The quality of soils, starting from local indicators of soil quality and chemical, physical and biological parameters, with the participation of farmers of the micro-catchment of the river *Cabuyal, Cauca Columbia*

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1. INTRODUCTION

One of the main problems considering the soil of Colombia and especially of the hillside of the department of the *Cauca* is the degradation process and erosion of the soil, due to wrong use and unsuitable application of the soil. Approximately, 40% of the Colombian territory corresponds to hillside areas and more than the farmers' third two parts still belong to the Andean area, which is mostly exposed to the migratory pressure and consequently to the degradation of its soil (Gonzalez, 1996).

There has to be pointed out the demographic pressure in marginal areas of hillside as a consequence of an unequal agrarian structure, among the big landowners who possess the best soils and the small farmers who exploit hillside floors which are very fragile.

Referring to the state of the landowning, you can enumerate, also, the ecological unsustainability of the hillsides which gives reason to mention some causes of the deterioration of the hillside floors like for example: water-erosion, deforestation to use the plains in agricultural activities, overgrazing, clean cultivations.

After the world Summit of the Earth in Rio 1992 the soil is considered amongst the important lines of protection and conservation due to the importance for life conservation and their relationship with the global climatic change. In this same summit the handling and knowledge of the local communities to be an employee in the sustainability of use of the soil and development was considered of supreme importance (Winkler Prins and Rhoades 1994).
The present work tries to investigate and to validate participation (investigators and farmers), to generate technical proposals and methodologies starting from the knowledge of the farmers that allow them to be effective for the conservation and protection of the health and quality of the resource soil.

The general Objective of the present investigation is to evaluate and to differentiate the quality of soils, starting from local indicators of soil quality and chemical, physical and biological parameters, with the participation of farmers of the valley of the river *Cabuyal* in such a way that contributes long term to the improvement of the limitations of the use of the soil and improvement of the quality of the farmers' life.
It is started from a database of analyses of soils gathered during 25 years to demonstrate that the resource soil within the basin has not been deteriorated, to identify with participation of the farmers, the local indicators of the soils health, and to compare them with the scientific parameters of the respective analyses.

2. Description

2.1. Definition of the Indicators

The definition of indicators - according to Feijoo- she becomes complex by the variation of the interactions in time, space and intensity. Nevertheless, it is recommended to initiate identifying the basic list of measurable properties that define the main processes in the operation of the soil. In agreement with Doran et al (1994), the indicators must satisfy the following criteria:

1. Encompass ecosystem processes and relate to process-oriented modeling Encompass.
2. Integrate soil physical, chemical, and biological properties and processes.
3. Be accessible to many users and applicable to field conditions.
4. Be sensitive to variations in management and climate. The indicator should be sensitive enough to reflect the influence of management and climate on long-term changes in soil quality but not be sensitive as to be influenced by short-term weather patterns.
5. Where possible, be components of existing soil data bases.

The need for basic soil quality and health indicators is reflected in the question commonly posed by practitioners, researchers, and conservationists: "What measurements should I mike should I make to evaluate the effects of management on soil function now and in the future?" Too often scientist confine their interests and efforts to the discipline with which they are most familiar. Microbiologist often limit their studies to soil microbial populations, having little or no regard for soil for soil physical or chemical characteristics which define the limits of activity for microorganisms, plants, and other life forms. Our approach in defining soil quality and health indicators must be holistic, not reductionistic. The indicators chosen must also be measurable by as many people as possible especially managers by as many people as possible, especially managers of the land, and not limited to a select cadre of research scientist. These indicators should define the major ecological processes in soil and ensure that measurements made reflect conditions as they actually exist in the field under a given managements system. They should relate to major ecosystem functions such as C and N cyclin (Visser and Parkinson, 1992) and be driving variables for processoriented models which emulate ecosystem function. Some indicators, such as soil organic matter and nutrient content can be better related to actual field conditions at time of sampling. (DORAN, 1996: 30).

2.2 Local Knowledge and science

Recent research has underscored differences between local knowledge systems and science. Although local knowledge often embodies substantial observation -derived understanding of biophysical processes and artifacts, it is distinct from science, as the latter is conventionally defined. Primary differences include those between trial and error learning versus scientific control- centered experimentation and knowledge and its applications. One example of these differences is shown by study of local plant knowledge. Local systems of biological classification commonly exhibit non-exclusive taxonomic relations, a property which differs from the hierarchic structure of scientific taxonomies. These findings indicated that local understanding of the biophysical world often differ with respect to the conventional ones of science and scientists. (Zimmerer, K.S. 1994: ??)

3. Characterization of study area

The study area is the *Cabuyal* micro-watershed of the *Ovejas* river basin of the *Cauca,* with 7.000 ha. Between 76° 33' – 76° 33' west of Greenwich and , 2°42'-2°52' latitude north of Hillsides program.
The *Cabuyal* micro-watershed is divided in three agro-ecological zones: high, medium, and low. Coffee is the main crop in the high and medium zones. Cassava is the main crop in the low zone.

4. Materials and methods (Procedure)

The first phase consisted in the recognition of the region and the inventory of the investigations developed in the area.

This study has been developed within the following phases:

4.1. Grouping of the Information (Clarification of the Information)

There was taken a database with 520 analyses of soils of the valley of the river *Ovejas,* carried out by the secretary of agriculture of the *Cauca* department, being selected only 100 samples of soil analysis that belong to the micro-catchment of the river *Cabuyal*.

There were evaluated more than 400 analyses of soils from the file of the program of match of the CIAT, selecting 40 samples of soils which correspond to the of the river watershed *Cabuyal.*

Finally a chart of data was obtained with 140 analyses of soils corresponding to farmers of the valley of the river *Cabuyal*, carried out through 27 years from 1970 to 2000.

The samples were carried out with the methodology of the laboratory of soils of the Agricultural Colombian Institute. Determining the following properties: pH, Organic Matter, Match, Potassium, Calcium, Magnesium, Sodium, CICE, Aluminum.

4.2 Statistical analysis of the physical parameters of the soil analyses

The statistical analysis for the three areas of the catchment was carried out with the program SAS
The test " T "; squared ANOVA,Chi; normality for each parameter of the chemical soil analyses.

In synthesis there was carried out an exploratory analysis with the purpose of seeing tendencies and values of more representative soils, (C, P, SAT. of To the, Ca, Mg, K, CICE) to compare the significant statistical differences in each one of the areas. With the help of the program Sigma Plot and Excel there were elaborated diagrams of bars.

4.3. Interviews, to know about the farmers

There were made a survey and several direct interviews with 70 farmers that coincided with the analyses of the selected soils.

The survey had as central topics: Type of property, Georeferentiation, meters on the level of the sea, use of the soils, transformation of the superior layer of the soils through the time, slope, approaches of quality or fertility of the farmers' floors, type of security of the soil, practical of more used conservation, difficulties for the conservation of the soil, importance of the scientific analyses of soil.

4.4. Descriptive and multivaried statistical analysis of the data.

With the help of the program S.A.S. the quantitative values of the parameters of soils (C, To the, Ca, Mg, K, CICE) were related to the qualitative variables of the survey made to the farmers.

With the help of the program S.A.S. there was carried out an analysis of main components and of correspondence to be analysed later on with the diagrams and respective clusters.

Besides an analysis of main components, throwing the main cluster, and graphics that later were interpreted with the agronomic approach.

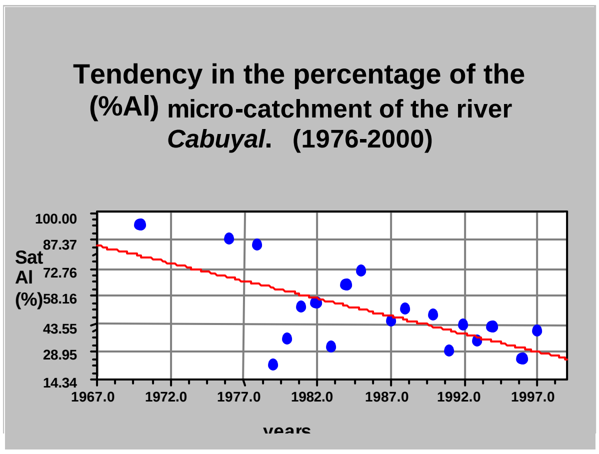
5.RESULTS OF RESEARCH IN PROGRESS

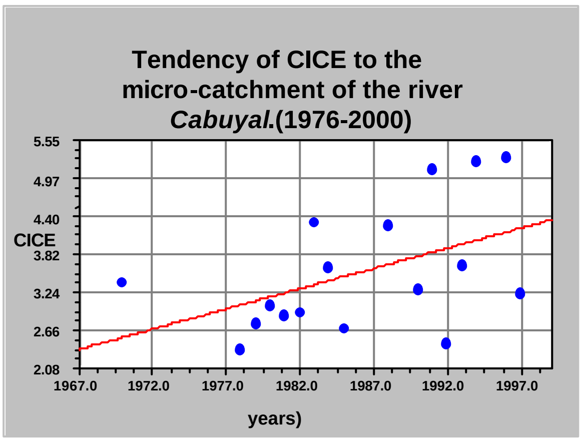
Alterations of the nutrients through 27 years

With the selected samples of soils the chemical behavior of the soil was observed during 27 years for the chemical parameters: Carbon (C), match (P), calcium (Ca), magnesium (Mg), potassium (K), aluminum saturation (To the), capacity of cationic exchange (CICE).
In the period 1970 - 1997 there are improvements in the percentage of the (%Al) 8O%, it decreases to 30% (See graph 1). Consequently the Match (P) improved of the 2,3 ppm. to 4 ppm. and the Calcium (Ca) increased from 0,5 meq/100g to 1,5 meq. / 100g

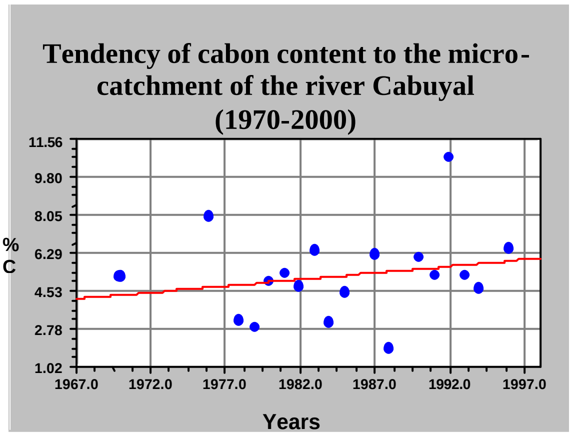
There exists a slight tendency of increase of the Carbon (C) of 4,5% in 1972 to 6,3% in 1997. (see No.2)

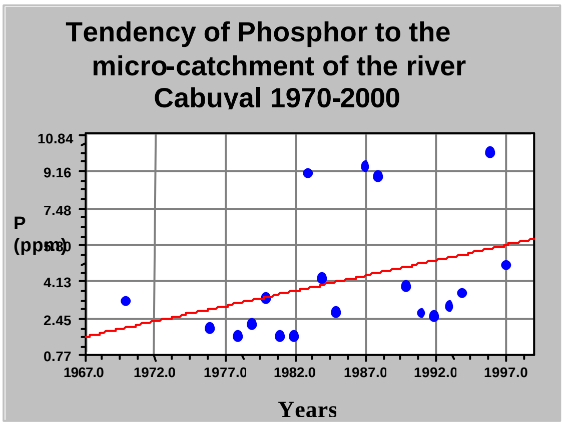
GRAPH No. 1





GRAPH No. 2





In Chart No. 1 the three more important clusters and the most representative variable which can be interpreted with the approach of quality of soils are observed.

The quantitative variables of the analyses of soils have been crossed with the qualitative variables of the surveys. The program threw contingency charts among the three (3).

Cluster 1.
For this group of soils it is considered that 85% of the samples of soils present an increase of the superficial horizon bigger than 3 cm. 90,88% has a bigger slope to 7% (7-70%).
The system of fertilizing mostly employed is the use of vegetable remains; the use of chemical fertilizers is about 55% and 60%. The system of soil protection more used by the farmers are the vegetable coverings and the curves at level (44% and 63% respectively).

The farmers outline that there is an improvement of the A horizont, and it is considered that the content of C of this group of soils is relatively high. This allows to demonstrate the equivalence or correspondence among the scientific knowledge starting from the samples of soils and the knowledge of the farmers.

In this group of soils the indicators for quality of more representative soils for the farmers are respectively the color, the macroinvertebrated and the indicative plants with 67%, 66,6% and 56%. See Chart 2

Chart No. 1
CLOSTER

CLOSTER	C	P	Ca	Mg	K	Al	Increa A Horiz		Decr A Hor			Gradient			Soils Indicator quality									
							< 5 cm	>5	< 5cm	> 5cm	flat	7-30%	>30%	>70 %	Colour			Gradien		Macroinvertebra				Pl
															brow	Yello	Blac	flat	Gra	worm	ant	beetle	cadillo	pa a
CLOSTER 1	6	2,6	0,8	0,3	0,2	2,1	85%	15%			9,1%	39,4%	42,4 %	9,1%	14,3 %	2,9%	82,9 %			83,3%	12,5 %	4,2%	11,1%	5
CLOSTER 2	6	5,6	1,9	0,6	0,7	0,6			100%			26,7%	73,3 %					90,9%	9,1%					
CLOSTER 3	4	3	0,9	0,3	0,3	1,7																		

Chart No. 2 Indicators quality soils of farmers to the micro-catchment of the river Cabuyal

Importance Disposition	Indicator Type	Frecuency	Observatión	Chemical Analysis of soil
1	Colour	67%	Colour Brown black= Gut soils; Colour yellow = average, bad soils	C= 5,53 % P= 2,63 ppm. Ca= 0,83 meq/ 100 g Mg=0,3 meq/100g K= 0,23 meq/100g Al= 2,12 meq /100 g
2	Macroinvertebrated	66,6%	Worm= significant gut soils Ant, beetle	
3	Indicators Plants	56%		

82% of the farmers identify the black color and coffee as indicator of a good soil. 2,86% of the farmers identify the yellow color as regular indicator of soils.

For the soils of closter 1, the most important macroinvertebrated as indicator for quality of soils is the earth worm, the ant and the "cucarron". In first order the worm with 83,33% of the samples of this cluster.

And the most representative plants for indication of quality are:
The "Papunga"(Bidens pilosa) in first order with 55% in reference to the other ones; followed by the always alive (Commelina difussa) with 11%.
As indicator of infertile soils there are: the "Mangaguasca" (Braccharis trinervis) with 22%, the fern "marranero" (Pteridium aquilinum) with 5,5% and the "Yaraguá" (Melinis minutiflora) with 5,5%.

Cluster 2.

The results of the soil analyses of this group present the best values for each parameter (C, P Ca, Mg, K, To the) and a decrease of the superior layer is possibly appreciated between 3 and 5 cm by water erosion.

These soils are in slopes between 7 and 70%; for this type of farmers the most representative indicator of soils is the slope. Identifying that the best soils are in the plane area or to the banks of the rivers, because it is where there is bigger concentration of nutriments.

The mostly used fertilizing system is the one with manure, with 88% of frequency, besides it has to be noticed that this group of soils present the best chemical values, it might indicate that the use of the poultry dung has favored this process.

There is no relevance to the conservation practices kept in mind.

Cluster 3.

These are the soils that present the lowest chemical characteristics. Furthermore the used fertilizing practices are the vegetable remains and the biological degradation.

There is a direct dependence of the non use of the fallow and the bad quality of these, therefore 72% of these parcels doesn't produce fallow.

This group of parcels is characterized by not making its seeds in curve at level; one can affirm that there is a direct relationship between the non use of this practice and the low chemical state of these soils**.**

5. CONCLUSIONS

- In the last 27 years the chemical soil conditions of the basin of the river Cabuyal has improved, for example: aluminum saturation, match, carbon, interchangeable bases.

- In general the soils of the valley of the river Cabuyal are sour, faulty in match, with medium contents of organic carbon. And the main cause physics of the erosion of the soil is water.

- The main practices of the farmers' conservation are the curves to level, and the alive barriers. In the farm of Inter program CIAT there are technical and economic proposals of conservation of soil, which are expedient, valid and economical.

- The participation of the farmers in the investigation improves the adoption of techniques of conservation, because they are the best technology transmitters. In the interior of the river valley there are rural leaders with knowledge of soil conservation that can help to avoid the degradation of the soils.

- The farmers don't use the chemical analyses of soils. They use own approaches simultaneously, such as: color, presence of worms, texture, slope and indicative plants.

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