



Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program

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Trip Report: Bolivia & Ecuador

1-16 October (Bolivia) and 16-29 October March (Ecuador) 2011

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Contracted through International Programs
The Pennsylvania State University

Purpose of Trip: To visit the SANREM field sites with PROINPA and INIAP collaborators, review soil and plant sampling regimes and protocols, and set up microplate analysis for inorganic N and available P.

Sites Visited: Bolivia: PROINPA-Cochabamba, Forage Research Center (CIF), Universidad Mayor de San Simon, and Centro de Investigacion, Formacion y Extension en Mecanizacion Agricola (CIFEMA) in Cochabamba, and research sites in Tiraque and Anzaldo.

Ecuador: INIAP Santa Catalina, and Universidad Estatal de Bolívar, and research sites in Illagama and Alumbre, Guaranda.

Description of activities:

Summary of Accomplishments - Bolivia: The main accomplishments in Bolivia include 1) review training with host country collaborators (Mamani, Saavedra-Rivera, and Gutierrez) of the soil extraction/preparation procedures for Mehlich III, inorganic N, particulate organic matter (POM), hydraulic conductivity and water holding capacity; 2) training in the analytical procedure for potentially mineralizable N; 3) helped to facilitate a collaboration with the Centro de Investigacion en Forrajes (CIF); 4) on-site review of the primary long-term CAPS and associated tillage/cover crop experiments at four field sites in the Tiraque region; 5) delivered a seminar to the students and faculty at Universidad Mayor de San Simon in Cochabamba (approx 35 people attended); and 6) further discussion with director of Centro de Investigacion, Formacion, y Extension en Mecanizacion Agricola (CIFEMA) on current and future collaboration with our SANREM project. Pablo Mamani has replaced Ruben Botello as the project leader and appears to be very knowledgeable about agronomic issues in Bolivia and enthusiastic about the SANREM project. Team Bolivia has done an excellent job at procuring all

the necessary soil and plant samples, but still requests assistance with the laboratory protocols and data management/analysis.

Summary of Accomplishments - Ecuador: The main accomplishments in Ecuador include: 1) further refining the experimental designs to meet the objectives outlined in our proposal and workplans; 2) collaborative review of past and present data from the SANREM-related experiments and preliminary analysis of these data; 3) initiating the protocols for microplate analysis of available P and inorganic N; 4) collaborative review of ICP and AA analysis of soil cations, and hydraulic conductivity and waterholding capacity in intact soil core samples from the CAPS experiments; 5) delivered a seminar to the students and faculty at Universidad Mayor de San Simon in Cochabamba (approx 125 students attended); and 6) helping to negotiate an collaborative arrangement between field-based group managed by Dr. Victor Barrera and the soil science group managed by Dr. Soraya Alvarado.

Bolivia

Much of this visit was spent working with Team Bolivia to establish the experimental designs and the associated soil/plant sampling analysis protocols for the experiments being initiated this year. I was very impressed with Pablo Mamani, who has replaced Ruben Botello as the SANREM project director. Pablo has considerable experience with the upland mountain agriculture systems in Bolivia and elsewhere, and demonstrated a great deal of enthusiasm and initiative for the SANREM project. He is well respected by the SANREM team members, as well as by his other PROINPA colleagues. In particular, I was pleased with the level of ownership he helped to instill with the field and laboratory team. I also spend a considerable amount of time working with the team going over the soil and plant analysis protocols. Although this was review for Saavedra-Rivera and Gutierrez, it was the first time Mamani had been exposed to many of these protocols. Team Bolivia has done well implementing the various experiments and taking the necessary soil and plant samples. They lack the confidence, however, to “plunge” into the preliminary processing (i.e. sieving, chemical extractions, etc.) of those samples. I strongly encouraged making this sample processing a priority so that the analytical phases of the protocols could be initiated. With respect to the analytical phase of the protocols, we were unable to make much progress here since the necessary reagents were not readily available in country and I was not permitted by the TSA to transport them via the airlines as planned. Steps have been taken to ensure that these reagents will be in place for my next visit so we can fully implement the protocols.

The experiments that were successfully established in 2010 were limited to the “15 de Octubre” site located nearest to Tiraque. In the long-term CAPS experiment at this site, the Avena-Viciacover crop had been incorporated into the soil for the appropriate experiments and a good stand of potatoes was achieved this spring. In addition, the “No till Mulch Seeded Potato” study had been harvested, giving a preliminary indication that this approach to potato production may be feasible. Team Bolivia had also taken the independent initiative to set up experiments on 1) direct seeded quinoa; 2) optimizing irrigation regimes and 3) *Bacillus*-induced P availability for potato.

The overall climatic conditions in Tiraque region this spring were considerably more favorable than in 2010, and the re-initiation of the failed 2010 CAPS experiments at Sank’ayani Alto and

Cebada Jich'ana sites looked quite feasible. Given the adequate soil moisture at the time of my visit, I encouraged to seed the cover crops (Avena + vicia) as soon as possible. I was very pleased with collaboration between the PROINPA and the Centro de Investigación en Forrajes (CIF). Here, Franz Gutiérrez Ferrufino, Rodrigo Rodríguez Arze and Ruddy Meneses Arce from the CIF station near Cochabamba joined us in Touring the field sites. These scientists had many good insights on how to optimize cover crop and forage production in our experiments, and were eager to collaborate with the project. The Director of CIF, Jorge Delgadillo Arnez, was also very supportive of this collaboration. In addition, we had the opportunity to meet some of the other scientists at the station. Most notably, I discussed a possible collaboration with Katia Ramírez Molina, a forage seed specialist at CIF, to help her study and alleviate seed dormancy mechanisms in some of their problematic forage varieties.

During my visit I also traveled with Pablo to the Anzaldo region, approximately 100 km south of Cochabamba. Here we visited with another PROINPA field facility and toured the region's agronomic systems. This region is characterized by very sloped terrain that apparently was once quite agronomically productive. The soils, however, have become highly degraded due to over cultivation, and climatic patterns have become increasing more erratic over the last two decades making crop production more difficult. Pablo and his other PROINPA colleagues suggested that it would be interesting to implement the CAPS concept here, and it was agreed that a long term CAPS experiment would also be established in this region.

In addition to the field and laboratory activities of this trip, I was also asked to give a seminar at the Universidad Mayor de San Simon in Cochabamba. This request was made by Mgr. Evaristo Venegas, the Director the Research Institute. My seminar was titled "Considerations for a More Holistic Evaluation of Cropping System Sustainability" and was attended by approximately 35 students and faculty members. I also visited the Centro de Investigación, Formación, y Extensión en Mecanización Agrícola (CIFEMA) to discuss collaboration between CIFEMA and SANREM to generate the necessary data to help CIFEMA design a planter for direct seeding quinoa. This will be a thesis project for Pedro Miranda, a student at Universidad Mayor de San Simon. Apparently, very few agronomy student at this university are interested in conducting field-based studies for their thesis project. Investing in students like Pedro is a valuable capacity building opportunity for the Bolivia SANREM project and our Andes-based SANREM project as a whole.

In summary, I believe Team Bolivia is making very good progress in the SANREM project, in particular with their limited experience and facilities for soil analysis and the less than ideal weather conditions in the 2010 season. Pablo Mamani and Antonio Gandarillas (the Director for PROINPA) requested that I make an additional visit in January or February of 2012. I believe such a visit would be merited to continue to build on the progress we have made with Team Bolivia.

Ecuador

My first week in Ecuador was spent in the Guaranda region touring the Illangama and Alumbre field sites and working with Victor Barrera's field-based crew to review the field sites, data collection protocols, and experimental data. During my time in Guaranda, Victor remained in Quito, but I was collectively hosted by Luis Escudero, Moazir Celleri Forestal, David Moposita

Rosa, and Juan Arévalo. Andy Sowell, from the IPM CRSP project, assisted with language translation.

At both the upper (Illangama) and lower (Alumbre) watershed sites, SANREM has three related experiments: 1) New CAPS experiment (Ensayo Nuevos CAPS); 2) Old CAPS experiment (Ensayo Antiguos); and 3) Erosion Plots. I was very pleased with how Team Ecuador has implemented and maintained all of the experiments. The base line soil samples had been taken and the cover crops (Avena, Vicia or a combination of the two species) had been established in all of the experiments. Likewise, the crew had implemented a perennial vegetation component in the *Ensayos Antiguos*, help to meet the agroforestry objectives outlined in our proposal. There were some minor modifications to the crop management protocols, primarily related with fertility management following cover crops. However, consensus was reached among Victor's and Soraya's team members on how to best proceed.

While in Guaranda, I was also invited to give a seminar at the Universidad Estatal de Bolívar at the request of Carlos Monar, the Dean of Agronomy at the university and SANREM collaborator. This seminar was very well attended, with over 125 students in the audience. Other faculty members were also in attendance. The seminar I gave in Bolivia was slightly modified for this event. Andy Sowell provided the English – Spanish translation. Many good questions and comments came from the audience, and I believe this was good opportunity to promote the SANREM project, as well as INIAP's efforts as whole in the region.

The second week in Ecuador was spent in Quito and INIAP's Santa Catalina Research Station. Here, Dr. Soraya Alvarado was my primary host, although Fernando Chamorro from Victor's group took responsibility for transporting me to and from the Santa Catalina station. During this week, I worked with various members of Dr. Alvarado's soils group to review the soil sample analysis protocols. I was very pleased with the progress here, as all of the samples from the 2010 season had been processed and analyzed. This was largely due to the efforts of Arnulfo Portilla, a university student doing his thesis project in collaboration with SANREM, and the guidance of Dr. Alvarado and her staff. I was also pleased that we had a tentative agreement between Drs. Bararra and Alvarado that Arnulfo would continue on the project in 2012 as a technician.

One of the major goals of this trip was to implement the microplate analysis of available P and inorganic N. For these analyses, I transported a microplate reader and associated accessories to Ecuador from the United States. A considerable amount of time at the Santa Catalina station during this visit was used to set up these protocols. As in Bolivia, not all the necessary reagents were available, so we were unable to complete this task.

In summary, Team Ecuador is doing an excellent job at implementing and maintaining the SANREM experiments as outlined in our proposal and modified through the various discussions during our visits. I am particularly pleased the degree of involvement from under graduate students, from both the Quito and Guaranda regions. These students include Rosa Arevalo, David Moposita, Juan Arevalo, and Arnulfo Portilla. Inclusion of these types of students is an efficient and effective way to meet the capacity building objectives of our project. In addition, a student like Arnulfo Portilla may make an excellent candidate for future US-based SANREM supported graduate student.

Suggestions and Recommendations

1. Gallagher and/or Stehouwer need to continue the development and implementation of the soil/plant analysis protocols, particularly in Bolivia.
2. A transparent data management system needs to be created in both participating countries. This will be a focus of my next visit in February 2012.
3. A transparent agreement needs to be established on who will take responsibility for analysis and publication of the data generated in the SANREM project. There will be a lot of potentially very “publishable” data being generated, but putting these data into a publishable form will take considerable effort, particularly if we would like to reach the more reputable and cited journals.
4. Bolivia needs to continue to develop its soil analysis facilities/capabilities. I will continue to work with Team Bolivia to help advise them in this process.
5. There is excellent opportunity to promote more direct collaboration between the Bolivian (PROINPA) and Ecuadorian (INIAP) groups. I strongly encourage more active discussion among the US, Bolivian and Ecuadorian based groups to help facilitate this outcome.

Training Activities Conducted:

Program type (workshop, seminar, field day, short course, etc.)	Date	Audience	Number of Participants		Training Provider (US university, host country institution, etc.)	Training Objective
			Men	Women		
Seminar	Oct 13, 2011	Students and faculty at Universidad Mayor de San Simon (Cochabamba, Bolivia)	10	20	R.S. Gallagher	Explain the importance of conservation agriculture and encourage further student participation
Seminar	Oct 19, 2011	Students and faculty at Universidad Estatad de Bolivar (Guaranda, Ecuador)	45	65	R. S. Gallagher	

List of New Contacts Made:

Name	Title/Organization	Contact Info (address, phone, email)
Jorge DelgadilloArnez	Agronomist (Eng.) Director of Investigation Center in Forages "La Violeta" (CIF), Universidad Mayor de San Simón (UMSS)	+ 591 4 4318856 / 4315706 cifumss@supernet.com.bo
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Katia Ramírez Molina	Agronomist (MSc.) Investigadora de programasdel CIF "La Violeta"	+ 591 4 4318856 / 4315706 katia.ramirez1971@gmail.com
Ruddy MenesesArce	Agronomist (Eng.) Líder de Programasdel CIF "La Violeta"	+ 591 4 4318856 / 4315706 menesesruddy@yahoo.com
EvaristoVenegas	Director of the Research Institute and Social Interaction, Universidad Mayor de San Simon	
Pedro Miranda	Student in the Faculty of Rural and Territorial Development, Universidad Mayor de San Simon	

Appendix: Daily Log

Friday, September 30: Departed from Greenville, SC.

Saturday, October 1: Arrived in La Paz, Bolivia, on schedule, but checked baggage did not arrive. Needed to make arrangements with American Airlines for the transfer of the baggage to Cochabama. Departed for Cochabamba later that morning.

Sunday, October 2: Worked at hotel to review the PROINPA SANREM experiments.

Monday, October 3: Spent the day at PROINPA. Was introduced to Pablo (the new in-country leader for the project). Team Bolivia did an overview of the progress of the field experiments in the Tiraque region.

Tuesday, October 4: Reviewed laboratory sample preparation protocols for inorganic N, available P and other cations, PMN, POM, total C & N hydraulic conductivity, and water holding capacity with

Ana, Oscar and Pablo. This was a review for Ana Karina and Oscar, but the first time that Pablo had been exposed to most of the procedures. Had a meeting with Antonio to discuss the current SANREM project and the possibility of expanding the activities. Agreed to help coordinate collaborations with US scientist for USAID – NSF proposal call.

Wednesday, October 5: Continued the review of the laboratory protocols outlined above.

Thursday, October 6: Visited Tiraque region field sites with Pablo, Ana Karina and the CIF team. Reviewed the experimental designs and sampling protocols, and discussed how the CIF team could collaborate with the SANREM project.

Friday, October 7: Continued the review of the laboratory protocols and discussed modifications to the designs of the field experiments.

Saturday, October 8: Day off

Sunday, October 9: Day off

Monday, October 10: Continued the review of the laboratory protocols and discussed modifications to the designs of the field experiments.

Tuesday, October 11: Continued the review of the laboratory protocols and discussed modifications to the designs of the field experiments.

Wednesday, October 12: Visited the Anzaldo region and discussed the design of potential CAPS experiments for that site.

Thursday, October 13: Delivered a seminar at Universidad Mayor de San Simon. Visited CIFEMA and discussed the collaboration between SANREM and CIFEMA on the development of reduced till quinoa planter with Pedro.

Friday, October 14: Summarized experiments, protocols and upcoming work plan with Team Bolivia.

Saturday, October 15: Departed for La Paz.

Sunday, October 16: Departed for Quito. Picked up at airport by Victor and Andy (IPM CSP).

Monday, October 17: Visited the Santa Catalina INIAP station. Discussed the plan for my visit with Victor and Soraya. Delivered Chromate Plate reader and associated accessories to be used for analysis of inorganic N and available P. Travelled to Guaranda with Moa and Andy.

Tuesday, October 18: Visited Illagama field site.

Wednesday, October 19: Delivered a seminar at Universidad Estatal de Bolivar. Reviewed erosion plot data with Luis.

Thursday, October 20: Visited Alumbre field site.

Friday, October 21: Continued to reviewed data with Luis. Returned to Quito.

Saturday, October 22: Day off

Sunday, October 23: Day off

Monday – Wednesday, October 24 – 26: Worked at Santa Catalina station with the soils group led by Soraya. She demonstrated the hydraulic conductivity and water holding capacity apparatuses, atomic absorption and ICP protocols, and set up the microplate reader. Also reviewed data from Arnulfo.

Thursday, October 27: Worked on microplate protocols. Helped negotiate collaborative arrangement between the SANREM project managed through Victor and the soil group for the current and future analysis of the soil and plant samples from the project.

Friday, October 28: Had food poisoning.

Saturday, October 29: Returned to US.



Fig 1. Gallagher and Sowell tour the Alumbre (Ecuador) field site with INIAP staff and the farmer collaborator.



Fig 2. Gallagher delivers a seminar on the evaluation of cropping system sustainability at the Universidad Estatal de Bolivar located near Guaranda, Ecuador. Over 125 students were in attendance.



Fig 3. Ana Karina and Oscar, of Team Bolivia, develop proficiencies at soil analysis protocols being employed by the SANREM project.



Fig 4. Collaboration among in-country agency helps to ensure the success of the SANREM project in Bolivia. Here, forage scientists from CIF join Gallagher in helping to optimize forage management in our CAPS experiments.



Fig 5. The sloping terrain in the Illagama region of Ecuador complicates soil conservation efforts in tillage-intensive crops such as potatoes.



Fig 6. Primarily driven by innovations by the farmer-collaborator, the CAPS experiments at Alumbre, Ecuador integrates perennial grass strips and fruit trees with the production of the annual staple crops, such as corn, beans and wheat.