** Civil Eng., M. Sc. Environmental Engineering. Field engineer, and support for the characterization of the physical baseline and the formulation of management ideas.

For water quality tests, the consultants used the laboratories of DAPHNIA Ltd., of Bogotá, a recognized center with equipment and personnel well versed in the required analysis.

SECTION 7 APPENDIX

REFERENCES

All of the references used in this study are Spanish language publications from the Government of Colombia or from the Departments and Municipalities in the area of influence of the project.

1. Almidones Nacionales. Presentación en Power Point, Año 2001.

2. CALTHERON. Informe Nacional sobre el Estado of the Biodiversidad, Tomo I, Instituto Alexander Von Humboldt. Año 1.997.

3. CENICAFE. Anuarios Hidrológicos, 1993.

4. Centro de Investigación de Agricultura Tropical, CIAT. La Cassava en el tercer mileno. 2.002.

5. Corporación Autónoma Regional del Cauca, C.R.C. Agenda Ambiental del Municipio de Santander de Quilichao. Año 2.001.

6. Corporación Autónoma Regional the Valle the Cauca, C.V.C. Resúmenes Hidrológicos, 1996.

7. Fundación Norte Caucana para el Desarrollo, FANORCA. Proyecto the Socialización para la Integración of the Comunidades Campesinas en la Cadena Productiva de la Cassava en las Municipalidades norte Caucanas de Caloto, Corinto, Miranda and Santander de Quilichao. Popayán, Febrero de 2.002.

8. Instituto Geográfico Agustín Codazzi, IGAC. Zonificación Agrológica Dpto. del Cauca. 1985.

9. Moreno, Isabel. Diagnóstico De la Cassava Industrial en the polo the desarrollo del Norte del Departamento del Cauca, Sur del Valle del Cauca. CIAT, Año 2.002, Cali-Colombia.

10. Municipio the Santander the Quilichao (Departamento del Cauca). Plan Básico the Ordenamiento Territorial del Municipio de Santander de Quilichao. Año 2.000.

11. Municipio the Miranda, (Departamento del Cauca). Esquema the Ordenamiento Territorial "Miranda para la vida" Año 2.000.

12. Municipio de Corinto (Departamento del Cauca). Plan the Ordenamiento Territorial, 2.001.

13. Ruiz, B., Elías. Estudio Detallado the Suelos del sector río Palo – río Desbaratado para fines
Agrícolas Departamento del Cauca. IGAC, 1.968. Bogotá, Colombia.