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TRIP REPORT TO INDONESIA AND SRI LANKA BY
SOIL MANAGEMENT CRSP PLANNING TEAM

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ENT
RESEARCH AND PUBLIC SERVICES

Jakarta, February 21

Drs. Buol, Malcolm and Sanchez arrived late Wednesday night February 20 at Jakarta and were met at the airport by Dean Goeswono Seopardi of Bogor Agricultural University (IPB)*, Mrs. Soepardi, Dr. M. S. Sudjadi, Head of the Soil Fertility Section of the Soils Research Institute (SRI)* and Ir. Subadjo, pedologist of the Soils Research Institute. Dr. Michael K. Wade, Chief Agronomist of P. T. Kapas joined the team at the hotel. The following morning was spent at the USAID Mission in Jakarta where the team met with a group of agricultural officers first and then later with the mission director and deputy director. At the first meeting the main participants were Dr. Ernesto Lucas, an agricultural economist and potential project monitor for the Soil Management CRSP, Dr. Barry Prim, agricultural economist, Dr. Enrique M. Barran, an agronomist of Spanish origin from Colorado State University, and Dr. Green, the Mission Title XII Officer. They informed us that USAID/Jakarta has just signed a memo of understanding with AARD (The Indonesian Agency for Agricultural Research and Development) and the Small Ruminants CRSP. USAID is doing the protocol matters and will serve as an umbrella organization. After being briefed to the purpose of our visit, they expressed interest provided the Indonesians are very interested.

At the meeting with the Mission Director, Mr. Thomas C. Nieblock (accompanied by the Deputy Director, Mr. W. Bollinger and Dr. Lucas) he emphasized the previous points but suggested very clearly that the Mission will be willing to back up this project provided the Indonesians indicate a very strong expression of support, and that it would complement rather than duplicate present AID-sponsored activities such as: The IADS Station Development Project in Sumatra, the Benchmark Soils Project, and projected institution building projects including the one awarded to the University of Wisconsin for Bogor and another awarded to Washington State University for the eastern islands. They are looking for an additional university to do the Sumatra institutional development work. In addition, Mr. Nieblock mentioned that the Mission is interested in supporting the development of a soil conservation service in Indonesia and that funds are available for 1982 however, they have not been able to convince the Indonesian government of the need for such a project.

*Most acronyms used in Bogor refer to the names of the institutions in Indonesian. Bogor Agricultural University = Institut Pertanian Bogor (IPB); Soils Research Institute (SRI) = Lembaga Penelitian Tanah (LPT), Central Research Institute for Agriculture (CRIA) = Lembaga Pusat Pertanian (LP3).

We asked the USAID mission staff for guidance as to which Indonesian institution involved in soil science would be the most desirable lead institution for cooperation with the Soils CRSP. They mentioned the strengths and weaknesses of several but offered no concrete suggestions.

Bogor, February 21-22

A team moved into Bogor and went directly to the Dean's office at the university (IPB) where we met with Dean Soepardi and Professor Satari, Head of the Soils Department and former President of the University. Dean Soepardi described the activities of the university within the overall Bogor campus, which seems analogous to the Los Baños campus in the sense that there are many research institutions involved. They have about 4,000 students 300 of which are graduate students and 30 of which are in the Soils Department. Most of them are M. S. degree candidates but three of them are candidates for a Ph.D. degree.

The basis of the transmigration project in Sumatra was described to the team. The idea is to transmigrate 2.5 million people from Java to the other islands in four years. That is about 1/2 million families, each of which will be given 2 ha. Therefore, 1 million ha. need to be developed and ready in a very short period of time. Because of the sense of urgency and the tremendous pressure the government is putting on transmigration, there is no time to do slash-and-burn, mechanical clearing has been selected as an alternative. There also has not been time to do significant research and they very much welcome the opportunity to get involved in soil management research as they feel this is a major gap.

The following morning (February 22) we met first with Dr. D. Muljadi of the Soils Research Institute and then had a chance to introduce our program objectives to a large gathering of people at the Soils Research Institute. This included from the Soils Research Institute, Dr. Muljadi, Dr. Sudjadi Head of Soil Fertility, Ir. Soepraptohardjo, Head of Pedology, Ir. Subagido pedologist, Ir. Yunus Dai, mineralogist, and Ir. Abdulrachman Ali, physicist. From the University, Dean Soepardi and Professor Satari were present, from USAID Dr. Ernesto Lucas, from CRIA, a person whose name we didn't catch, from IRRI, Dr. C. P. Mamaril, from the Benchmark Project, Mr. George Manuelpilli. Sanchez introduced and presented the background of the Planning Grant. Copies of the CRSP Newsletter Number 1 were xeroxed and distributed to all participants. Dr. Lucas followed by saying that USAID will respond to a Government of Indonesia request and emphasized the issue of no duplication of efforts.

In response to both Sanchez and Lucas' presentations, Dr. Muljadi mentioned that soil management research in the humid tropics is a major priority for them, especially as related to food crops, because they presently have no appropriate technology. He felt no duplication would be encountered and this project would fit perfectly well in the development programs of the Government of Indonesia. He mentioned that out of 200 million ha. of Indonesia there are 56 million ha. of Red Yellow Podzolic soils (mainly Ultisols) and these areas

are where most of the problems in the upland areas of transmigration exist. He noted that the Soil Management CRSP is broader in scope than the Benchmark Soil Project and welcomes the opportunity to cooperate with the CRSP. In response to one of his questions as to whether we would only be interested in working with Typic Paleudults, the team answered that we would be interested in working with whatever soil fits their priorities best at the most appropriate location.

Professor Satari from IPB seconded Dr. Muljadi's interest in terms of the enthusiasm and the sense of urgency. Dr. Wade had a chance to explain his experience in Yurimaguas as a way of training graduate students which is of particular interest to IPB. After the meeting, we gave Dr. Muljadi and Dean Soepardi copies of the Memoranda of Intention signed with INIA and CIAT as well as copies of the six preproposals of the universities that specifically mentioned Indonesia.

During the afternoons of February 21 and 22 we had the opportunity of traveling around Java and seeing some very intensive production systems in the steeplands. We traveled as far as Cipanas, roughly about 70 km up a volcano southeast of Java where we saw extremely intensive agriculture with tiny terraces. At about 1200 meters we saw a tea plantation on a Dystrandept where we learned that the very strong pruning that tea requires every four years can cause tremendous soil erosion because it really exposes the soil.

At Cipanas we visited a secondary Benchmark site on a Hydric Dystrandept accompanied by Mr. Manuelpilli, the Benchmark Soil Scientist stationed in Indonesia. It was very similar to the one Dr. Malcolm has seen in the Philippines. Corn was growing with trickle irrigation and each plant tied up with plastic ribbons for support against lodging. Some of the nitrogen and phosphorus responses are erratic and very much influenced by previous intensive fertilization history before the Benchmark Project took over this land.

On our way back to Bogor, we kept seeing extremely intensive agriculture, and unlike what we assumed previously, there is some significant erosion taking place in these apparently stable systems. We saw a second profile (very deep) of a Dystrandept near Ciawi and on the road to Jakarta we stopped at an area with deep red soils which are classified probably as Rhodic Paleudults and observed the rice paddies and very intricate upland systems there, including heavily manured sweet potatoes, pigweed grown for salad. The change from puddled to well granulated condition soils, is no problem at all in these well aggregated soils.

During the trip, Dr. Sudjadi expressed very strong interest in using the FCC as a short cut for developing the main soil constraints map of Indonesia. Also, he expressed extremely strong interest in developing land clearing experiments such as the ones done in Yurimaguas which they were very familiar with in the transmigration areas, and the desire to develop a soil fertility evaluation and improvement program in Indonesia. So far, these seem to be the first three issues in which the Indonesians are interested.

That evening in Bogor we met with Dr. Joel Levine who is the first small ruminants CRSP scientist assigned to Indonesia. He expressed optimism in developing the project in Indonesia as relationships with Indonesian scientists are good and they mean business. However, the 13 universities involved in the small ruminants CRSP now have to come to grips with stationing people in Indonesia to do the actual work which cannot be handled by remote control from a U. S. university campus. This is putting a severe strain on their budget even to the point that U. S. scientists assigned to Indonesia would not even receive the normal AID perquisites.

Padang, February 23

Dean Soepardi, Dr. Sudjadi, Ir. Subadgo, Ir. Abdulrachman and our team left Jakarta. After a pleasant one and one-half hour flight on a DC9 we arrived at Padang, the capital of the West Sumatra Province. This is a city of about 1/4 million people, most of which are native Sumatrans. We were met at the airport by Dr. Sjarifuddin, Director of the CRIA Station at Padang and Ir. Asdriman, a CRIA agronomist. Later we met Dr. Jamie Bell from the IADS group. The CRIA Padang Program is fairly new and it has four major priorities for the island of Sumatra: 1) The upland food crop based farming systems, 2) lowland paddy systems, 3) high altitude vegetable production systems, and 4) tidal swamps.

They are trying to develop a "site center system" in which CRIA, university and extension subject matter specialists will be working together. This is in the process of being established. This is supported by USAID loan for Sumatra Agricultural Station Development which accounts for about U.S.\$18 million, including the Indonesian counterpart portion. A total of nine stations will be developed. There will be five USAID/IADS specialists in agronomy, plant protection, farm development, economics and the Project Leader, Dr. Bell. The Farm Development Specialist is Jack Traywick from the Rockefeller Foundation with ample experience in station development in Latin America.

Dr. Sjarifuddin mentioned that the official approach for the transmigration areas is to give each family 2 ha., 1/4 homestead garden, and the rest in areas somewhat away from the settlement. He wishes to try a different approach. A scheme should fit on 50-100 ha. watersheds which would include rice terraces, fish ponds, upland crops, poultry and cattle. He expressed a sense of urgency to help the transmigration areas.

Then we took off on a 300 km trip from Padang to the Sitiung transmigration areas. First we had to cross very steep volcanic mountains that border the west coast of Sumatra where we saw very sophisticated terrace rice irrigation systems very similar to the ones found in Java but built by native Sumatran peoples who are culturally quite different. The minute attention to detail, including extremes such as terrace with only two rice rows was

truly remarkable. The average rice yields in West Sumatra are an impressive 3.8 tons/ha in about 300,000 ha. The main variety is IR36 which is resistant to brown planthopper. Some of the terraces were almost as spectacular as the rice terraces in the Philippines. Then the road joined the trans-Sumatra highway which is beautifully paved and well maintained. We were fascinated by the marks indicating "Caution: Tiger Crossing" as we approached the lowlands and got into the true rainforest regions. Also, we were impressed by a series of limestone mountains near Tangungadang (which in Bahasa Indonesia means indeed tiger crossing). This would be an initially available source of lime for the transmigration areas.

Sitiung-Kotabaru Area, February 24

This day will probably stand out as one of the most memorable days in our professional lives. We first visited the Sitiung I transmigration area. This consists of several blocks with highly developed infrastructure of roads, irrigation canals & power lines in about 2534 ha. that have been cleared by bulldozer two years ago and are now settled by 2200 families. Each family was given an average of about 1.25 ha. short of the 2 ha. goal. It is obvious that most of the topsoil had been removed by the bulldozing but fertilizers are amply used. Farmers grow mainly upland rice (about 1600 ha.) but average yields are 1.1 ton/ha. They also plant about 20 to 50 ha. each of corn, peanuts, soybeans and paddy rice. Corn yields are 2.5 tons/ha, peanuts = 0.7 and soybeans = 0.8. These are all official figures from the transmigration director whose name we didn't catch.

The Sitiung I farmers are truly in a pitiful situation. Their upland rice production is very low even though they have added as much as 1 ton/ha of rock phosphate in some of the soils and they use ample quantities of urea and triple superphosphate. Most of them are now growing cassava which is difficult to compare with cassava growing elsewhere. The cassava plants have only one stem, are about 3 meters tall with a very tiny leaf canopy. Some farmers said that they no longer form tubers.

The main soils in these areas are probably classified as a Aquic Tropudult, clayey, mixed isohyperthermic. 1/ They are high in exchangeable aluminum content according to the soil survey data that we have, about 80% of Al saturation, low in phosphorus, potassium, magnesium and calcium. Liming should obviously be considered, especially when the lime source is only about 30-40 km away on a well paved road. Sitiung I is in bad shape. These people come from lowland rice areas in Java and it is easy to imagine how they feel by not having neat fields

Some comparisons between this first transmigration area and the situation we generally find in the Amazon are very evident. First, the soils here have a mixed mineralogy, are somewhat more fertile and have higher clay content, which will probably help reduce leaching losses. Consequently, the soils are likely to be better than let's say the soils of Yurimaguas or Manaus, although only slightly so. Secondly, they have absolute population control as whole towns were moved lock, stock and barrel from a region of Java that was going to be flooded when a dam was built. Third, this is a civil engineer's domain and not an agronomist's domain. They have done excellent work in roads, markets, irrigation, infrastructure and miserable land clearing with bulldozers. The vegetation also is different; it looks a bit more luxuriant and we could not identify many of the familiar trees of the Amazon. There is invading grass called Pinting which we have not been able to identify, but also Toro urco (Paspallum conjugatum), the main invading grass in Yurimaguas is also very well widespread. Alang-alang (Imperata cylindrica) is not widespread in this settlement.

Then we went to Sitiung 3, an area that is in the process of being cleared. Unlike Sitiung 1 which is essentially a flat area, Sitiung 3 has rolling topography not unlike the topography along the Transamazonian Highway near Altamira. Sitiung 3 consists of about 1,000 ha. and 1300 families already have moved into the middle of a half cleared rainforest. Bulldozing is done with D-7 Caterpillar tractors managed by people with little experience in land clearing. They do remove some of the largest logs afterwards and then the farmers burn as much as they can around it. This is a place where the ecologists can cry "rape" with justification. We saw instances where there was ash on the surface and upland rice was growing very well, but one meter away where there was no ash, rice was hardly growing. The main soils are Oxic Dystropepts, very clayey (70-80% clay) from top to bottom, which makes them quite difficult to manage. There are also Ultisols, probably Oxic Paleudults, also quite clayey in the uneroded areas. Of course, the bulldozing is removing much of the surface soil. Erosion is rampant. These people again came from well tended areas of Java and need agricultural technology.

Then we went to Sitiung 2 which was cleared at about the same time as Sitiung 1 but the situation looks somewhat better. The soils are strikingly different; they are probably Tropeptic Haplorthox with only about 50% clay on top and apparently kaolinite mineralogy rather than mixed mineralogy which makes them easier to manage. Also, the farmers have been transmigrated from an upland area and they are not traditional rice farmers. The better shape of the fields is only slight however, because like the other two transmigration areas, this one is severely eroded.

We were very fortunate to see the first CRIA experiment in this area which is the responsibility of Ir. Asdirman, on a 8% slope of this Oxisol. In the cleared areas where no vegetation is growing it is badly eroded. The experiment consists of a corn-cassava-rice-cowpea-peanut intercropping system identical to the one that Mike Wade developed in Yurimaguas. They are comparing the system with complete fertilizers, roughly about 2 tons

of lime per ha (as Ca(OH)_2 , the only source they have like in Yurimaguas) and 90 kg N/ha, 45 kg P_2O_5 /ha and 25 kg of K_2O /ha per crop. They did compare this trial with the NPK + lime, a check plot and also with and without terraces. They intended also to incorporate Leucaena mulch but they have been trying to grow Leucaena from seed and that hasn't worked. Sanchez suggested that they use the traditional system of growing Leucaena in a nursery and transplanting the stakes.

There is a tremendous difference between the check plot which has essentially no yield even though this is the first crop after clearing. Rice and cassava look good in the lime + fertilized + terraced plots. The design is excellent. They are measuring erosion, runoff loss of terraced and non-terraced areas. However, we saw plenty of secondary and micronutrient deficiencies, including boron and magnesium.

This is a cooperative effort between several of the Indonesian institutions and once more shows a tremendous spirit of cooperation and a very intelligent design of this work. Certainly there is great potential to do relevant work here. The surrounding farmers are impressed with this experiment and are trying to copy some of its features.

It is interesting to note the striking differences that mineralogy can make here. In this kaolinitic Tropeptic Haplorthox with lower CEC farming seems better. It is certainly an easier soil to handle than the higher CEC Oxic Dystrupepts or Oxic Paleudults with mixed mineralogy. The latter are messy, sticky and certainly much more susceptible to erosion. Acid low CEC clays are easier to manage in this environment than acid high CEC clays.

The following day we went to another transmigration area roughly about 70 km from Sitiung called Rimbo Bujang located in Jambi Province. The soils of this area are darker red in color and even though it rained very heavily the previous night the dirt roads were in reasonably good shape, indicating oxidic or kaolinitic rather than mixed mineralogy. We saw areas that are just in the process of being cleared. These are in tertiary roads along which crews are clearing strips roughly about 100 meters wide on each side of the road. The spatial arrangement is different from the one we saw before and this is called the "transmigration model" as opposed to some other model before. Logging crews come in first and cut the best wood with chain saws and truck it out. Then standard D-7 bulldozers come in and push the rest of the wood down and away. They make an incredible mess, creating mounds, leaving heaps of logs, etc. Bulldozer operators are supposed to push all the wood into windrows every 40 meters but the only evidence we saw of that was in an area selected for the marketplace. Carpenters then built a simple house and an outhouse 6 meters away and then the transmigrants come in. It must be one heck of a shock for the transmigrants to see their hectare in the shape it is. No burning has taken place yet so they may have to do that. Since they are allowed the 2 full hectares in this scheme, they are responsible for clearing the second hectare. Since the second hectare away from the road will be cleared by traditional methods, it would probably be more productive than the cleared hectare near the road.

The soils in the Rimbo Bujang area seem of better quality. However, it took us about one hour to find an undisturbed profile along the road, but when we found it, it was finally classified as Oxic Humitropept with a characteristic nice porous granular structure in the top 30 cm or so. This was pretty much wiped away in the bulldozer clearing and most of the surface soil in the areas where the transmigrants are coming in have a completely different structure, more blocky or platy. Since the bulk density of the soil is roughly about 1 g/cc, it is possible that the physical damage due to bulldozing will be less than what we found in the Amazon. However, the bulldozer makes a tremendous physical mess. The soils are high in organic matter content on top, roughly about 7% O.M. and the transmigrants in this region seem to be somewhat better off than those in the Sitiung areas where the organic matter content is lower. Unfortunately the bulldozing clears away most of the organic matter depositing it in trash piles and exposing lower O.M. content subsoil.

We also stopped at the IPB Test Farm located in the Rimbo Bujang transmigration area. The land was opened in 1976 and cleared by slash-and-burn. Several experiments are being conducted on the residual effect of fertilizers and some were in their fifth continuous crop (peanuts). However, the plots were not uniform and no clear response of any nutrient but nitrogen was seen. Ditches are built around each plot making them almost like an invert paddy field with considerable soil disturbance. In addition, watching the lady laborers apply fertilizers, they dump a larger quantity at the end of the rows to empty their measured cans, causing additional soil variability. Labor costs are about US \$0.80 per day for women and U.S.\$1.20 per day for men. The main problem in this station is the lack of at least a B. S. level scientist on site. Also, of interest we saw that the pathways of the station were planted with the legume tree Sesbania grandiflora. They feed the leaves to cattle and the people eat the young flowers. Unlike the questionable fertility data, however, the soil survey data for this region conducted by IPB was excellent. It kept impressing us all the time the quality of the Indonesian scientists and the spirit of cooperation between the Soils Research Institute, the University (IPB) and CRIA. They do genuinely work together as a team, are most complementary of each other, and the caliber of the soil survey data, both the ones done by IPB in Rimbo Bujang and the ones by Soils Research Institute in Sitiung is about the best we have seen in most of our travels.

After dinner, we had a long conversation which stretched until almost midnight with Dr. Sudjadi and Ir. Subagio on the possible levels of collaboration. They were very intrigued as to how to relate soil survey and soil fertility. We explained our personal view of the process, starting from good soil survey and taxonomy, then grouping soils by FCC units, and finally the development of a soil fertility evaluation service. They were very receptive to this idea and spent about three hours questioning us on it. I suggested that they get together with Dr. Soepardi and the other people on the team who were not staying at the same guest house as we were and put their ideas

together and develop what they would like the Title XII Program to do. It was an excellent discussion with extremely good questions again reflecting the keen interest, the sense of urgency and the high quality of Indonesian scientists.

Bukittinggi

On Wednesday we traveled from the Sitiung Rest House to Bukittinggi which is located at about 1,000 meters above sea level and a most pleasant city with a delightful isothermic climate. As we left the transmigration areas and entered into the settled steplands agriculture based on the paddy rice terraces, we observed once more the marked contrast in both agriculture and the quality of life. Paddy rice was being grown at all stages and we updated our rice cropping systems slide files. More interesting however, was the fact that we did not see any children working in the fields--they were all in school. Unlike many other similar countries we also did not see many pregnant women; in fact, very few, suggesting that population growth rates are under control.

Around Solok we visited a Clove Research Station and met with Peter Hunt, ODM British plant pathologist. This is a small substation of the Industrial Crops Institute and following the pattern of other small Indonesian stations in this area it was well equipped and well managed. There is a bacterial disease that is wiping out cloves in West Sumatra and other parts of Indonesia. This tree crop is extremely important to small farmers since one tree can net about U.S.\$100 per year with an average production of 10 kg per year. The culprit has been identified as a bacterium but control is not yet developed. It was a sobering reminder that there are other very serious problems in the tropics that have nothing to do with soils.

The next morning at Bukittinggi we visited a soil testing laboratory which was set up by German technical cooperation and which is slated to pass to the control of the Soils Research Institute. It will be used to support the FAO Land Evaluation Program and for soil testing. The lab is equipped with very traditional equipment and they run about 20 soil samples a day for pH, organic matter, total nitrogen, lactate phosphorus, CEC at pH 7 and texture, in fact analyzing the bones rather than the bloodstream. Based on this data, they develop fertilizer recommendations without correlation with field trials. With the possible takeover by the Soils Research Institute, Bukittinggi would be an ideal location for a headquarters area where a scientist and his family could live in most pleasant surroundings although without an international-type school. It is roughly about 200 km from the transmigration areas which still would mean either some rough commuting or overnight stay. It probably takes about 3 to 4 hours to get there. This lab is in a complex that also includes extension offices, entomology and veterinary science services.

Padang

We then returned to Padang and had dinner at Jamie Bell's house in a function put together by the Bells and Dr. and Mrs. Sjarifuddin. At dinner we reported our findings and a consensus gradually began to emerge. Drs. Sjarifuddin and Bell suggested that a consortium of Indonesian institutions led by the Soils Research Institute but including also CRIA, IPB, the local Andalas University and extension services could be formed to serve as a counterpart for the Soil Management Project. Bell estimated that a five-senior scientist team headquartered at Bukittinggi or Padang will cost about U.S.\$700,000 per year. Prices are relatively cheap as he lives in a very nice house by U. S. standards which is supplied to him at no cost by CRIA and CRIA pays roughly about U.S.\$300 a month for rent. Also, given the strong financial Indonesian counterpart support, they provide cars, telexes and many other facilities.

Unfortunately, CRIA is planning to move its headquarters to the town of Sukarame, also in the mountains near Bukittinggi. This is unfortunate in the sense that there are two places of possible headquarters but not one as it should be. On logistics, the situation at Padang is very good. The CRIA office has a telex (no. 73-5527 via ITT), direct dialing to Java and it is connected by three daily jet flights to Jakarta.

The suggested steps for cooperation would be: 1) Develop a letter of intent outlining the framework during this visit; 2) keep the USAID mission and the Indonesian institutions aware and interested in this project as the planning grant progresses; 3) prepare a formal document upon approval of the planning grant by AID which would then be signed by AARS, USAID and the management entity. However, our colleagues are in a hurry and they wish to know if something could be done before the planning grant terminates. We suggested the possibility of hiring a consultant to help set up a fertility evaluation service probably headquartered at Bukittinggi. This was very well received and they have money in the present IADS/USAID contract to do so.

Joining us was the Dean of the Faculty of Agriculture of Andalas University, Ir. Fachri Ahmad. He has conducted studies of limestone deposits near Sitiung and found they are dolomitic with a 6% MgO content.

On Thursday we visited Andalas University guided by Dean Ahmad. Dean Ahmad is a soil scientist and a former student of Goeswono Soepardi. The University has 630 students and has inherited all sorts of old equipment from other universities. The library has mainly very old books. We promised Dean Ahmad to include him on our mailing list and send new materials to him.

Bogor, February 28-29

Then we returned to Jakarta and then to Bogor. On Friday, the 29th a meeting was held at the Soils Research Institute with participation from several of its scientists plus additional scientists from IPB and with

Dr. Rusli Hakim, the Director of CRIA and with Mr. Frank Dent of FAO and two of his associate experts. We did report our findings in the field which were summarized as follows:

1. The high degree of technical competence among Indonesian soil scientists and their genuine degree of cooperation between the various Indonesian institutions (SRI, IPB and CRIA).
2. The high quality of the Indonesian soil characterization data which was about the best we have ever been able to travel with and look at in an area.
3. The urgency on soil productivity depletion in the transmigration areas visited.
4. That technical solutions to the problem are feasible at present and can be divided into two strategies: a) How to repair the damage of improper land clearing and provide for continuous cultivation at high yields and b) how to prevent the damage by better land clearing practices for future transmigration clearings.

a) How to repair the damage. It is imperative that a soil fertility evaluation program be established and implemented at the farmer's levels as many nutritional deficiencies are apparent such as potassium, magnesium, micronutrients and so on. Through the interpretation of soil surveys the areas with specific fertility constraints could be investigated and then soil fertility evaluation programs could provide the answers at the site specific level. A second aspect is to include dolomitic lime in fertilizer recommendations and provide it to farmers. The presence of excellent dolomitic limestone deposits about 100 km away from these transmigration areas is indeed a lucky thing and it could easily be developed. Liming is simply not practiced in Indonesia because of the neutralizing effect of flooding rice soils but in this case, absolutely essential as many of the soils have close to 90% Al saturation. Even though upland rice and cassava are quite tolerant to aluminum, they are not tolerant at such high levels. The third point would be the development of alternative cropping systems to supplement the farm income generated by 2 ha. plots which at best is going to be quite meager. This area is ripe for tropical pastures and testing of the CIAT germplasm and developing pasture technology could pay very well. This last suggestion was received positively as the demand for beef in Indonesia is high and because a pasture scheme would fit with the concept of a "Nucleus Small Holders Project" where the individual farmers will retain their 2 ha. or so but they would work cooperatively as a nucleus on large developments such as permanent crops or in this particular case, pastures and beef production.

b) How to prevent the soil damage presently being done is primarily a matter of better land clearing practices. We made a point that 700 ha. of primary forest were cleared in Yurimaguas by about 700 men with no more than

an axe, machete and a box of matches, in about a week and planted to pastures. Therefore, it might be better to use manual slash-and-burn techniques and pay the workers for it rather than to present the transmigrants with a "fait accompli." The problem is that the transmigrants are traditional rice farmers and have no experience with land clearing. However, there are plenty of shifting cultivators in this area of Sumatra who could teach transmigrants how to clear land properly. A second point is the need for alternative land clearing methods, including clearing only during the dry season, the use of tractors linked by chains, KGB blades, tree crushers and tree pushers as well as root rakes. The different alternatives have to be evaluated although we were told that there were some experiments underway on this subject but we did not have the chance to see them. Nevertheless, if they are as good as the other experiments we have seen they would provide an excellent base to go ahead.

Indonesian colleagues were very receptive to these suggestions. Dr. Muljadi supported them. Dr. Sudjadi put a strong plea with the need for using FCC and Mr. Frank Dent mentioned that they will be using FCC in interpreting the FAO land resource. After this meeting Drs. Hakkim, Muljadi, Sudjadi, Soepardi, Malcolm and Sanchez sat down in executive session and developed a letter of intent, a copy of which is attached. It is not as specific in the operational sense as the similar letters of intent developed with Peru and Colombia because it was felt that the administrative issues should be dealt with at a higher level. Therefore, the exact level of effort was not included but in our team's opinion (Buol, Malcolm, Wade and Sanchez) at least three CRSP senior scientists are needed: 1) To establish a soil fertility evaluation program, 2) to conduct soil management work on land clearing, continuous cultivation, liming, etc., 3) to transfer the technology available immediately to the farmers and because of the tremendous urgency this activity should start right away even with rough guess work but should not be delayed until the complete research answers are found. This group would be supplemented at least by two graduate students per senior scientist working on specific subjects. One of them could work on the adaptation of tropical pastures, others with soil survey interpretation, etc. A similar level of counterpart personnel from the Indonesian side is expected. The senior scientists with their families could be located at Bukittinggi which is attractive because of the housing facilities and the future involvement of the FAO Program there, or at Padang which has better living facilities, or at Sukamare, the future site of the CRIA headquarters. We told the Indonesian group that they should recommend to us their choice, according to their priorities.

That morning we also visited the facilities of the Soils Research Institute and we were extremely impressed by both the physical setup as well as the degree of the work. They have excellent X-ray and DTA facilities for detailed mineralogical work and the equipment made Stan Buol envious since he doesn't have such a degree of sophisticated X-ray at North Carolina State. The soil physics and chemistry sections are well equipped and there is a brand new lab full of the ISFEIP-type soil testing equipment to set up a soil testing laboratory and they are waiting for someone to do so. We suggested that Dr. Ron Stryker, who is working in an extension program in Jakarta with experience in the ISEFIP project, could help to set it up or perhaps Dr. Mike Wade, as both of them have had ample experience with this program in Latin America and in Raleigh. They have a large and sophisticated printing facility.

Jakarta, February 29

In the afternoon we went back to Jakarta to report our findings to the US AID Mission. We met with Mr. Walter Tappan for the first time and with Dr. Lucas. They were very pleased to see that the letter of intent was signed by the Director of CRIA, Rusli hakim, the Director of the Soils Research Insitute, Dr. Muljadi and the Dean of the Faculty of Agriculture of IPB, Dr. Soepardi. They agreed with its content and said they will now fully support this project as it meets their requirements and will wait for further instructions from Dr. Muljadi's group and from us.

Bogor, March 1

On Saturday, Buol and Sanchez gave a long seminar at Bogor attended by about 55 people from a wide variety of institutions. Buol talked about the basic characteristics of soils from Southeastern U.S. and Latin America and how to interpret them in terms of management practices. Sanchez described at length the results of the Yurimaguas work, the work of N. C. State of the Cerrado of Brazil and the CIAT Tropical Pastures work. The questions were very good and the general opinion summarized by Dr. Soepardi was "now we know that we are not alone." They saw in our slides depicting strikingly similar problems to those in the Indonesia upland areas and now they felt that there are some points of references. Within the Southeast Asian rice world they felt alone in the problem of developing soils management systems for rain-forest areas.

Saturday afternoon we also visited the IPB headquarters. The Faculty of Agriculture has 8 departments, the strongest of which is Soils which has about 37 faculty members, six of whom are full professors, 4 associate professors, 3 assistant professors and the rest apparently instructors. The Faculty of Agriculture has about 200 faculty members, 40 of which have Ph.D., and additional 40 have an M.S. degree and an additional 40 studying abroad for M.S. and Ph.D.'s mainly in the United States and Japan. They have about 1,000 students, 10% of them majoring in soils and a large contingent of graduate students, many of whom attended our seminar. Later in the afternoon we visited the Botanical Gardens which was a fitting way to end our tour, given its impressive beauty. We then went to Jakarta to catch our night flight to Sri Lanka.

Kandy, March 2-4

We were met at the Colombo Airport by Dr. S. Somasiri, Head of the Land and Water Use Division of the Department of Agriculture, who took us on a winding two and one-half hour drive up to Kandy, where we stayed at the house of Dr. Carl M. Hittle of INTSOY, who cheerfully received us at 2:30 AM. The next morning we met with Dr. Christopher Panabokke, Director of Agriculture and Dr. Somasiri. Dr. Panabokke mentioned that the steeplands are a major cause of concern in Sri Lanka, specifically in the agroecological zone IM3 (intermediate elevation and intermediate moisture regime zone). This is between

300 and 1,000 meters. Watershed management trials measuring runoff and erosion have been installed into watersheds with the collaboration of Professor Norman Hudson of Great Britain. Dr. Panabokke did not consider it important to work on the seasonal non-acid tropical part of Sri Lanka since he feels that this is adequately covered by cooperative work with ICRISAT and IITA.

Then we went on the first day to the well managed steeplands accompanied by Dr. Somasiri and Dr. S. Nagarajah, Head of the Chemistry Division of CARI (Central Agricultural Research Institute) which is also part of the Department of Agriculture. We first visited the Kandy home gardens which are a beautiful example of replacing the original rainforests with highly productive spice crops. This is only possible in an udic soil moisture regime where the dominant soils are Rhodudalfs or Rhodic Tropudults. In the Manu-Oya catchment area we saw excellent installations for measuring runoff at different percent slopes under the currently farmed gardens and in intensively managed tea plantations.

All the valley bottoms are covered by rice terraces where the main soil management problem is the interflow of water high in reduced iron from the upper parts of the valley into the lower parts causing iron toxicity for many of the new rice varieties. Dr. Nagarajah, who is working on this problem prefers to call it an imbalance between iron and other cations. He also mentioned that they do have a soil test for phosphorus that works well in flooded rice soils. They use the Olsen method without any EDTA modifications with 10 ppm as the critical level.

The large tea estates are well managed including heavy fertilization and using a legume tree Glyceridic maculata as a shade crop which they also cut and feed to animals or use as a mulch. However, there is quite a bit of poorly managed tea which is mostly owned by small holders that have 2-3 ha and are essentially out of business when the price of tea drops. The well-managed estates have about 100 ha. Therefore, the big farmer or rather government corporation can make it with tea but the little guy cannot. The alternatives in this udic environment is clearly the Kandy home garden that averages in size from 0.2 to 0.5 hectares. They informed us that the tea leaf litter is high in polyphenols which cause acidic reaction and makes phosphorus more available in the soil.

The interflow work is done in cooperation with the IRRI Cropping Systems Program and also Frank Moormann comes once a year to help out.

At around Gampola we visited a crop diversification station which is providing materials for starting new home gardens. The germplasm available is pepper, coffee, cinnamon, cardamon and so on. There were some excellent row intercrop schemes planted on very steep slopes.

After returning to Kandy, we met in the evening with Dr. Howard Ray, Project Leader of an AID-sponsored program to develop the Post graduate School at Peradeniya. This is a consortium formed of the Institute for Food and Agricultural Development (IFAD) attached to the Ford Foundation, Texas A & M, Virginia Polytechnic and Penn. State universities. They are investing

large amounts of funds in developing a Postgraduate School but the work is just getting started. Apparently there is very little contact between the Postgraduate School and the Department of Agriculture in terms of research.

The following day, Monday was devoted to visiting the drier steeplands on the east of Kandy characterized by a rainshadow effect and an ustic or nearly ustic soil moisture regime. We were accompanied by Dr. Somasiri and Dr. P. Krishnarajah, physicist and conservationist in charge of the watershed work. We visited the Hanguranketha area. In this region the dry season is too strong for home gardens and watersheds consist of rice terraces on very, very steep slopes whenever there is a source of water. When there is no water, a serious erosion situation develops when attempting to grow tobacco or vegetables on slopes ranging from 30 to way over 100%. The main soils are probably Ustropepts although there are some Ultisols and Alfisols as well. The problem is what to do with these steepland areas that are not in rice. Formally they were in under shifting cultivation but population pressure has eliminated that. Farmers make the classic mistakes due to the timing of labor demands, of preparing the land during the dry season while the tobacco beds are planted, and the land lays exposed for about two months and with the first rains, tremendous erosion occurs. Some of this erosion has washed down and has damaged some of the very well attended rice terraces. They do not know what to do about it and frankly we could not offer any concrete suggestions other than searching for cropping systems that would keep the soil covered all the time. In this regard, we only saw one example of this and that is a snake gourd, a Cucurbitaceae that covers the ground very well. We saw more iron toxicity on the side of the terrace walls caused by interflow. In some areas they grow finger millet which is an important food source. The species grown in Eleusine kurocana.

We went as far as Walapone and then returned to the Hanguraketha catchment area where Dr. Krishnarajah has new runoff plots just installed. A Typic Haplustult profile was examined and on our way back we saw Mollisol areas under coconuts.

That evening we had a social gathering at Dr. Hittle's in which the key soil scientists from the Department of Agriculture were present. They were: Drs. Panabokke, Somasiri, Krishnarajah, Nagarajah and in addition, Mr. H. Somabala who is a soil physicist with a master's degree. The discussions were quite business-like and ended at about midnight. Basically, these and other discussions conducted during the following day with the soils groups and finally with Chris Panabokke came to the following conclusions:

There is certainly concurrence about the area of interest as this is the kind of steeplands project that our CRSP is looking for, i.e. severe danger of erosion on ustic or nearly ustic soil moisture regime and not, hopeless. They are also interested in this and it's high priority area. An additional positive aspect of this possible cooperation is the fact that they are working on the entire watersheds and also that there is a government development project to help stabilize erosive lands being developed right now and

under discussion with probable participation of the Ceylon Tobacco Corporation for financing. They immediately thought that the CRSP research project could be a component and be attached to an operational project.

The degree of work that could be envisioned in such an area would be to place one senior scientist ideally a cropping systems agronomist since they are relatively weak in this area, and supplemented by a team of soil physicists, soil conservation, soil fertility people and pedologists who are already working. This would be backed up by graduate students both from U.S. universities and from the Post graduate School of Agriculture at Peradeniya. It seems likely that the CRSP program would have to pay for all operational costs but they would seek a special budget funding for the counterpart money to support their own work. The graduate student input is local and more attractive than working with their junior scientists because of less bureaucracy and to get the scientists a chance to get a degree.

Dr. Panabokke and his staff, however, did not feel they were ready to sign a letter of intention with us. Part of the hesitation was due to the fact that they want to think it over more, they are over committed, that Dr. Panabokke intends to retire soon, and that there are some serious administrative difficulties that we are not aware of. They were quite realistic in stating that none of the top people with whom we actually met would likely work in this program because they are fully committed. Perhaps their sense of urgency is not as high as in the other areas we have visited previously. Consequently, we left it on the basis that they would discuss it further and would send us a letter of intent prior to April 1st in case they are interested in being considered further.

This was a bit disappointing, being the first site that we visited where no concrete agreements were arrived at but in retrospect it is probably a good thing. Although the situation described by the External Panel on steplands is certainly there, we see some serious difficulties in logistics. If it weren't for Dr. Hittle's support, we would not have been able to travel by car at all. The level of interest was certainly not as strong as that found in Peru, Colombia or Indonesia. Consequently, we must look at other stepland areas.

Often one look at a new country and at the head soil scientist like Dr. Panabokke and say well, this would be an excellent place to work. But with Dr. Panabokke making retirement noises and with some extremely qualified people but apparently not available at the working level, the situation becomes less attractive. Dr. Panabokke received a copy of all the preproposals of universities interested in the steplands.

Colombo, March 4

In the afternoon we drove down to Colombo and at the Land Division of the Irrigation Department we met with Dr. Kingsley de Alwis, the soil scientist in charge of the Soil Survey of Sri Lanka, a job previously occupied by Dr. Panabokke. It was amazing to see in a rather dingy and dusty building

a very active soil survey program going on. They have about 60 people in the field, several correlators and maps are being made for specific uses such as suitability for paddy rice, sugarcane and even tourism. We were most impressed when we saw a fully operational laboratory for soil characterization in which several people were working, were in well equipped air conditioned instruments rooms with atomic absorption and other sophisticated equipment, while the chief's office was sweltering with heat. They certainly have their priorities in the right place. Unfortunately, this Division is just engaged in soil survey, and although they do an excellent job, they would not have any on-hands operation. However, we were again disappointed at our inability to obtain soil characterization data immediately. Throughout our visit we did not have a piece of data available as we went around. Dr. de Alwis will send us some but apparently he needs to do some tabulating beforehand. This is in sharp contrast with the ready availability of soil characterization data as we traveled through the boondocks of Indensia.

Afterwards , we went to US AID and met with Dr. James W. Bonner, in charge of Agriculture and Research and Development. Dr. Bonner was very cordial, very interested in this project as it supports other mission objectives and offered us total concurrence and encouragement from the Mission. He was also somewhat disappointed that no agreement had been reached but he indicated a series of political circumstances which contribute to their "go slow" posture. Dr. Bonner also emphasized that operationally the Mission is not able to backstop any of these projects even in the obtaining of official visas and other privileges. They would have to be done through the Department of Agriculture. Nevertheless, he is totally enthusiastic about it and promised the mission's moral support. They expressed that the Mission looks with disfavor at American graduate students doing their theses in Sri Lanka when this is not coordinated as part of an overall effort. In this regard we told them that this would be no problem at all.

Dr. and Mrs. Bonner were very kind to let us use their house for changing clothes after a long and hot day and then we boarded our night flight from Colombo to Frankfurt, Atlanta and Raleigh.

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