Report of the Review of
North Carolina State University's

TropSoils Program In Brazil and Peru

January, 1987

TROPSOILS

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The enclosed report was prepared by Dr. Marlowe Thorne, who at the time of this trip was a member of the External Evaluation Panel for the Soil Management CRSP.

Management Entity

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BRAZIL/PERU TRIP REPORT

15-24 January, 1987

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The objective of the trip was to review research conducted by North Carolina State University under TROPSOILS. An in-depth review of this program was conducted in 1984 by the other two members of the EEP plus one additional consultant. Since I was unable to participate in that review, this trip provided opportunity to see the research in the field and to make an interim review. There was also opportunity to confer with TROPSOILS scientists, their counterparts in EMBRAPA and INIPA, the Head of INIPA, and USAID Director and Agricultural Officers in Peru.

Dr. Charles McCants, Director of the Management Entity of TROPSOILS, Dr. Pedro Sanchez, NCSU Program Coordinator, and Dr. Walter Bowen of the Cornell project staff in Brasilia were already at Manaus when I arrived late on 15 January. My arrival was delayed one day because cancellation of a flight in the US prevented my catching the flight from Miami to Manaus on the 14th. The earliest I could then get there was about 24 hours later than intended, being rerouted from Miami through Barbados to Manaus. The four of us travelled together until Dr. McCants and I departed Lima early on 24 January.

January 16. Manaus, Brazil

<u>NCSU Project 309.. Soil Fertility Management in Oxisols of Manaus</u>

Research is conducted on or near EMBRAPA's UEPAE station near Manaus. The principal vegetation is primary forest and soils are clayey, very fine, kaolinitic Typic Acrorthox located mainly on flat plateaus. <u>Manoel Cravo</u>, Brazilian scientist, and <u>Ricardo Melgar</u>, NCSU graduate student from Argentina showed us their research. We were each given a short written description of the station, the experiments being conducted, and soil profile characteristics.

Soil Nutrient Dynamics and Fertility Management for Sustained Crop Production on Oxisols. (M-901)

This appears to be an innovative approach to identify and correct nutrient deficiencies in crops grown in this soil following cutting and burning of the primary forest in 1981. An area large enough to contain replicated plots of at least 35 treatments was cleared for the experiment. Soils and forest mass were analyzed to give reference data and clues as to which nutrients might become deficient with cropping. When a

deficiency was suspected, three rates of application were initiated to establish a response curve. If there was response, a uniform rate of application of that nutrient at the rate judged best was made to the entire experiment, except for checks. The soil pH is 4.2 to 4.6 with 70 to 80 percent Al saturation and relatively high organic matter content, typical of Oxisols in the humid tropics.

Upland rice was planted first, followed by soybeans, then a maize/cowpea rotation. Residues were returned to the soil and good records kept of soil and plant analyses and of all applications to plots. Phosphorus deficiency was detected in the first crop and an additional long-term experiment was initiated to evaluate rates and forms of P application. K deficiency was detected in the soybeans and Al toxicity in connection with the high acidity appeared in the 4th crop and Cu deficiency in the 5th crop. B, Zn, S, Mg, and Mn deficiencies have been suspected but not yet confirmed.
In the earlier years of the experiment, return of residues was equivalent to 50 kg of K/ha. Now return is not sufficient for succeeding crops.

An annual workshop is held for extension workers. One problem noted was that many farmers in the area do not return residues to the land and the experiment does not provide adequate information for them. There are differences in response of different cultivars of the same crop and the experiment cannot include all which farmers grow.

Approval has been received to continue the study only through 1989. Work beyond that time awaits approval of the CPAC equivalent organization, CPATU, located in Belem, which deals with the Humid Tropics.

A similar experiment was installed on Ultisols at Yurimaguas, Peru so results with the Ultisols and Oxisols can be compared. It was reported that if the best Yurimaguas treatment had been used at Manaus, with no interpretation for Ultisols vs. Oxisols, lime and potassium would have been applied earlier than needed and phosphorus would not have been applied soon enough. With no soil analyses, the Al/acidity and Cu deficiency problems would probably have been missed.

It would have been interesting to include a treatment based on Yurimaguas experience, modified by "best judgment" as to differences to be expected in Oxisols, and utilizing soil test information. While that was not an objective of this experiment, one wonder how well TROPSOILS scientists could have predicted satisfactory fertility practices for these soils on the basis of their state of knowledge at that time.

Phosphorus Fertilization Alternatives for Continuous Cropping Systems in Amazon Oxisols (M-902)

A maize/cowpea rotation is followed, using a split-plot design with broadcast P rates as main plots and banded P rates applied to each crop as subplots. Cowpeas require more P than maize. With the broadcast application, yields of cowpeas fell off more rapidly than those of maize. Broadcast applications did not become profitable until the 5th crop. Critical soil test P values were determined using the Mehlich extractant. This is the official extractant for Brazil, while Peru uses the modified Olsen procedure.

Effect of Lime and Gypsum on Leaching of Nutrients and Crop Yields

Local lime has 33% Ca and 0.8% Mg, with a calcium carbonate equivalent of 73%. The experiment started with maize/cowpea rotation and switched to peanuts. 1 ton lime/ha gave 87% of maximum yield in 7 crops. With gypsum, 1 ton lime gave about 91% of the yield with 2 tons/ha. Cowpea responded only to lime. Al saturation was reported to be greater than 65%. A sharp decrease in Al saturation is found following burning in these soils; dropping as low as 20%, but it returns to about original levels subsequently.

Nitrogen Fertilization of Maize

N is applied at 3 dates: at planting, 25 days later, and at silking (about 57 days). Rates are 0, 10, 20, and 60 kg/ha, with 80 to 90 plants of maize per hectare. Two locations are utilized, one on alluvial and the other on residual Oxisols. A much higher rate of N uptake is occurring in the crop on the alluvial soils. The group had visited the alluvial site the day before I arrived. It was reported that minimum night temperatures in this vicinity, 3 degrees S. Lat., are about 20 to 24 degrees C.

Guarana (Paulina cupana) Fertilization (M-906)

This includes rates of N, P, K, and Mg, with four rates for each nutrient. Other nutrients are kept constant at the highest rate. Three promising clones of guarana are planted as subplots in each fertilizer treatment. Analyses are made of both new and old foliage and numbers of branches are measured. The first flowering was reported to have been extremely erratic. The second crop is now in progress and appears to be more reliable. The spaces between rows of leguminous trees can be utilized for cropping systems research.

Guarana is becoming an important crop for the area, being utilized mainly as an ingredient of a soft drink. We were served some of this at lunch and found it very pleasing. Some is reported to be marketed in California now. The seed contains from 5 to 6% caffeine.

Meeting with Dr. Erci de Maraes, UEPAE Station Director, and others in Station Conference Room

EMBRAPA's greatest priority is for another scientist at the station. The Director had expected NCSU to replace Dr. T.J. Smyth at Manaus, but that has not happened and does not appear feasible in view of TROPSOILS budget cuts. One Brazilian scientist is studying for Ph.D. in soil physics at Sao Paulo and they are short-handed. This is one of the most expensive places in Brazil to live and they are losing staff because of inadequate salary levels. Also they have some sort of hiring freeze at present. He inquired as to whether Dr. Smyth or someone else could spend some extended periods there and if graduate students could be sent there for thesis research.

Another need is for assistance in paddy rice production. Mr. Cravo attended the workshop in Yurimaguas and they are anxious to try it at Manaus, but need some help. Could they get a consultant from Yurimaguas for this? Funds might be obtained from IICA and they are exploring this.

17 January, 1987 at Iquitos, Peru

Dr. Hugo Villachica of the NCSU mission in Peru, located with INIPA in Lima, was at Iquitos and met us on our arrival in late morning . During lunch he explained the organization of INIPA and its programs. After lunch the group went with Peru scientists to the INIPA station near Iquitos, but I did not feel well and spent the afternoon in the hotel room.

Dr. Villachica met with us again in the evening and the next morning presenting additional details of the INIPA national programs and discussing TROPSOILS involvement, future plans, etc. This background material was most helpful in understanding relationships during the Yurimaguas and Lima visits.

18-22 January, 1987 at Yurimaguas, Peru

The flight from Iquitos was delayed because of weather, so arrival in Yurimaguas was not until after 5 PM instead of the scheduled 11 AM arrival. The TROPSOILS staff and collaborating scientists met at the home of Dr. J. R. Benites at 6 PM for a

general review of the program and a firming up of the schedule. We were each presented with a folder of materials about each experiment, an Administrative Report, a nine page report on the Contribution of the Program to Peruvian Agricultural Development, and a Report of the Latin American Workshop on Tropical Soils Management.

A strike of farmers in the area would make travel by road to the research station impossible, but they would try to get us there by boat along the river and plans were made for this trip on the 19th.

Dr. Dale Bandy, Chief of the North Carolina State University Mission to Peru (including TROPSOILS and a Research, Education, and Extension Project, working with INIPA) arrived in Yurimaguas from Lima in time to join the entire group for dinner at "El Naranjo" restaurant. All visitors were housed at the homes of Dr. Benites and Dr. Julio Alegre.

On the 19th we made the trip to the Experiment Station by boat without interference from striking farmers. The regular boat dock at the station was not used, but a path had been cut through the jungle to another site in a secluded spot on the river. On the 20th a boat load of workers going to the station was not permitted to land there, so we were evidently fortunate in getting to the station for even one day.

In the following there is no attempt to present a complete discussion of each NCSU project, but primarily my impressions of the work during the visit. Complete information about the projects is given in various TROPSOILS reports, including the Triennial Technical Report, 1981-84; External Evaluation, 1981-84 (especially pages 41-58); Program Plan, 1984-89; Annual Review, April, 1986; and various trip reports of Dr. Pedro Sanchez (especially those of July, 1985 and October/November, 1986) and of other NCSU staff members. The name of the person(s) making the presentation during the field tour is given, along with some of the others at Yurimaguas mentioned as being also involved. The complete list of cooperators, including the NCSU campus faculty members and graduate students, is given in the Program Plan, 1984-89 and not repeated here.

<u>Project Number 301: Continuous Cropping Systems: Conservation Tillage</u> <u>Julio Alegre</u>

The project consists of four experiments titled: Rainfall Intensity, Conservation Tillage, Water Balance and Soil Trafficability. The Conservation Tillage experiment includes six treatments, all with tractor-drawn tillage implements and with weed control by herbicides. The traditional method of

planting is by use of a planting stick and a machete and this was not included in the comparisons.

Numerous detailed measurements of soil physical conditions are being made and a considerable mass of data has been accumulated. Dr. Alegre has been diligent in publishing results in technical journals and perhaps elsewhere. It is hoped that the work will achieve better utilization of soil physical data in understanding crop production systems than has been the case with much of such work in other parts of the world.

The Soil Trafficability experiment was started in 1980 and has shown that as soil moisture at the time of tillage increases, yields are reduced linearly. One tractor pass under the highest soil moisture content caused deeper wheel tracks, soil compaction, and a 50% reduction in corn yield.

The work appears interesting and well-conducted. The numbers and the variety of modern tillage implements and of instruments for measuring physical parameters was most impressive. It is apparent that the researchers are well equipped and the equipment is well maintained and used.

It was reported to have attracted considerable international attention. The question immediately arises as to the extent of areas of the Humid Tropics to which tillage with modern tractor-drawn implements has direct applicability. The answer given was that there are now numerous farmers in the Amazon who are cultivating up to 50 ha of land with tractors. The numbers are expected to increase and Dr. Villachica indicated INIPA gives this work quite high priority. It is assumed that mechanization is a thing of the near future. A person may homestead a maximum of 50 ha in new areas, but can purchase whatever amount he can afford.

Project Number 302: Continuous Cropping Systems: Fertility Management Julio Alegre and Eduardo Uribe

The experiment has now completed its 33rd crop, following a rotation of upland rice-corn-soybeans or peanuts. It has shown that continuous cropping can be maintained on these Ultisols following clearing if lime and fertilizer is applied according to soil tests. There has been some improvement in soil chemical properties and no deterioration in physical properties if fertilization is adequate to assure good crop growth. The 32nd crop was soybeans, yielding 1.5 t/ha for complete treatment and zero for the check. The 33rd crop was corn, yielding 3.5 t/ha average. Only the treatment without fertilizer or lime and the treatment with complete

fertilization have been used for crop evaluation beginning with the 32nd crop and the rotation is corn/soybeans. All other plots now receive complete fertilizer and lime according to soil tests.

It would be interesting to split the plots and provide adequate fertilization to areas unfertilized since clearing to see if yields could be brought up to the level of that which has had adequate fertilization. This was done in the Morrow Plots in Illinois and Mollisols unfertilized for about 80 years produced within two or three years essentially as much as adjacent plots which had been fertilized all along. It was indicated here that plot size is sufficiently large to permit this, but there is a question of cost of doing it, as well as whether it would be the most desirable thing to do.

An experiment in K dynamics in Ultisols is also included in this project. It had been originally thought that there was no response to K in these soils. However, H. Villachica found K response in his thesis work on the station and R. E. McCollum of NCSU also noted some response in his studies. Mr. Uribe made mineralogical characterization of soil samples at NCSU before coming to Yurimaguas for his thesis study. 4 rates of KCl application plus a check are included. The experiment seeks to explain response to K or lack thereof. Is K fixed or leached? Should applications be split? Would slow-release K fertilizers be helpful?

There was satisfactory crop in 1984, but a failure in 1985 because of bird damage, soil compaction and poor weed control. 1986 crop has just been harvested and data not yet summarized or analyzed.

Project Number 303: Low-Input Crop Production Systems for Acid Soils in the Humid Tropics Jose Benites and Jose Davelouis.

The approach in this experiment has been to follow initially the practices of shifting cultivators after clearing of the land. Changes are made about the time the shifting cultivators abandon their land. The system has lower input requirements and lower risk for the farmer and probably a greater probability of adoption by most farmers than the higher input system where lime and fertilizer are applied in adequate amounts, requiring greater capital, greater infrastructure to provide the inputs, and greater loss if the crop fails. However, it also has less potential for the higher returns which can be obtained if the inputs are obtainable and properly managed.

Results so far with the low-input systems research are very encouraging, although problems have developed. The seventh consecutive rice crop has been harvested and it is evident that fertilization rate has become inadequate. With the addition of a small amount of fertilizer then, cropping can continue but weeds become a major problem after the 7th crop. They can be controlled satisfactorily with herbicides, but the cost is currently prohibitive, being estimated by J. Mt. Pleasant at about $100 per hectare. With the traditional system only one crop is usually harvested after clearing, so this cropping option is a major improvement.

Four crops of rice and three of cowpeas have been harvested in that rotation with total yield of nearly 14 tons of grain in 34 months with no fertilizer added. It is now in the eighth crop, following a one year kudzu fallow.

The INIPA National Program staff have assisted materially with selection of acid-tolerant germ plasm for maize, upland rice and peanuts. The Co-Leader of the National Rice Program has left Peru and new germ plasm for that crop is no longer being obtained. Only one rice variety has the needed acid tolerance and that has poor milling quality. Better green manure crops are needed. It was suggested that mulching with leguminous residues should be included in the low-input cropping studies.

Project Number 304: Legume-Based Pastures for Acid Soils in the Humid Tropics___Daysi Lara, E. Uribe, Pedro Sanchez

The longest lasting grazing trial in the humid tropics using an acid-tolerant legume-grass mixture is a part of this study. The research focus must be quite different in this area where growing conditions are favorable throughout the entire year as compared to that in semiarid tropical and savanna regions where emphasis is on productivity during the dry part of the year. The study began in 1979 and the mixture now used is a result of 1 year's research with CIAT introductions. Interest is concentrated on species which will produce well with inputs of only 50 kg P and 50 kg K per hectare. Liveweight gains of cattle have reached 500 or 600 (occasionally near to 1000) kg/ha/yr.; the norm locally is about 50 to 100 kg/ha/yr.

Additional studies are concerned with nutritional requirements, potassium dynamics and recycling, and the nitrogen contribution of legumes in the mixed pastures. There is need for better information on sustainability of grass-legume mixtures and the best soil management for establishment and for regeneration of degraded pastures.

Since 1984, INIPA has taken over responsibility for agronomic management and germplasm selection in this project. It has high priority in the Selva program. A position was added at Yurimaguas in pasture management. It is currently vacant but effort is being made to fill it.

Two NCSU graduate students have been involved in the project; one has recently returned to campus. It is planned that another graduate student will come in 1988 for thesis research under this project. Subsequent TROPSOILS effort is expected to be minimal. There is great need for a popular publication to bring the lessons learned from this work to others interested in pastures on acid soils in the humid tropics. The information is being utilized in workshops and a publication in Spanish has been issued. The technology is being applied to steep lands at Kilometer 17. Information developed can be put into a model such as the Colorado "Grass Mod".

Project 305: Soil Management for Agroforestry Systems in the Humid Tropics A. Salazar, C. Palm, J. Perez, J. Alegre

The project includes a rather wide range of experiments such as collection, testing and propagation of species of trees (including native fruits), legumes, and grasses; litter and leaf quality; management for production; nutritional requirements; comparative soil dynamics under different management; nitrogen mineralization; improved management of fallows; alley cropping; forest and soil regeneration; response to mycorrhizae inoculation; and market potential. It involves cooperation of ICRAF, CIAT, IDRC, INIPA, and TROPSOILS. One NCSU student has completed thesis research and returned to campus, another is now completing thesis research at Yurimaguas and another is scheduled to come later in 1987. It was impressive that C. Palm, the student now completing research, reported she had the assistance of 8 persons on the total program in which she was involved. About one-half her time is devoted to the thesis research.

It was suggested that the term "alley cropping" is too restrictive and that a better term might be "legume residue management". There is serious doubt that farmers will plant trees amongst legumes or row crops, but they may well plant them in borders and adjacent to harvested areas, utilizing cuttings as mulch in the harvested area. In one experiment there was a striking control of weeds, particularly grasses, when residues of Inga were placed on the soil surface which otherwise would be bare except for weeds. Residues of this tree decompose slowly and provide considerable nitrogen. It appears that phenol composition of the residues influences the rate of decomposition more than lignin content.

There have been considerable studies of "alley cropping" on Alfisols, but not on Ultisols. The work at Yurimaguas now concentrates on 3 species: Inga edulis, Erythrina sp., and Leucaena leucecephala. A model has now been developed to predict performance.

Root studies were started in 1986 to help with selection of species. One-half the total biomass was found to be in the roots. This is about the same proportion as in temperate soils and was surprising that it was not lower in the acid soils. The biomass in the soil under acid tolerant grasses was about twice that under native forest.

Measurements of soil nitrogen, soil moisture, and of weed control are being made. It would be interesting to measure the effect of surface residues on soil temperatures as well, but instruments are not available there for this. It seemed a little strange that they had neutron meters for soil moisture, but not even simple soil thermometers, let alone soil thermographs.

Leaf-cutter ants are a particular problem and species which do not survive their ravages are eliminated in early screening.

It appears that the main function of the fallow period in traditional agriculture is weed control. No changes in soil nutrients was found until after burning

Considerable enthusiasm was evident for peach palm (Gulielma gasipaes), also known as pijuayo, pupunha, chontaduro and pejibaye. Its fruit is reported to be well balanced in terms of carbohydrates, protein, fats, and vitamins. It coppices, allowing harvesting of suckers for heart of palm production without killing the tree. At Manaus we also found much interest in peach palm and in guarana (Paulina cupana). At lunches in Manaus we were served a salad of heart of palm and a soft drink made from guarana. Both these have considerable potential for local sale as well as for export.

Project 306: Characterization, Classification, and Interpretation of Soils of the Humid Tropics.

Results of this study are evident in the map published by iiap, USAID, INIPA and TROPSOILS entitled: "Soil Fertility on Flood Plains of the Amazon Basin of Peru". This shows pH, Al saturation, Ca, Mg, K, Mn, Cu, Zn and P contents of soils at 20 locations. References to this information and to more detailed soils information regarding soils at specific experiment sites provided good evidence of the value of this project

and of its utilization. One detailed soil profile was viewed on the Yurimaguas station even though the pit was partially filled with water from recent rains.

NCSU is now working on a more sophisticated version of the Fertility Capability Classification system and working on better interpretation for tree crops. There is hope of developing a FCC map of all the developing areas of the world.

Project 307: Research Network for the Humid Tropics

In 1983 the first training course in soil management for Peru was held. Some of the participants have become leaders of their units.

The first Latin American Workshop on Tropical Soils Management was held at Yurimaguas August 31-September 21, 1986. , Its purpose was: "a) To acquaint key Latin American scientists with the most recent techniques in humid tropical soil characterization and management and b) To identify the common interests and framework for establishing extrapolation and validation of soils research in a network design." Co-sponsors were: USAID, INIPA, IICA, and TROPSOILS (NCSU). Published materials were also provided by IITA, CIAT, SMSS, and POTAFOS (Brazilian Association for Potash and Phosphate Research). 31 individuals from Bolivia, Brazil, Columbia, Costa Rica, Dom. Republic, Ecuador, Guatemala, Honduras, Panama, and Peru were attendees. They represented 23 potential research sites distributed among 15 national institutions in 10 countries. All participants had B.S. degrees in Agronomy, or equivalent training, and 14 had M.S. degrees in Agronomy.

A research network, called RISTROP, was organized with Dr. T. J. Smyth of NCSU providing central coordination. Workshop participants developed research proposals in the following areas: Low Input, High Input, Improved Pastures, Agroforestry, and Paddy Rice. NCSU will provide assistance in: Site selection and characterization, compatibility of analyses throughout the network, statistical analyses and data exchange. Responses to date were reported from the following: Brazil, Columbia, Costa Rica, Panama, Peru, and Venezuela. TROPSOILS maintains contact with participants and others through a newsletter and through visits. Additional workshops/conferences of network participants will be held when experimental results are available from participating organizations.

Mr. Pacora, Head of INIPA, evidenced great interest in the Network for Latin America and stated that he would see that it was

discussed at an upcoming meeting of the Ministers of Agriculture of the Andean Countries. He feels there is much to offer from the INIPA-TROPSOILS program which should be extended to other countries.

IBSRAM has requested TROPSOILS to hold a workshop for Africans and Asians in 1987. It would be financed by IDRC and the Asian Development Bank.

Economic Studies being conducted by INIPA scientist at Yurimaguas

The first objective is to find out just what is going on in the area. What practices do farmers actually follow? What inputs do they have? What do they need?

The second objective is to find out if farmers are getting any assistance from extension. She finds no evidence that they are. Extension people say they have no resources and that is probably too true.

The third objective is to analyze the work on the Yurimaguas station and ascertain what is feasible for utilization by farmers. She has determined that the profit margin for rice is $1.60 for each $1.00 spent in production; for pastures it is $1.20 for each $1.00.

Discussion on 20 January at Yurimaguas

The group met at J. R. Benites home for most of the day reviewing the research program and related matters. Specific matters included the following: (Some information relating to specific projects have already been included in discussions of those projects above. Some information in the following came from discussions at Manaus and Iquitos, but is more logically presented here.)

C. B. McCants discussed the general budget situation for TROPSOILS and its implications. TROPSOILS must take some programs and run with them; cannot continue to try to do everything. It is essential to develop some programs that get onto farms. TROPSOILS program will not be supported on the basis of research publications alone in view of the current AID budget situation.

P. A. Sanchez stated that the NCSU workplan follows the recommendations of the 1984 review. All matters were thoroughly discussed with INIPA and INIPA has taken action to hire people to take on the parts of the program that TROPSOILS had to drop. Now further cuts are inevitable and top priorities for the future must be agreed upon to

determine what is to be kept and what is to be dropped. This program stands alone in the Humid Tropics. IITA does not agree with the high input concept for humid tropics, nor do they work on representative acid soils. Considerable interest in this concept in Peru and in certain other countries in Latin America was reported.

INIPA requested expansion of the program beyond Yurimaguas and activities are now at 2 additional sites. Will these have to be dropped?

20 NCSU graduate students have been supported by TROPSOILS for PhD thesis research. (See Appendix for table giving details.) Nine have had total support from the CRSP and the others partial support. Nine will soon finish and cannot be replaced. NCSU has not offered any new assistantships under TROPSOILS since February, 1986.

J. R. Benites reported that 32 field workers paid by TROPSOILS had been transferred to INIPA payroll. Tropsoils still pays some seasonal workers. INIPA has added a socioeconomist to the staff at Yurimaguas. She has already made some studies, reported elsewhere in this report.

D. E. Bandy reported that INIPA had provided $500,000 for support of the Yurimaguas program. $200,000 was for operations, $200,000 for construction and $100,000 for commodities. He said that $100,000 of this came from PL 480 funds. All this money is under control of M. Villavicencio, INIPA's Yurimaguas station director. AID has invested more in mechanization in Peru in the last few years than has the World Bank or IDB. Both AID and INIPA are very interested in high input option as well as low input.

Discussion on 21 January at Yurimaguas

The following met at Dr. Alegre's home for discussions before leaving for Lima about noon: Alegre, Bandy, Benites, McCants, Palm, Sanchez, Villachica.

Dr. McCants stated that TROPSOILS is involved in three types of research:

1. Developmental. This is the main mission of TROPSOILS.
2. Adaptive. TROPSOILS should be involved but country organizations should take the major responsibility
3. Extrapolation. TROPSOILS must give more attention to this aspect. Networking is one aspect and is to be encouraged.

Drs. Bandy and Villachica agreed that INIPA has the responsibility for Adaptive Research and is making progress in intensifying it efforts in this area. The AID supported Project

for Research, Education and Extension (REE), for which Dr. Bandy is Team Leader, assists INIPA in developing capability and in conducting these activities.

Dr. Sanchez proposed the following actions to reflect the priorities of the NCSU TROPSOILS program in the Humid Tropics: (Numbers do not reflect relative priorities)

1. Terminate all graduate student support as soon as the commitment to each for completion of his/her degree is completed.
2. Restrict activities to Yurimaguas after termination of graduate students located elsewhere.
3. Continue TROPSOILS support of the following projects, which would account for about 60 percent of the NCSU asking budget: (TROPSOILS should maintain the two senior staff positions at Yurimaguas.)
   302. Conservation Tillage
   303. Low-Input Crop Production Systems
   305. Agroforestry
   306. Soil Characterization
   307. Research Network

4. Drop TROPSOILS support of the following:
   304. Legume-based Pastures for Acid Soils
   308. Soil Erosion and Reclamation of Humid Tropical Steeplands.
   309. Soil Fertility Management in Oxisols at Manaus.
   310. Soil Management in Transmigration Areas of Sumatra (this has already essentially terminated).

5. Reduce substantially the percentage of salary of Sanchez and Smyth coming from TROPSOILS. An approach has already been made by the Soils Department to the Dean of the College of Agriculture, but nothing is definite about this as yet.

6. Maintain a viable program that can be expanded if additional funds can be obtained from any source.

7. Adequate information has been accumulated for a number of publications of the work at Yurimaguas. These must have high priority and assistance from the ME editor is urgently needed. The low-input technology story has developed since initiation of the CRSP. An invitation has been received from Science magazine for a feature article and this would provide an excellent opportunity to get information to a wide scientific audience.

Dr. Bandy questioned whether low-input technology is ready for a publication since it has not been tested outside the station. Dr. Sanchez said it had been tried on farms around Pucallpa, Pichis; it is ready to go with on-farm testing by researchers but not yet for a big program by INIPA. There is a problem with quality of rice which is acid tolerant. Best procedure not is to plant local variety for the first crop and use the new for the second. Farmer acceptance has not been adequately assured, but IR8 rice adoption was rapid in spite of the quality problem with it. Ms. Palm thinks it is time to get the story out and there is an obligation to do so at this stage.

Conference on 22 January in Lima with Mr. Lander Pacora, Head of INIPA

Present were Bandy, Bowen, McCants, Sanchez, Thorne.

Dr. McCants gave an overall view of the total TROPSOILS program at 4 primary sites in 3 agroecological zones, with 4 U.S. Universities cooperating. He then concentrated on lessons learned at Yurimaguas: Forest land in the humid tropics can be cleared and farmed continuously, if properly managed; Low-input and High-input technologies have been developed for managing the soils under continuous cultivation; Legume and grass combinations have been developed for productive pastures on these soils; Agroforestry systems have been developed; and Mechanization has been successfully tested under high inputs.

The highest priority now is to validate the practices across broad regions and adapt them to each region. TROPSOILS will provide technical assistance, but INIPA should take the lead.

There have been cuts in the AID budget, cuts in TROPSOILS budget, and resulting cuts in the NCSU budget and program.

Dr. Sanchez stated this would amount to a reduction of about 40% in the NCSU budget over the next 3 years.

Mr. Pacora expressed his concern about INIPA's task of adaptation and his great support for this activity. INIPA has also suffered budget reductions. He is making plans for putting money into the budget for adaptation efforts this next year. He wants to bring all segments of the INIPA program into coordination; will start with programming. INIPA will strengthen its ties with the International Potato Center (CIP). He wants training of INIPA personnel in technology developed at Yurimaguas. He wants to strengthen ties with EMBRAPA in Brazil; perhaps TROPSOILS can help.

Dr. Sanchez related the request for paddy rice assistance at Manaus. INIPA scientists could provide this.

Mr. Pacora: Venezuela is interested in cooperation. The ministers of the 5 Andean countries (Peru, Bolivia, Ecuador, Columbia, and Venezuela) will meet in April. They have the authority to make decisions for their countries. He cannot get the item on the agenda but will see that there is a discussion of cooperation in adaptive research and extrapolation of research, particularly through some kind of network activity.

Dr. Sanchez: There is the beginning of a network for acid tropical soils. The International Board for Soil Research and Management (IBSRAM) has headquarters in Thailand. Workshops were held in 1985 in Yurimaguas, Manaus, and Brasilia.

Mr. Pacora served as the Peru representative on the International Fund for Agricultural Development (IFAD), a UN agency headquartered in Rome and suggested that a bid for support might be made to that agency.

Dr. McCants: A substantial program will be maintained by TROPSOILS at Yurimaguas. Cooperation with INIPA will continue and efforts to expand adaptive research supported. We need to develop large-scale adoption of technology. The international dimension of the Yurimaguas program must be expanded.

Conference on 23 January, in Lima with Mr. Donor Lion, USAID Director for Peru; Dr. David Flood, Acting ADO, Mr. Tim Miller, Project Officer, and Dr. Adolfo Jurado.

Bandy, Bowen, McCants, Sanchez, and Thorne attended the meetings.

Mr. Lion stated that an ATT Project (Phase II of REE Project) is in the design stage. This will give support to INIPA and may substitute to some extent for TROPSOILS funds. USAID, Lima will welcome a proposal from NCSU for AID support of activities which cannot be supported under TROPSOILS. The food assistance for Peru has not been cut, but all other AID assistance has been. AID funds are also contingent upon Peru's paying its debt to the US and upon Peru's complying with some narcotics controls mandated by the U.S. Congress.

Project Number 308: Soil Erosion and Reclamation of Humid Tropical Steeplands. Helmut Elsenbeer.

We did not visit the research site in the Pichis-Palcazu region of the Central Selva of Peru, but Mr. Elsenbeer was in Lima returning from home leave and gave us a seminar the morning of 23 January. He will soon finish the two years of field research for his thesis and go to NCSU campus to complete the PhD requirements. He hopes then to return to the research site to complete the second phase of the planned program. However

financing is not assured for his return and efforts are being made to explore sources other than TROPSOILS.

Research is near La Esperanza Station in Pichis, a 7 hour trip by road and boat from Pucallpa, the nearest commercial airport. A watershed in virgin forest was selected and detailed measurements made before clearing and a research catchment set up. The plan is that the area will then be cleared and at least four treatments established: 1) low input cropping, 2) pastures or cacao, 3) Achiote (saffron) with Desmodium ovalifolium understory, 4) peach palm with Desmodium ovalifolium understory. Detailed measurements will again be made.

About one ha, outside the research catchment was initially cleared and a house for Elsenbeer and his counterpart and a laboratory building were built. Pathways above the soil surface, bridges, and stairs were constructed to lead to the measuring stations in the experimental watershed so that the surface would not be disturbed by the necessary traffic in making the measurements.

The first phase of the project is to establish quantitative base line rates of hydrological and erosion processes under primary forest. How much water runs off? How much soil is lost? How much Ca is removed? Two experimental plots with different topographies are designated within the watershed to help understand just how slope, exposure, etc, affect runoff and soil loss. Average slope is not expected to have much meaning.

The second phase will be to establish the experimental treatments after clearing and set up the measuring stations in exactly the same locations as before. Measurements will be made to determine how the area performs under different management options after clearing. The treatments were selected to vary from the expected very good to the expected very poor.

A conceptual model will be developed from theoretical considerations, with no empirical terms. Hence it will need no verification for new sites. This requires more data over a longer period of time than the development of an empirical model (or black box model). Experimental catchments with different management will be established throughout the region and the model will be adjusted if needed as a result of data obtained from them. There should eventually develop an understanding of which agrosystem is most appropriate for the area and why. The presentation was very impressive. Elsenbeer appears to be very dedicated, enthusiastic, and capable. It would be tragic if the second phase is not completed because of lack of funds. INIPA provides one counterpart and another is planned. 5 laborers are provided by PL 480 funds.

SUMMARY/IMPRESSIONS/RECOMMENDATIONS

1. This member of the EEP was favorably impressed by the research program at Manaus and Yurimaguas. All aspects of the program appear to be making important contributions toward sustained productivity of soils in the humid tropics under different systems of management.

   1.1 Participation of campus-based faculty members has been good, with fine continuity.

   1.2 Field personnel are well-trained, energetic and enthusiastic. There has been excellent continuity in the field positions.

   1.3 The program has made an important contribution in training of graduate students, both from developing countries and from U.S.A.

2. Good progress has been made toward complying with recommendations of EEP in the Triennial Report and in the 1986 Annual Report.

   2.1 Additional INIPA input is evident and more is expected. INIPA has essentially taken over the pastures work, will do most of whatever paddy rice research is initiated, is providing leadership in economic studies and is providing most of the field labor.

   2.2 Annual work planning sessions are being held, with input from all participants.

   2.3 Progress is being made toward development of a tropical soil management research network.

   2.4 Laboratory support services are being strengthened.

3. Additional progress is needed in some areas.

   3.1 The program is probably still too large to be conducted effectively with the expected CRSP funds. The ME Director estimated that the cuts proposed by the NCSU Program Coordinator (Page 14 of this trip report) will not be sufficient in view of the reduced level of TROPSOILS funding expected to be available for the next three years.

   3.2 Too high a proportion of CRSP funding is used by NCSU for support of campus based scientists. While it has undoubtedly produced an effective overall program, other sources of funding must be obtained for some of the campus based positions or field research and/or graduate student

training must be even further reduced.

It is most unfortunate that no additional graduate student training has been initiated with CRSP funds for the past year. This is likely to be one of the most lasting benefits of the entire program. If NCSU can provide support for one or more of the campus based positions, perhaps additional graduate students can be supported.

4. Additional publication of information accumulated by research at Yurimaguas must be accomplished in the near future. Assistance of the ME editor must be provided to NCSU to get this done promptly and properly.

5. The TROPSOILS Board of Directors, the Management Entity, and the External Evaluation Panel must give serious consideration at an early date to termination of CRSP support to one of the four U.S. Universities rather than continued cutting of funds to all four. There are understandable difficulties for the Board in deciding to eliminate one of its members. The EEP can set priorities for the four programs for consideration by the Board and action by the ME.

6. Since I have resigned from the EEP, I wish all my colleagues in TROPSOILS much success in their responsibilities and future endeavors.

APPENDIX

NCSU GRADUATE STUDENTS COMPLETING THESIS RESEARCH UNDER TROPSOILS

Name	TROPSOILS Assistantship?	Date Return To Campus	Date to Finish PhD	Advisor
Szott	Yes	Returned	May. 87	Davey
Mt. Pleasant	Yes	Returned	Aug. 87	McCollum
Gill	Yes	Returned	Sep. 87	Kamprath
Subagyo	No	Returned	May 87	Buol
Lins	No	Returned	May 87	Cox
Ayarza	Yes	Returned	Aug. 87	Sanchez
Palm	Yes	Feb. 87	Dec 87	Sanchez
Ara	Yes	Aug. 87	Jan 88	Sanchez
Ubiera	No	Returned	Feb. 87	Weed
Elsenbeer	Yes	Aug. 87	May 88	Cassel
Davelouis	No	Oct. 88	May 89	Sanchez
Salazar	No	Returned	****	Buol
Melgar	No	Dec. 87	Sep. 88	Smyth/ Sanchez
Fontes	No	??	Dec 90	Weed
Uribe	Yes	Dec 88	May 89	Cox
Ngachie**	No	??	****	Smyth
Fernandes	Yes	May 89	Dec 89	Davey
C. Smith	Yes	??	Dec 89	Buol
Castilla	Yes	Sep. 90	Dec 90	Sanchez
G. Smith**	??	??	??	Wollum

**** M. S. degree candidate
** Not yet on TROPSOILS but may be.