REG 010/2000

Fertility Management in the Andes[(1)]

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1. PARTICIPATION IN BOLIVIAN TEAM OF TROPANDES: " Fertility Management in the Tropical Andean Mountains: Agroecological Basis for a Sustainable Fallow Agriculture" [Project of the European Union (Contract ERBIC18-CT98-0263)]

1.1 CONDENSED PROJECT PRESENTATION

1.1.1 Participants

Bolivia/Peru:
Instituto de Ecología (IE) de la Universidad Mayor de San Andrés (UMSA) La Paz, Bolivia.
Institut de Recherche pour le Developpement (IRD)- Montpellier , France
Venezuela:
Instituto de Ciencias Ambientales y Ecológicas (ICAE) de la Universidad de Los Andes (ex-CIELAT), Mérida, Venezuela.

Europe:
Instituto de Investigaciones Agrobiológicas de Galicia (IIAG), del Consejo Superior de Investigaciones Científicas (CSIC), Santiago de Compostela, Spain, (Coordinator).
Centre d'Ecologie Fonctionnelle Evolutive du Centre National de Recherche Scientifique (CEFE-CNRS), Montpellier, France.
Laboratoire d'Ecophysiologie Végétale de l'Université Paris Sud (UPS-LEV), Orsay, France.
Plant Research International (UR AB RIASF, ex-AB DLO), Wageningen, The Netherlands.

1.1.2 Goal

The goal of this project is to integrate ecology, agronomy and socio-economics to analyze the agroecological basis of the fallow production system common in much of the high tropical Andes.

Based on an improved understanding and modeling of the biological, physical and socio-economic forces that determine specific practices, improvements will

[1] Synthesis elaborated for the Annual Meeting of Board of CONDESAN (17/11/00 , Lima Peru)

be designed and their short term and long term implications will be evaluated.

1.1.3 Location

The study is being performed in the Northern and the Central Andes, in the areas called *paramo* **(**Venezuela), between 2800 m and 4800 masl, and *puna* (Bolivia) between 3400 m and 4400 masl. In both locations, a key component of soil fertility management is the practice of agricultural fallows. In Venezuela, the area includes the higher zone of the Chama, Santo Domingo and Motatán river basins (2500 to 4000 masl) and precipitation is between 800 and 1500 mm. Specific studies were developed at the Quebrada Piñuelas valley (Gavidia, Sierra Nevada de Merida) at an elevation range of 3350 to 3700 masl. In Bolivia, the main area of study is located in the *altiplano,* in the community of Patarani, at 3800 masl, where the mean precipitation between 1987 and 1991 was 358 mm and the annual mean temperature is 8.3°C. Specific studies were developed also at the experimental Station of Patacamaya and at the Huaraco community.

The soils from Gavidia were coarse textured, rich in organic matter (O.M.) and nitrogen (N), acidic and with a strong buffering index. The soils from Patarani are only slightly acidic, neutral or even alkaline with a very low content in O.M. and N.

1.1.4 Specific Project Objectives

At a regional scale, to delimit the spectrum of ecological and demographic factors, that shape fallow agriculture and influence fallow duration;

At a farm scale, the agro-ecological and socio-economical determinants of fallow duration and fallow dynamics will be analyzed in order to optimize the balance of the fallow-crop periods and evaluate the effects of farm strategies on economic, food and soil fertility sustainability.

At the agro-ecosystem scale, the mechanisms of soil organic matter (SOM) changes and resulting changes in nutrient availability will be studied to explain the quick decline of fertility during the potato crop period and the progressive fertility restoration during the fallow period. Particular attention will be paid to nitrogen cycling in the soil-plant system, by analyzing fallow plant succession and the annual necromass return to the soil (Near InfraRed Spectrometry), and by using ^{14}C and ^{15}N labeled plant material.

Process based models (fallow/production model; necromass/ crop residue/ organic fertilizer decomposition model; potato crop model and soil water model) will be coupled to describe the complementary of the fallow and crop phases. These models will be linked at the plot level and will interface with the whole farm management model.

1.2 BOLIVIA UPDATE

1.2.1 Land use dynamics at community and farm level

In the Bolivian altiplano where sectorial fallowing is still commonly practiced, land use dynamics were monitored and mapped in five communities. With a combination of field work and aerial photography analysis covering a period from 5 to 40 years: three communities were monitored by the Instituto de Ecologia (Huarina, Titicani-Sataca, Huaraco) and two by Institut de Recherche pour le Development (Patarani and Pumani).

In a 10-km strip from the Titikaka Lake to the southern limit of Aroma province, the localization and importance of sectorial fallowing systems have been determined. The local fallow systems are very heterogeneous, however the same common rules are being applied, which reveals the socio-cultural variability in the application of the same basic land use framework.

A multi-component model was defined to represent farm operation, including an economic component, soil nitrogen status resulting from fallow component, and cropping systems component. The resulting Finpupa model (Fincas en Puna and Paramo) is being written in Java language (Object Oriented Language) and may be connected to other databases (Oracle) and with georeferenced data bases (GIS).

1.2.2. Biomass production on fallow land

Several technologies are being used to estimate the quantity and quality of the plant biomass returning annually to the soil (above-ground and below-ground necromass) through the successional vegetation. Some of the issues include:

- depth and spatial distribution of shrub root systems,
- biovolume and biomass evaluations in different fallow duration plots, during wet and dry seasons,
- above ground - below ground ratios of fallow colonizing grass, herb and shrub species,
- aerial necromass fallen to soil, which is collected in one-plant traps,
- marked leaves and final shoots to monitor life and mortality of new leaves (shrub and perennial grass).

The necromass decomposition and organic matter decomposition are studied through litter-bags analysis, Near InfraRed analysis of the necromass, and N15 monitoring (post Tropandes work is planned with IBTEN) . The microbiological compartment is studied with special interest as this data will allow team members to fit the Momos model to puna and paramo conditions.

1.2.3 Potato production after fallowing

Two potato campaigns, 1998-1999 and 1999-2000 are being used to calibrate the Lintul model to the central Bolivian altiplano context. The effects of native legume cover in the fallow and ovine dung applied on first potato crop are being assessed on crop rotation yields.

2. NEW DIRECTIONS/SATELLITE ACTIVITIES

- Work with CONDESAN colleagues to conduct an electronic forum on soil fertility management in the Andean ecoregion

- Collaborate with other teams to complete a suite of crop models for the high Andes. For example, the available data on potato cultivation on Bolivian altiplano may be used to test DSSAT potato sub-model as was done with previous Gavidia data from Venezuela. Data is expected for barley (IRD), faba bean (ICARDA) and quinoa cultivation (IRD Research Unit of CLIFA) to complete the extensively practiced cropping systems in the Andes.

- Complete the CONDESAN funded book on saline soil management in the Lake Titikaka basin and develop a research proposal for additional research and extension work.

- Help to establish the “Consortium on Terraced Land Rehabilitation and Intensification” with A. Rodriguez (ICARDA), A. Kendall (British archeologist), the Peruvian Cusichaca trust, Catholic University (Lima, Peru), social scientists from the IEP (Instituto de Estudios Peruanos) and the Bolivian NGO CESA.

- Complete the editing of the Proceedings of First Bolivian Soil Science Congress (July 1999)