Sustainable Agriculture and Natural Resource Management
Collaborative Research Support Program

SANREM CRSP
Office of International Research, Education and Development
Virginia Polytechnic Institute and State University (0378)
526 Price's Fork Road, Room 211
Blacksburg, Virginia 24061

Phone: (540) 231-1230
Fax: (540) 231-1402
sanrem@vt.edu
www.oired.vt.edu/sanremcrsp

Trip Report: Ecuador
Feb. 27, 2011 – Mar. 5, 2011

Michael J. Mulvaney, Assistant Program Director
SANREM CRSP, OIRED/Virginia Tech

Purpose of Trip: To build local capacity in soil physical property determination and bulk density sampling; and
To visit field sites and discuss the best experimental designs appropriate for the given cropping history.

Sites visited: Marcopamba, Ecuador;
Santa Catalina, Ecuador;
Rio Alumbre, Ecuador.

Executive Summary:
I met with Rob Gallagher (Penn State) in Quito, and together we visited the INIAP team in Santa Catalina (at the INIAP soils laboratory) to discuss the experimental design and analytical procedures for plant and soil samples. We also visited both the mid- and upper-altitude watershed sites to refine experimental designs and sampling procedures, as well as collect GIS data on the experimental units. Upon our return to Santa Catalina, we constructed a prototype of a hydraulic conductivity apparatus to build the capacity of INIAP's soils lab to investigate soil physical properties.

Description of activities:
Rob Gallagher arranged to purchase and send me bulk density sampling equipment at Virginia Tech, which I brought to Quito with me. This equipment allows for sampling of three inch diameter intact soil cores at 0-10 cm depth, and includes a slide hammer. Also included were soil probes and extensions that will allow for soil sampling up to 2 meters deep. This equipment was brought to the INIAP Experiment Station in Santa Catalina. Several of the staff there received training on how to use the equipment. While there, we discussed the experimental design and analytical procedures with Dr. Soraya Alvarado Ochoa, who was keen on greater

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collaboration and capacity building at the soils laboratory that would lead to publications in peer-reviewed journals.

On March 1, 2011, we visited the sites around the Microcuenca del Rio Alumbre (Figure 5). GIS data were recorded. The corner placement of each experimental block follows:
Ensayo Viejo, S 01°54'53.0" W79°00'55.4", 1806 m.
Ensayo Nuevo, Rep 1, S01°54'53.4" W79°00'55.4", 1813 m.
Ensayo Nuevo, Rep 2, S01°55'14.1" W79°01'01.2", 1946 m.
Ensayo Nuevo, Rep 3, S01°55'19.4" W79°01'16.4", 2010 m.

Figure 1. Data collection at the Rio Alumbre, Ecuador site on March 1, 2011.

These sites represent the mid-altitude sites and are approximately 100% (45 degree) slopes. The "old plots" (Ensayos Viejos) currently have 4 treatments applied to them in a maize-oat/vetch intercrop-bean-oat/vetch intercrop rotation. (It is worth noting that during years that involve bean production, there are three crops per year (oat/vetch-beans-oat/vetch), while years that produce maize have two crops per year.) The four treatments are: Ditches, Full tillage, Minimum tillage, and Zero tillage. Sub-treatments on these plots are with removal of the oat/vetch intercrop biomass and without removal of the oat/vetch intercrop biomass. The researchers are interested in altering this experiment in order to provide publishable data, although there is a confounding issue with the ditches in these plots. One solution that was discussed was to keep the ditches and make the experiment a 2 (tillage) x 2 (ditches) x 2 (biomass removal) factorial design.

The "new plots" (Ensayos Nuevos) are blocks that lay within 1 km of each other. The four treatments are 1. Minimum tillage without fertilizer, 2. Minimum tillage with fertilizer, 3. Zero tillage with oat/vetch intercrop with biomass removal, and 4. Zero tillage with oat/vetch intercrop without biomass removal. There are also runoff plots at this site, which are replicated three times with the same four treatments mentioned above.

Figure 2. Runoff plots at the Rio Alumbre site.

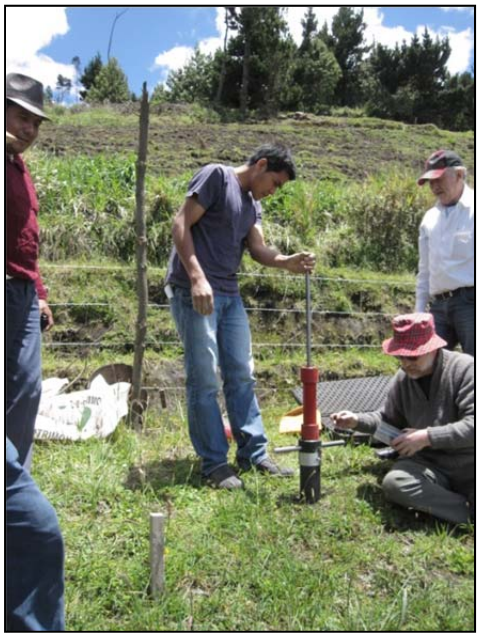

Figure 3. Intact soil core sampling at the Marcopamba site in Ecuador on March 2, 2011.

On March 2, 2011, we visited the sites around Marcopamba, to the north of the Rio Alumbre sites (Figure 6). These represent the high-altitude sites. GIS data were recorded. The corner placement of each experimental block follows:
Rep 1: S01°32'15.0", W78°54'21.1", 3665 m.
Rep 2: S01°32'11.8", W78°55'16.6", 3484 m.
Rep 3: S01°31'50.4", W78°55'32.5", 3371 m.

These sites are on approximately 100% slopes. The four treatments, each measuring 6 x 15 m, are blocked (reps) within 2.4 km of each other. Intact soil cores to 10 cm depth were obtained for some of these blocks while we were there, so that the trainees could practice the sampling protocols in the field. Since these are 100% slopes, there was some discussion about the angle of sampling for intact cores. It was decided that samples should be taken vertically (as opposed to perpendicular to the soil surface), since water movement is expected to move through the soil profile vertically. There are also runoff plots at this site, which are replicated three times with the same four treatments mentioned above.

Interestingly, there seems to be some adoption of conservation agriculture in this area, as evidenced by "pothole" cultural practices for bean production (Fig. 4).

Figure 4. Local "pothole" conservation agriculture practices for bean production outside of the research plots in Marcopamba, Ecuador.

On March 3-4, 2011, we focused our effort on building a prototype of a hydraulic conductivity apparatus with the INIAP staff to build the capacity of their soils laboratory to include soil physical property measurements. The lab is well staffed and has the following partial list of capabilities: TKN, total B, available P (colorimetric), total N & C (no total N is available for solid samples), and ICP (will be online in a couple of months). It is worth noting that the lab currently runs P availability studies using the Olsen P extractant, which they recognize as problematic, and are working on correlation studies using water and Mehlich III extractants. Further discussions ensued regarding exact procedures for POM, P digestion, and the Illinois Soil N Test (ISNT), which is a measure of the amino-sugar N content in a soil sample and is likely to be a sensitive indicator of management practices.

The parameters that will be measured on soil samples collected during this experiment will include the following:

Dry soil, sieved to pass through a 2 mm sieve

- Total C & N (LECO or TKN)
- Exchangeable cations (ICP or AA, Mehlich III) at the beginning and end of the experiment
- POM (53 μm) followed by total C&N
- pH
- Texture
- Total P

Fresh soil (frozen or refrigerated)

- Inorganic N (microplate)
- Potentially mineralizable N (microplate)
- Available P (microplate or ICP)

Intact cores

- Hydraulic conductivity
- Water holding capacity
- Infiltration rate (possibly)
- Bulk density

Suggestions, Recommendations, and/or Follow-up Items:

1. Arnulfo Portilla, Graduate Student in Chemistry, will send me the bulk density data for the 0-5 and 5-10 cm samples they sent me earlier.
2. I will send Soraya the procedure detailed in Wander, M. 2004. Soil organic matter fractions and their relevance to soil function. p. 67-102. *In*: F. Magdoff and R. R. Weil (Eds.), Soil Organic Matter in Sustainable Agriculture, CRC Press, Boca Raton, Florida.
3. I will investigate the feasibility of using the ISNT as an indicator of management practices: Khan, S.A., R.L. Mulvaney, and R.G. Hoeft. 2001. A simple soil test for detecting sites that are nonresponsive to nitrogen fertilization. Soil Sci. Soc. Am. J. 65:1751-1760.
4. I will investigate methodology for the determination of greenhouse can ammonia gas studies for use in the Ecuador plots. The main N fertilizer used in Ecuador is urea.

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		
Field training (Santa Catalina)	Feb. 28, 2011	INIAP staff	4	1	Penn State/Virginia Tech	Bulk density and deep soil sampling

List of Contacts Made:

Name	Title/Organization	Contact Info (address, phone, email)
Soraya Alvarado Ochoa, PhD	Especialista en Suelos, INIAP	spalv_2000@yahoo.com (593-2) 2 690 694
Victor Barrera Mosquera	Program Director, INIAP	vbarrera70@hotmail.com
Franklin Valverde	Engineer, INIAP	frankiniap@yahoo.es
Arnulfo Portilla	Graduate student, INIAP	apart_@hotmail.com
Luis Escudero	Engineer, INIAP	
Moazir Celleri	Engineer, INIAP	
Rosa Arevalo	Graduate student, INIAP	
David Moposita	Graduate student, INIAP	

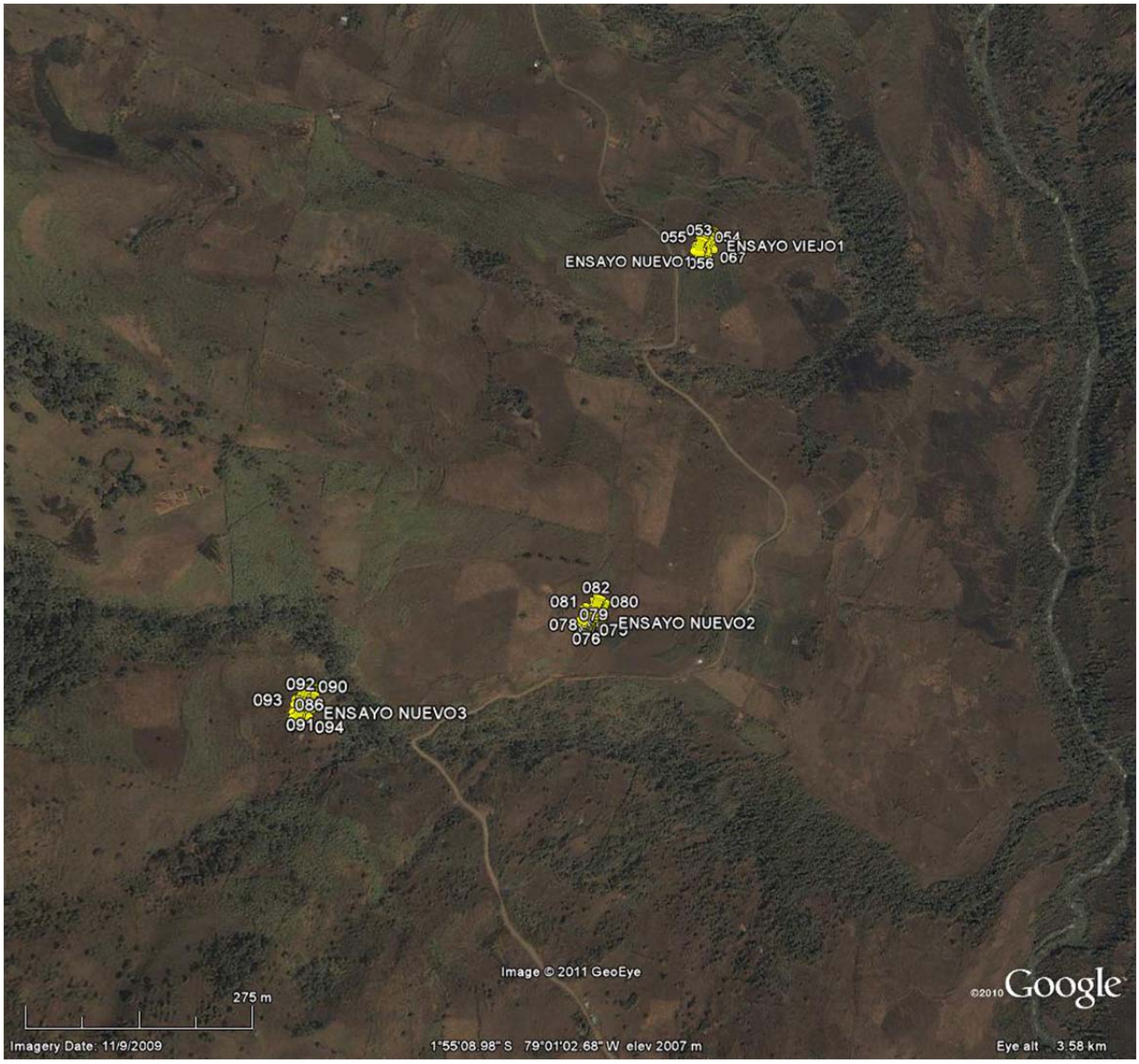

Figure 5. Overview of the Microcuenca del Rio Alumbre sites in Ecuador. The Google Earth file for these sites is available upon request to Michael J. Mulvaney: mulvamj@vt.edu.

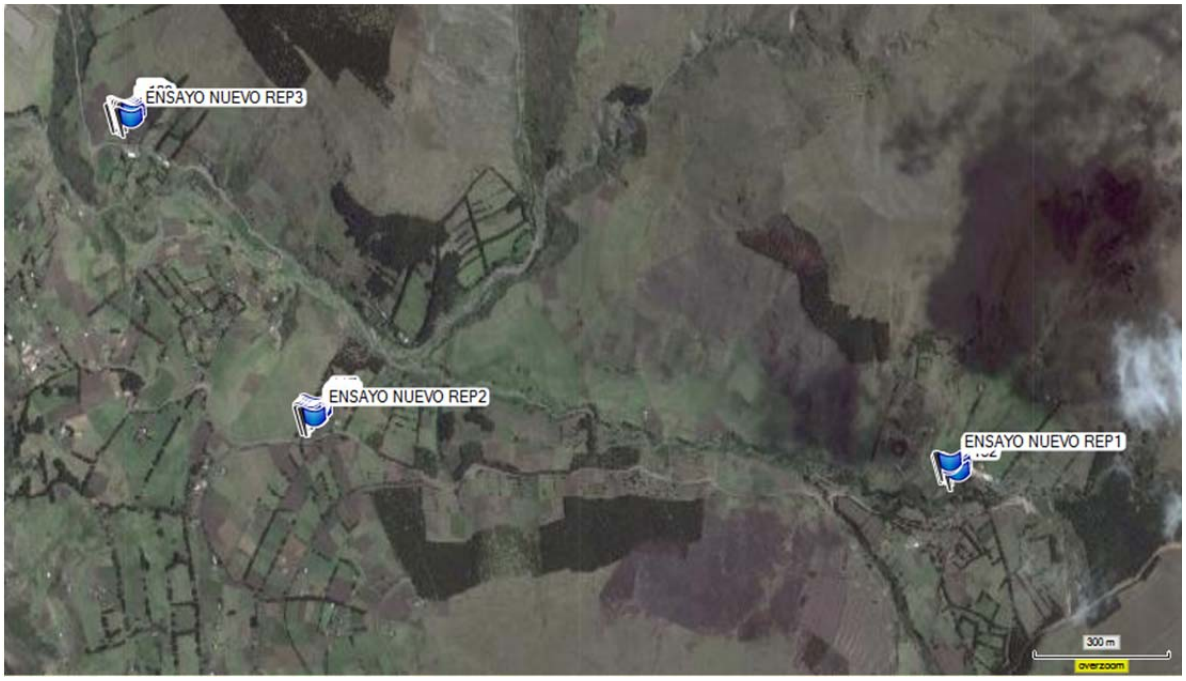

Figure 6. Overview of the Marcopamba sites in Ecuador. The .gpx file for these sites is available upon request to Michael J. Mulvaney: mulvamj@vt.edu. Google Earth imagery does not have good resolution for these sites.