Report on Trip to Peru, Ecuador and Costa Rica
September 22 - October 6, 1998
USAID Grant No. LAG-G-00-97-00002-00
SM-CRSP Project *Decision Aids for Integrated Nutrient Management*

Travel Team:
Jot Smyth - North Carolina State University

Rationale and Objectives:

In order to ensure that decision support software we develop for integrated soil nutrient management (IntDSS) are user-friendly and have user-value, these systems must be piloted under a variety of location-specific conditions. We intend to do this via an extensive network of evaluators. The network should include individuals with (a) knowledge that should be incorporated into our products, (b) field and laboratory data sets that could be used to evaluate our products under various conditions, and (c) established networks who would be interested and benefit from testing our products in their programs. Development of the first prototype for IntDSS, although incomplete, has now reached a point where developers can display it on computer monitors and effectively communicate to potential evaluators what the software strives to do and how it will do it (in simpler words this is a product "touch and feel" approach to illustrating what our project is about).

Organization of the extensive evaluation network should begin now in anticipation of the release of the first IntDSS prototype by the end of this fiscal year. Network organization involves establishment of contacts with potential evaluators, identifying areas of common interest and mutual benefit, and developing suitable working relations. An invitation to participate in the 6th Peruvian Soil Science Congress, with expenses covered by the organizers, provided a cost-effective opportunity to initiate network organization in Peru and Ecuador.

A stop-over in Costa Rica was also included in this trip to monitor progress and provide backstopping assistance to ongoing activities for our project's intensive testing site for nutrient management in peach palm plantations for heart-of-palm production in the Sarapiqui region (Hue et al., 1998). While in Peru and Costa Rica I was also able to work with former SM-CRSP scientists on data analysis and interpretation for a 10-year cropping systems study conducted in Yurimaguas, Peru.

Itinerary:

September 23	Arrival in Lima; meetings at CIP headquarters with Dale Bandy and Julio Alegre (ICRAF) to discuss Yurimaguas research data; meeting with Walter Bowen (IFDC) to exchange information on IntDSS and nutrient simulation model softwares.
September 24	Travel with Julio Alegre from Lima to Huanuco by plane; met by Luiz Zuniga and traveled by car to Tingo Maria; presentation of paper at 6th Peruvian Soil Science Congress on soil nutrient dynamics under continuous cultivation of Oxisols and Ultisols in Amazon was given that evening.

September 25	Attended continuation of soil science congress; visited on-farm trials conducted by Agronomy faculty of the National Agrarian University of La Selva-Tingo Maria.
September 26	Travel by car to Pucallpa with Julio Alegre.
September 27	Worked in Pucallpa with Julio Alegre on Yurimaguas research data.
September 28	Continued work on Yurimaguas research data, visited Julio's managed fallow research plots; demonstrated and discussed with Julio the IntDSS software; flew back to Lima.
September 29	Flew to Guayaquil, Ecuador; met by Jose Espinosa (INPOFOS) and Francisco Mite (INIAP); visited Boliche Exp. Station and drove to Quevedo.
September 30	Visited Pichilingue Exp. Station; presented and discussed IntDSS software with Espinosa and Mite; toured commercial plantation of plantains and cacao; and drove back to Guayaquil.
October 1	Flew from Guayaquil to San Jose, Costa Rica
October 2	Drove to and from Guapiles with Univ. Costa Rica (UCR) technician to assist in sampling of litter bags for field experiment on peach palm residue decomposition and nutrient release; met with Larry Szott (UCR) to discuss Yurimaguas research data; met with Larry Szott and Alfredo Alvarado (UCR) to discuss potential funding opportunities with C.R.-U.S.A.
October 3-4	In San Jose working on Yurimaguas research data.
October 5	Presented and discussed IntDSS software, discussed project activities and potential proposal to C.R.-U.S.A. with Alfredo Alvarado, Rafael Salas and Eloy Molina in San Jose; presented and discussed IntDSS software with agronomy/soil science graduate students at UCR.
October 6	Completed discussions with Alfredo Alvarado on IntDSS activities in Costa Rica; departed Costa Rica for Raleigh.

Peru:

6th Peruvian Soil Science Congress - the congress was held at the National Agrarian University of La Selva in Tingo Maria during September 21-25. Julio Alegre and I arrived in Tingo Maria on September 24, presented our papers that evening, and attended the closing ceremonies and business meeting of Peruvian Soil Science Society on September 25. The focus of my presentation was on diagnosis of soil nutrient constraints and prediction of nutrient inputs for continuous cultivation in Oxisols and Ultisols of the Amazon. Julio's presentation focused on soil fertility improvement and weed suppression with improved tree fallow management in Yurimaguas Ultisols. Congress attendance, including students from the National Agrarian

University, was about 200 and included representatives from five or six different universities in Peru. The society's business meeting was attended by about 30 scientists.

Field Trials at Tingo Maria - Tingo Maria is located in the high "selva" region of the Peruvian Amazon at 660 m elevation. Annual rainfall in this steepland region is 3,000 mm and mean temperatures fluctuate between 22 and 25°C. Inceptisols are the dominant soil order in the region. Data on selected soils indicated effective cation exchange capacities of 7 to 9 cmol kg^{-1} and Al saturation values of 60 to 80%. During former Soil Management CRSP programs, North Carolina State University conducted a field trial to investigate legume groundcover establishment on Ultisols cropped with achiote (*Bixa orellana*) plantations (Benites et al., 1989). Surface soil characteristics in that experiment were pH 4.9, effective CEC of 2.1 cmol L^{-1}, 81% Al saturation and 2 mg L^{-1} Mod. Olsen-extractable P. Slopes at the Ultisol site ranged from 30 to over 100%. According to Benites et al. (1989) a fern (*Pteridium aquilinum*), locally known as *macorillo*, is considered an indicator plant for high levels of soil acidity.

There are large deposits of calcitic and dolomitic lime in the mountains surrounding Tingo Maria. Mr. Adelo Vivanco has conducted several field trials with local lime materials (Vivanco, 1989). However, I was not able to locate any data related to the characteristics of these lime materials.

The field trials we visited were on a farm about 6.5 km from Tingo Mario on the road to Pucallpa. Soil at the site appeared to be Inceptisols and slope exceeded 50%. Ing. Hugo Huamani maintains these trials with strong reliance on undergraduate students in the Agronomy Department for field labor. Two experiments involved N, P and K trials in replicated plots for peach palm (*Bactris gasipaes*) and pineapple. Plots for both experiments had been nicely laid out along contour lines and weed control was excellent. There were strong visual symptoms of an N deficiency in the peach palm on all fertilizer treatments and replicates. All fertilizers are applied once per year at the start of the high rainfall period near the base of the trees. The most interesting observation was from an unreplicated peach palm plot adjacent to these experiments. When establishing the experiment several years ago, Ing. Huamani had some extra peach palm seedlings which he planted among some inga (*Inga* spp.) trees. He frequently prunes these trees, to minimize shading, using the prunnings as a groundcover/mulch for the surrounding peach palm. There were no visual symptoms of N deficiency in the surrounding peach palm and they had superior growth to all full-sun plots that received NPK. Apparently, N is a major nutrient limitation on this soil and the fertilizer N rates used in this trial are either too low or have a short residence time in the soil rooting depth when applied as a single annual application.

Additional trials at the site involved the enrichment of natural fallows with high cash-value medicinal plant species and vegetable crop production between contour hedgerows of natural vegetation. Julio suggested the evaluation of vetiver grass in these hedgerows. He is very pleased with the performance of vetiver grass in some of his studies and has compared plant material imported from Kenya with material he has collected in the Peruvian Amazon (the local name in both Peru and Brazil is *pachouli*). Detailed genetic tests of these materials by ICRAF indicates that they are identical.

Other cash crops grown in the region include bananas, papaya, and some cacao and coffee. Corn, rice, cassava and cowpea are also cropped in the region. Tingo Maria has good road transportation to Lima, which serves as the principal market for agricultural products.

Other Related Programs of the National Agrarian University - several faculty members have participated in studies to characterize local and regional (high and low selva) systems and practices used in coca production. This information has assisted various agencies in implementing successful intervention programs throughout the Peruvian Amazon. University faculty also are involved in several non-governmental organizations seeking to develop production alternatives for rural farming communities. Their most successful alternatives involve the introduction of small ruminants and poultry. Farmers will grow grain crops to feed these animals which they raise primarily for cash income. Development and access to local markets were some of the main bottlenecks encountered in this program.

CGIAR Programs Based in Pucallpa - the 230 km drive from Tingo Maria to Pucallpa was very interesting from the standpoint of observing the transition from high "selva" to lowland "selva" across a 300 m drop in elevation (see map of Peru in Figure 1). The road also crosses the full length of the Aguatia watershed, which is the focus of CGIAR programs based in Pucallpa.

Figure 1. Map of Peru.

The Tingo Maria-Pucallpa road was in good condition, with evidence of frequent maintenance. This is the major outlet for shipping refined petroleum products from Pucallpa to the highlands and Lima. The Pucallpa region is a major beef cattle production area in the Peruvian Amazon. Annual rainfall is about 1700 mm with a distinct 3-month dry season. Soils, climate and pasture production/management data are described by Toledo and Morales (1979).

CGIAR centers involved in the Aguatia project are CIAT, CIFOR and ICRAF. Project headquarters are in the National Institute for Amazonian Research (INIA) offices in Pucallpa. Additional collaborators include INIAP, IVITA and the Peruvian university in Pucallpa. Winrock also joined the project recently.

The Aguatia watershed was a major coca production region. Successful intervention measures, targeting the buyers rather than farmers, have disrupted the coca market. Consequently, farmer receptivity to other cropping alternatives has been very good. The CGIAR project seeks to develop viable agricultural alternatives through participatory research and on-farm tests with communities in the watershed. Initial activities involved a biophysical and economic characterization of the watershed. Rapid rural appraisals were performed in communities throughout the watershed. Shifting cultivation was identified as one of the main driving forces for deforestation, natural forest fallow periods are too short, and disease and soil nutrient problems indicated a need for introduction of new crop species and improved varieties. Principal commodities under investigation include corn, rice, cassava, cowpea, cacao, peach palm, medicinal plants, cotton, and trees for timber and firewood. Agroforestry systems are also being evaluated within the context of these commodities. There is limited use of fertilizers. Magnesium deficiencies are common throughout the region and Tingo Maria lime is being considered as a source of nutrients (Ca and Mg) rather than a liming amendment. They are currently using 10% Mg saturation of the effective CEC as a diagnostic criteria for Mg deficiency or sufficiency. Peru's Fosbayovar phosphate rock is viewed as a potential P input to systems under evaluation.

CIAT maintains a geographic team in Pucallpa. Their work with GIS is producing maps for deforestation patterns over time, major land uses and changes with time, and soil distributions. On-farm participatory research includes tests of introduced germplasm, best management practices and weed control. CIFOR activities are centered on enrichment of primary and secondary forests with species of high cash value. ICRAF activities include evaluation of improved fallows, peach palm production and reforestation with species for timber, fruit, firewood and medicinal purposes.

All CG staff work jointly with Winrock on large scale testing and economic evaluation of improved technologies directed towards increasing productivity. Each trial comprises 0.5 ha per farmer for a total of 50 ha in the watershed. Farmers receive training in the use of organic and inorganic fertilizers, whenever these inputs are deemed necessary. Inorganic materials include Fosbayovar PR, Tingo Maria lime and urea. Organic inputs include composts of legume residues and manures mixed with PR and lime. Many of these tests include either crop rotations with improved fallows or multistrata systems. Planting in contour rows is being strongly encouraged throughout the watershed.

Field trials to investigate management issues related to the Aguatia development programs are conducted in replicated experiments near Pucallpa. Julio is conducting such an experiment on

degraded pasture land in an Ultisol to evaluate corn production during several cycles of improved fallows. Tree, forage legume and natural fallows are grown for 18 months, then cut and burned prior to planting a corn crop without lime or fertilizer inputs. After harvesting corn the fallow cycles is repeated followed by a subsequent corn crop. The experiment was in the transition between fallows and the first crop of corn. Tree fallows under evaluation were *Inga edulis*, *Inga* spp. ('shimbillo'), *Gliricidia sepium*, and *Senna reticulata*. Forage legumes tested were *Stylosanthes guianensis* and *Centrosema macrocarpum*. Among the trees *I. edulis* and shimbillo produced the most biomass during the fallow; these also were the only trees which re-sprouted after slashing and burning. Among the forage legumes it appeared that stylosanthes might be too aggressive for these fallow rotations. The corn was two weeks old and the plots were covered with stylo seedlings. Plot size was large enough that they could be divided in future fallow-crop cycles to evaluate an additional variable which might be identified upon harvesting the current corn crop.

Discussions on the IntDSS software - in separate sessions the existing software was presented to Walter Bowen and Dale Bandy in Lima and Julio Alegre in Pucallpa. Walter felt that his investigations could help us determine default values for some of the N coefficients under those soil conditions were no other information is available. He has been collecting data throughout Latin America for use with simulation models. Interestingly, both he and David Bouldin have found through different approaches that proper prediction of soil N movement in Cerrado Oxisols requires proper accounting for anion retention capacity. Dale Bandy encourage inclusion of soil nutrient diagnosis and prediction information for tropical pastures. He also suggested that we explore possible linkages between IntDSS software and CIAT's GIS and databases. The initial contact should be through Dr. Richard Thomas.

Ongoing CGIAR/Winrock activities in the Aguatia watershed would be suited to the evaluation and testing of the IntDSS software, especially for the 0.5 ha trials where fertilizers are being introduced. Julio Alegre would like to see the IntDSS software account for the liming effect of the ash from slash-and-burn clearing when diagnosing and prescribing corrective measures for soil acidity. We discussed the uncertainties in predicting the lime value of ash resulting from differences in intensity of the burn and combustible biomass. Julio would also be interested in IntDSS predictions for the mineralization and N supply to crops by prunnings from multi-purpose leguminous trees species like *Inga*, *Gliricidia*, and *Senna*.

Julio Alegre agreed serve as our primary contact for IntDSS software evaluation and testing in Peru. A spreadsheet designed for collection of soil, plant and lime quality data on previous lime experiments was left with Julio. He will contact Mr. Adelo Vivanco to assemble data for various lime trials conducted in the Tingo Maria region.

Julio also alerted me to an interesting website at CIAT for gray literature in Latin America:

http://www.ciat.cgiar.org/greylit

Ecuador:

Upon arriving in Guayaquil, I was met by Dr. Jose Espinosa and Ing. Francisco Mite. Espinosa is the director of the Quito-based Potash & Phosphate Institute's office for the Andean region (INPOFOS). He has collaborated with the SM-CRSP in former projects on PDSS (Espinosa, 1992) and the Latin American Soils Research Network (RISTROP). Francisco is the national coordinator of soils programs for Ecuador's National Institute for Agricultural Research

(INIAP). He also coordinates the soil and plant analysis laboratories at INIAP's Pichilingue Tropical Experiment Station near Quevedo. I first met Francisco during our days as graduate students in NCSU's Soil Science Department.

Original travel plans in Ecuador were to become familiar with research and commercial agricultural activities while driving from Guayaquil to Quito (Figure 2). While in Quito, I would also meet with Charles Crissman (CIP-Quito), during the 4-day trip, and visit the site in Carchi Province for the SM-CRSP project on *Tradeoffs in sustainable agriculture and environment in the Andes: a decision support system for policy makers.* My travels in Ecuador had to be shortened to two days due to a nationwide strike which would make travel by road impossible within the country. Consequently, I was only able to visit INIAP stations and agricultural activities in the region between Guayaquil and Quevedo.

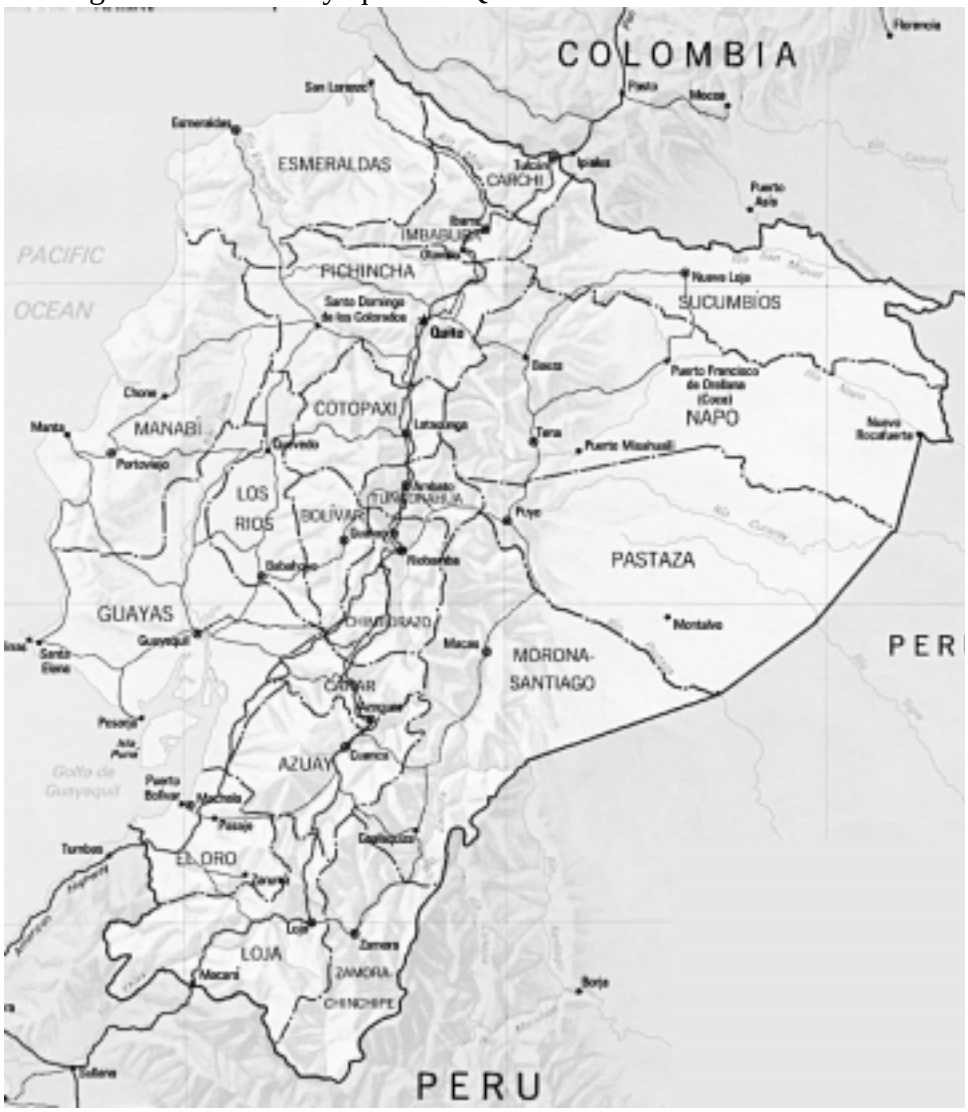

Figure 2. Map of Ecuador.

Visit to INIAP's Boliche and Pichilingue Experiment Stations - Boliche Experiment Station is about 80 km from Guayaquil on the road to Quevedo. This is where Dr. Sam Porch, currently with PPI-Hong Kong, helped established the national soil testing and plant analysis laboratory during the late '60s - early '70s as part of the AID-funded International Soil Fertility Evaluation and Improvement Program. The original sample trays, stirrers, dispensers and diluters are still being used in these laboratories, although the diluter valves need replacing after over 25 years of use. In a meeting with Ing. Carlos Cortez, station director, and Saúl Mestanza, regional coordinator, I described our IntDSS project and possibilities for INIAP's participation in the extensive evaluation network. Both of them were receptive to collaborating in the project and felt that their access to the IntDSS software would improve the services they provide to farmers through their soil testing laboratory. They had considerable soil and plant analysis data in their files which could be used for location-specific calibration of the software. These data should be investigated but it was never clear whether corollary field data on crop responses to fertilizers and lime was also readily available.

The same afternoon we drove the 120 km from Boliche to INIAP's Pichilingue Station near the town of Quevedo. Elevation at Quevedo is 200 m and about halfway to Quito. Some of the major differences I noted during travel from Boliche to Quevedo are summarized in Figure 3. Mollisols and Vertisols are the dominant soil orders in the Boliche region. Rice is planted in advance of annual flood waters from the Daule River. Soils near Quevedo have greater volcanic ash influence. Selected properties for the Pichilingue series (Andisol) are shown in Table 1.

	Boliche ⟷	Quevedo
Rainfall/yr , mm	800	2160
Volcanic ash	Low	High
Soil drainage	Poor	Medium
Soil Orders	Mollisols, Vertisols	Andisols
Crops	Paddy rice	Dryland cereals & Irrigated tree crops

Figure 3. Transitions in rainfall, soils and agricultural practices between Boliche and Quevedo, Ecuador

Quevedo has a 5-6 month dry season when monthly rainfall is less than 50 mm. Corn and soybean are the primary dryland crops. Most are grown with conventional tillage, but IDIAP has been doing field trials and promoting minimum tillage systems. Tree crops, with irrigation during the dry season, include cacao, plantain and banana. There is some interest in peach palm and coffee, but banana is the dominant crop. Although initial soil P levels are adequate, fertilizer P inputs eventually are needed for succeeding crops on these Andisols. Farmers routinely apply N, P and K fertilizers many of which use recommendations based on soil testing and plant analysis by the laboratory at Pichilingue.

Table 1. Selected characteristics for the Andisol at the Pichilingue Experiment Station in Ecuador (Pichilingue series).

SOIL				SOIL WATER		ORG.	TOT.	pH in	EXCHANGEABLE					EFF.	P
DEPTH	CLAY	SILT	B.D.	15 bar	⅓ bar	C	N	H_2O	Ca	Mg	Na	K	Acidity	CEC	RETN.
cm	----- % -----		g cm^{-3}	---------- % ----------					---------- cmol kg^{-1} ----------						%
0-10	7	54	0.91	20	47	4.33	0.46	6.5	18.2	3.9	0.1	0.9	16.3	39.4	70
10-50	3	40	0.78	18	50	1.65	0.17	6.6	8.9	0.9	0.1	1.1	18.9	29.9	85
50-83	3	48	0.82	17	52	1.65	0.16	6.4	7.7	0.4	0.2	0.9	22.0	31.2	85
83-102	13	52	0.88	15	52	0.58	-	6.7	5.8	0.6	0.2	1.6	9.8	18.0	43
102-130	27	40	1.40	16	27	0.24	-	6.8	4.6	1.1	0.3	0.5	5.9	12.4	46
130-150	52	28	1.21	27	39	0.15	-	6.6	5.8	1.7	0.4	0.7	7.3	15.9	53
150-170	65	22	1.13	34	44	0.19	-	6.5	6.3	2.2	0.4	1.0	8.1	18.0	53

Source: Mimeographed country report provided by Ing. Freddy Amores (IDIAP-Pichilingue) at the Latin American Tropical Soil Management Workshop, Yurimaguas, Peru, 31 August - 21 September, 1987.

Francisco Mite provided some interested rainfall data from the Pichilingue Station on “El Niño” phenomena, shown in Figure 4. Average rainfall for a biennium is 4190 mm. During two separate “El Niño” bienniums rainfall essentially doubled. During the ‘96-’98 event agricultural damages to 843,873 ha are estimated at $1,527 million.

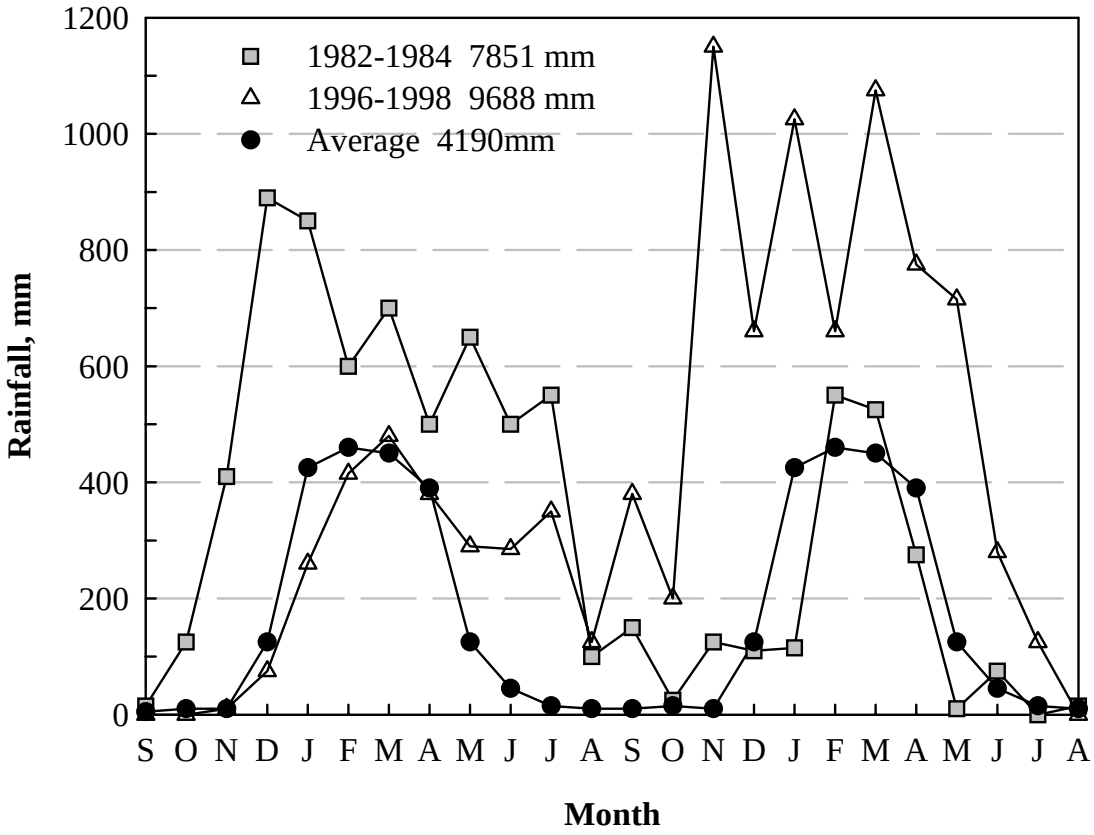

Figure 4. Comparisons of rainfall distribution at Pichilingue Station, Ecuador between average bienniums and two “El Niño” phenomena.

Discussions on the IntDSS software - both Espinosa and Mite were interested in collaborating on future development and local evaluation/calibration of the IntDSS software. Francisco Mite agreed to serve as the contact in IDIAP for project-related matters. He can provide data on lime trials for several location in Ecuador, and I agreed to send him the spreadsheet to facilitate collection of data. They also have good data on fertilizer N response for corn at Pichilingue. Shaw Reid and/or Deanna Osmond may wish to follow up on this with Francisco.

We continue to interact with Espinosa on P fertilization trials. I recently assisted Jose, via e-mail, with development of linear-plateau models for soil test-yield relations for several potato trials he is conducting in Andisols of the Ecuadorian highlands. Soil samples from these trials were shipped to Costa Rica for inclusion in laboratory studies which Fred Cox and Eloy Molina with perform to develop short-term estimates for soil P buffer coefficients. Espinosa and Mite

also identified two other P fertilization studies with data useful to IntDSS. The first is a field trial at Pichilingue evaluating fertilizer P response by corn and soybean. The experiment was conducted over several crop cycles wherein fertilizer P response changed progressively from nil to a moderate response yield. The second study was conducted in Colombia with support of INPOFOS. If soil samples are still available for these studies, they will forward them to Costa Rica for inclusion in the laboratory investigations. Fred Cox and/or Russ Yost may wish to follow this up by contacting Espinosa and Mite to obtain additional details about these two experiments.

At the time of my visit, only Espinosa had access to e-mail but they were in the process of installing e-mail service on computers at the Pichilingue Station. Since returning to Raleigh, I have sent test messages to Francisco but have not obtained a reply. Addresses, phones and faxes for Espinosa and Mite are listed in the following:

Dr. Jose Espinosa	Ing. Francisco Mite
INPOFOS	INIAP
Los Shyris y Telegrafo 2260	Estacion Experimental Tropical Pichilingue
Casilla 17-17-980	Casilla Postal 24
Quito, Ecuador	Quevedo, Ecuador
E-mail: inpofos@uio.satnet.net	E-mail: fmite@tp.iniap-ecuador.gov.ec
Voice: 593 246-3175	Voice: 593 575-0966/575-0967
Fax: 593 246-4104	Fax: 593 575-1018

I am most grateful for the hospitality and time invested by Jose Espinosa, Francisco Mite, INPOFOS and IDIAP in a very informative visit to Ecuador.

Costa Rica:

Project Activities - since June 1998 two separate visits by U.S. project members led to the development of collaborative laboratory and field activities with Univ. of Costa Rica's faculty in the Center for Agronomic Research. These investigations target the enhancement of our knowledge base on soil acidity, nitrogen and phosphorus management for Andisols and/or permanent crop systems such as peach palm. Final plans for laboratory soil P incubations and field evaluations of peach palm response to fertilizer P depend on completion via e-mail of discussions initiated during Fred Cox and Adrian Ares' trip to Costa Rica in September/October..

Activities outlined during Hue, Smyth and Wagger's trip in June are in various stages of development. The field trial, under Gabriela Soto's supervision, to evaluate litter decomposition and nutrient release of peach palm prunnings was in the tenth week of data collection for the rainy season period. Preliminary evaluation of data for harvested litter bags indicates little or no loss of dry weight for prunnings during the first six weeks of field exposure. I was able to visit this experiment which was installed in a 15-year peach palm plantation on an Andisol at DEMASA's farm at Guapiles. I noted that DEMASA has begun to apply heart-of-palm residues

from their processing plant adjacent to this farm between peach palm rows. Based on the thick mulch layer applications are rather high, but seem to be effective in controlling weeds. Gabriela has taken samples of this residue for analysis of nutrient content, and is interested in conducting a decomposition study similar to the one which is ongoing with peach palm litter pruned during field harvest of the heart-of-palm.

Lidieth Uribe, Alfredo Alvarado and Rafael Salas have almost completed the collection of soil and plant materials in preparation for the greenhouse trials on (a) peach palm root growth response to lime, Ca and Mg; (b) lime-equivalence bioassay of peach palm litter; and (c) effect of peach palm residue on soil chemical properties. They plan to initiate these trials in November.

Eloy Molina has sampled soil in the lime and gypsum field trial at DEMASA, but laboratory analyses are still pending. Alfredo Alvarado has begun to search for field sites for the year-long experiment to measure biomass and nutrient accumulation in peach palm plantations at 2, 4, 8, and 16 years of age. A crucial aspect of site selection is to minimize soil and management history differences between these plantations. Otherwise, time is confounded with these variables. Rafael Salas has received the porous cups and is beginning to construct suction lysimeters to be placed in plots with different plantation ages.

There are several positive developments in Costa Rica that relate to our project's activities. A peach palm growers association, AGROPALM, has approached Alfredo Alvarado seeking to develop linkages with the Center for Agronomic Research on agronomic research, technology transfer, food processing and marketing of heart-of-palm. AGROPALM membership includes 478 families in 36 communities throughout the Sarapiqui region. Alfredo recently learned of the Costa Rica - U.S.A. Foundation for Cooperation (CRUSA). The foundation provides grants to Costa Rican organizations that involve U.S. participation in cooperative activities in Costa Rica. Thematic areas include natural resource management, scientific and technological development in strategic areas, and technical exchange, cunsultanships and scholarships. Additional information on CRUSA is available on their web page (*http://www.crusa.or.cr/ing/index.html*). Alfredo and Larry Szott are drafting a proposal for CRUSA that could possibly include development of linkages and activities with AGROPALM. The next evaluation of proposals by CRUSA is scheduled for March 1999.

Discussions on the IntDSS software - the software was presented to Alfredo Alvarado, Rafael Salas, Eloy Molina and graduate students in two sessions. As with similar sessions in Ecuador and Peru, there is a quantum leap in communication, understanding and interest into what this project is trying to do once they run through the software. Rafael and Eloy volunteered to put together a series of images on nutrient deficiencies for sugarcane, coffee, macadamia and other tree crops grown in Costa Rica. They have slide collections for missing element trials performed on several of these crops in large pots. They can scan these slides and provide digital images, but we need to provide specs on image size, resolution and desired file format. Deanna may want to follow up on this after consulting with Steve Pratt.

Both faculty and graduate students were interested in pursueing the identification of plants in Costa Rica that could be used as indicators of soil acidity or P deficiency in the diagnosis module. I detected several discussions in the group as to how this might become an interesting topic for graduate student research. A good suggestion was made for ADSS on the approach used to obtain user input about the $CaCO_3$ equivalence of lime materials. ADSS currently asks for

particle size, Ca content, Mg content and calculates $CaCO_3$ equivalence. The suggested alternative was to allow direct input of $CaCO_3$ equivalence by the user. The rationale is that some users may know the $CaCO_3$ equivalence of their lime material, but not the individual variables used for its calculation. Some students expressed particular interest in understanding the inner workings as to how the software performs a diagnosis and prediction. I was able to point them to an article Russ presented at the 1990 workshop in Costa Rica that is published in Spanish (Yost et al., 1991).

There was some discussion that required undergraduate senior projects for Agronomy majors could focus on reviews of local literature for plant and soil data needed for local calibration of IntDSS. Availability of the IntDSS software prototype would be essential in enticing students to focus their projects appropriately.

Literature Cited:

Note - *names listed in parentheses for reports correspond to the hyperlink names to the Acrobat Reader files which can be downloaded from the project's Web site located at the following address:*

http://intdss.soil.ncsu.edu/sm-crsp/Download/Download.htm

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Contacts:

Peru-

International Center for Research in Agroforestry (ICRAF)

Dr. Dale Bandy

Dr. Julio Alegre

Dr. John Weber
Mr. Arnold Braun
International Fertilizer Development Center (IFDC)
Dr. Walter Bowen
International Forestry Center (CIFOR)
Ms. Peta Braun
National Agrarian University of La Selva, Tingo Maria
Ing. Luis Zuniga, Natural Resources Faculty
Ing. Hugo Huamani, Agronomy Faculty
Peruvian Amazon Research Institute (IIAP)
Ing. Luiz Arevalo
National Research Institute (INIA)
Ing. Kenneth Reategui
Ecuador -
Potash & Phosphate Institute (INPOFOS)
Dr. José Espinosa
Boliche Experiment Station (INIAP)
Ing. Carlos Cortez Bedón, Director
Ing. Saúl Mestanza Solano, Regional Coordinator
Pichilingue Tropical Experiment Station (INIAP)
Ing. Francisco Mite, National Soils Coordinator
Costa Rica -
Center for Agronomic Investigations, Univ. Costa Rica
Dr. Alfredo Alvarado
Dr. Rafael Salas
Mr. Eloy Molina
Ms. Gabriela Soto
Ms. Floria Bertsch
Ms. Gloria Melendez
Univ. Costa Rica
Dr. Larry Szott