NRCS Conservation Information Exchange with Cuba and Implications for Soil Management / Interpretations

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Abstract

The intent of the USDA-NRCS visit to Cuba during December 2016 trip was to exchange information regarding soil conservation, management and irrigation. Field visits were made to various sustainable land area demos and several organic and urban agriculture farms. There were excellent exchange discussions about soil management, soil conservation, agroforestry, irrigation and drainage, as well as soil survey, conservation delivery and building sustainable farming systems. Discussion included conservation issues and opportunities Cuba is facing and also the advances made in urban and organic agriculture with biofertilizers, vermiculture, biopesticides, energy conservation and surface irrigation. Due to the drastically reduced availability of chemical inputs, Cuba replaced them with locally produced, and in most cases biological, substitutes. This has included biopesticides (microbial products) and natural enemies to combat insect pests, resistant plant varieties, crop rotations and microbial antagonists to combat plant pathogens, and better rotations and cover cropping to suppress weeds. Scarce synthetic fertilizers were supplemented by biofertilizers, earthworms, compost, other organic fertilizers, animal and green manures, and the integration of grazing animals. NRCS' unique model approach for soil survey and conservation/watershed planning for sustainable agriculture was received very well by the Cuban counterparts. Initial recommendations were discussed for future follow-up between NRCS and the Cuban Ministry of Agriculture, including soil management/interpretations. Further discussion of future collaboration will be made with NRCS leadership and technical disciplines as well as partners. During this poster presentation, solicitation of input from partners will be made as to further exchange opportunities.

Periods of Soil Conservation in Cuba

- Precolonial, before 1492 – Virgin soils, covered with forests, aboriginal communities in equilibrium with nature
- Spanish colony (1492-1902) – Virgin soils, start of commercial agriculture (sugar cane, tobacco and coffee), start of degradation, some conservation, small and medium farms prevail
- Cuban Republic (1902-1958) – Rapid degradation with little soil conservation, large plantations with monocrops prevail, 1920s – Hugh Hammond Bennett participated in the Soil Survey for Cuba and recommended crop diversification and soil conservation. Beginning of soil conservation policy.
- Socialist Cuba (before collapse of Socialist Bloc 1961-1989) – Large state enterprises with high input practices prevail. Soil degradation continues, though less rapidly
- Socialist Cuba (after collapse of Socialist Bloc – 1990-present) – Rapid increase of soil conservation practices, small and medium properties with low-Input practices predominate

"Probably in no other country of the world has soil character had stronger influence upon national welfare than in Cuba. The wealth of the nation has been derived directly and almost wholly from its varied soils."

Each July 7th, in memory of Hugh Hammond Bennett, Cuba celebrates National Soil Conservation Day

Exchange at Soils Institute

- **Soils Institute in Boyeros outside Havana for a morning of information exchange regarding soils. Approximately 30 Cuban soils specialists, including several soil** microbiologists, met to discuss soil management, including biofertilizers – as related to sustainable agriculture development during the "Special Period" following departure of the Soviet Union. A general overview of the institute and its mission was provided: "to provide the technical scientific basis for the correct use, management, conservation and improvement of the soils of the country".
- NRCS presented the basics of how NRCS functions as well as soil management and sustainability. NRCS also shared innovative approaches to technology exchange with farmers in developing sustainable farming systems. The unique model approach for soil survey and conservation planning/watershed planning was received very well by the Cuban counterparts. They were very interested in Web Soil Survey.
- Several good discussions concerning some of the issues Cuba is facing, including erosion, salinity, compaction, and advances made in urban and organic agriculture. Copies of the overview presentations of the Soils Institute were provided to the NRCS team. Likewise, NRCS provided copies of our team's presentations and other NRCS resources in Spanish.

Soil and Geographic Regions

Ferritic

Cabbage and lettuce cultivation in Cuba. Ferritic soils are much in demand by farmers for the production of crops as sugar cane, tobacco, vegetables, and coffee. Weathered soils with low-activity (kaolinitic) clay having high P fixation potential, an abundance of Fe oxides (very red soils), and having strong soil structure. Are likely productive soils, but also very fragile under crop production.

Soil Conservation and Management

- Total land area of 42,426mi2 and a population of 11,247,925 approx. About 55.4% is currently used as agricultural land. The average annual rainfall is 51 in, with a marked seasonal variation between the driest months (November–April), when 26% of rainfall occurs, and the wettest (May–October), when 74% occurs. Rainfall also varies from 12 in annually in the southern areas of Guantanamo to over 118 in in the north.

Discussed agroforestry conservation practices, incl. Multi-Story Canopy

- Cuba grows more than 3.7 million acres of vegetables, grains, tubers, citrus, root crops, coffee and sugarcane and maintains more than 7 million acres of pasture and forest. Rice, potatoes, and cassava are important staples.

Soil Conservation and Management – Tobacco

Cuba has the second largest area planted with tobacco of all countries worldwide. Tobacco production in Cuba has remained about the same since the late 1990s. Cigars are a famous Cuban product worldwide and almost the whole production is exported. The center of Cuban tobacco production is the Pinar del Rio Province. Tobacco is the third largest source of hard currency for Cuba. The income derived from the cigars is estimated at US$200 million. The two main varieties grown in Cuba are Corojo and Criollo. 85% of the tobacco grown in Cuba is Produced by National Association of Small Farmers members.

Soil Conservation and Management – Tropical Fruits

Plantains and bananas account for 47% and 24% of the local production respectively. Both are only produced for domestic consumption. Other tropical fruits produced in Cuba are mango, papaya, pineapple, avocado, guava, coconut, and Annonaceae (custard apple family).

Soil Conservation and Management – Recent Emphasis on Organic and Urban Agriculture

- Only about 20-30% of cropland utilizes some chemical inputs. They utilize biofertilizers and biopesticides.
- Due to the shortage of the fuel and severe lack of transportation, a growing proportion of the agricultural production takes place in urban agriculture. In 2002, 35,000 acres of urban gardens produced 3.4 million metric tons of food. Current estimates are as high as 81,000 acres. In Havana, 90% of the city's fresh produce come from local urban farms and gardens. Havana has a population of 2.1 million in the city proper, which makes it the third largest metro area in the Caribbean.
- Following the dissolution of the Soviet Union in 1991, Cuba lost its primary source for fertilizer and petroleum. The loss of production reduced food supplies to the extent that the average Cuban lost 15 pounds. Their response was to return to their roots of organic production. Urban organic farms are now capable of meeting the majority of the food requirements.

Soil Management Alternatives Used

Recycling sugarcane and other residues as organic fertilizers

- **cachaza (filter cake mud)**
- **liquid residues from sugar processing and citrus industry and from alcohol distilleries**

Biofertilizers

- Bacteria, including Rhizobium, Azotobacter, Azospirillum
- Mycorrhizae, Phosphorus-solubilizing microorganisms, Biofertilizer mixtures, such as Azotobacter, MVA, and Fosforina

Soil Management Alternatives Used

Principal Uses of Biofertilizers in Cuba

Biofertilizer	*Crops*	*Substitution Achieved*
Rhizobium	*Beans, peanuts, cowpeas*	*75-80% of N fertilizer*
Bradyrhizobium	*Soybeans and forage legumes*	*80% of N fertilizer*
Azotobacter	*Vegetables, cassava, sweet potato, maize, rice*	*15-50% of N fertilizer*
Azospirillum	*Rice*	*25% of N fertilizer*
Phosphorus-solubilizing bacteria	*Vegetables, cassava, sweet potato, citrus fruits, coffee nurseries*	*50-100% of P fertilizer*
Mycorrhizae	*Coffee nurseries*	*30% of N and K fertilizers*

Soil Management Alternatives Used

- **Manure, Compost, "Bioearth" and Earthworm Humus**
- **Green Manures, Polycultures,**
- **Intercropping**
- **Agro-ecological Soil and Pest Management, Biodiversity**

Integrated Pest Management in Cuba – Management Strategies

Crop	Chemical Insecticides	Biopesticides	Release of Natural Enemies	Conservation and Enhancement of Natural Enemies	Resistant Varieties	Agronomic Practices
Coffee	N	L	N	H	M	H
Citrus	L	M	N	H	M	L
Sugarcane	N	L	H	H	H	M
Tobacco	L	M	N	L-M	M	M
Pastures	N	H	H	L-M	M	L
Rice	M	M	N	L-M	H	M
Corn	M	L	L	L	N	L
Beans	M	L	N	L	H	L
Cabbage	L-N	H	N-L	M-H	N	L
Tomato	M	M	N	L	H	M
Sweet potato	N	H	H	L	M	H
Cassava	N	M	H	H	M	H
Potato	M	H	N	M	H	M
Plantain and Banana	L	M	M	M	H	H

Level of use: N = none; L = low; M = medium; H = high

Common Intercrops in Urban Organoponics (Raised Beds)

Lettuce – radish
Lettuce – chard
Lettuce – garlic or onions
Cabbage – lettuce
Cabbage – chard
Cabbage – garlic or onions
Pepper – radish
Pepper – garlic or onions
Pepper – lettuce
Pepper – chard
Pepper – string beans
Bush beans – lettuce
Bush beans – chard

(Casanova and Savon 1995; Casanova 1995; Caraza et al. 1996)

Field Visits to Havana Province

Field Visits – Polygon Demonstrations

UBPC: Basic Cooperative Production Units = 100% State
CPA: Agricultural Production Cooperatives = Partial State
CCS: Credit & Service Cooperatives = Mostly "Private"

"Cuba's agricultural system has seen many structural changes over the past decades. A development from small-scale to large-scale, industrial monoculture practices was followed by a return to small-scale farming. To combat soil degradation from the previous decades of monocultures, Cuba initiated a country-wide program, based on principles of sustainable land management (SLM). Since 2009, SLM demonstration areas (polygons) have been introduced to ensure the implementation of integrated conservation and melioration technologies for soil, forest, and water resources at a farm production level."

Polygon Demonstrations

Outcome indicators of soil conservation polygons in Cuba.

Category	Outcomes	Indicators
Economical	Increased efficiency in production and services	– Cost per Peso* (from the economic balance of each production unit) – Agricultural yield of main crops
Social	Improving social indicators	– Workforce (total workforce by gender) – Monthly average personal income (salaries) – Social services to the community (generated by the production unit)
	Integration of actors	– Units integrated into the polygon (unit) – Contribution to vocational and technical training
Technological	Implementation of the principles of sustainable land management (SLM)	– Technologies for improvement of soil – Conservation (Benefited Area) – Water productivity – Water harvest and retention – Pest control alternatives – Use of renewable energy sources
Environmental	Improvement of the Soil Quality Index	– Saline and pH stress on the soil – Degree of compaction – Organic matter quality and nutrient content
	Decreased soil erosion Reduction of the use of pollutants	– Anti-erosive activities established – Use of chemical fertilizers and pesticides
	Biodiversity improvement	– Production and use of organic manures and bio fertilizers – Water quality for irrigation – Management of forest plantations, reforested area – Floristic composition and plant species of economic importance – Fauna composition- Number of fires and controlled fires – Areas with invasive species handled

* Peso = CUP (The Cuban Peso); own compilation of the authors [3-5].

Organic Raised Bed Operation – Oar Playa State Run

Organopónico

State run organopónico, Oar Playa in west Havana. Approximately 25 vegetable crops were grown on 10 acres in raised beds (made from tile roof) with compost and biofertilizers, manures, use of biological controls, and micro-sprinkler irrigation using well water. The team learned seed is bought from Japan, and that the native soil at the site has a shallow hardpan layer, hence the raised beds and shallow-rooted vegetable crops.

Field Visits – Polygon Demonstrations – Finca Estrella

State run farm- fruit orchard and agroforestry species. The slope was approximately 5 to 12% and erosion control included rock barriers, terraces with vetiver grass, and organic residue management. 100% of the conservation practices are paid by the state (National Program for Soil Conservation and Melioration – NPSCM); however, there was interest in how NRCS provides cost share for conservation practices. There was some discussion on getting landowner buy-in and how money is tied to that. NRCS shared the idea of Plant Materials Centers which service several states which was of great interest to the Cuban counterparts. This polygon did have its own plant nursery, but some/many do not. Soil compaction issues were discussed and an item of further exploration would be no till.

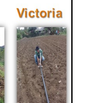
Field Visits – Efrain Mayor CCS

ANAP (National Association of Small Farmers), consisted of 65 acres total between the son and dad. They had an elaborate greenhouse with drip irrigation growing sweet peppers, raised beds, fertigation and acid cleaning of drip. Other crops grown include lettuce, cucumber, tomato, beets, as well as fruit trees, such as plantain and mango. Due to their agricultural success, the Cuban government is letting them farm another 30 acres of state-owned property adjacent to their current operations. There are 25 farms in the cooperative; they share equipment and credit. Water and soil samples are paid for by MINAG. This is an example of more intensive farming, using inputs such as synthetic fertilizers and herbicides. The greenhouse systems were well constructed, providing all-season climate control. Irrigation is provided from pond storage supplied by runoff as well as underground spring flow, and pressure for drip irrigation is supplied by a Soviet-built, electric, motor-driven pumping plant. The Cubans shared they are evaluating the balance between increasing production (intensive methods) and long term sustainability. While soil types/textures do vary, there were noticeable differences between the organic and intensive farms. We shared presentations and resources on conservation practices – they would like to exchange practices in a series of sustainable agriculture workshops with farmers, soil scientists and conservationists.

Field Visits – Polygon Demonstration – Organic

UBPC Polygon, Cooperativa Victoria Uno 26 de Julio, 1300 hectares, established in 2010, produces coffee, papaya, tomatoes, sweet potatoes, other fruits and vegetables. Contour farming and terraces (with kinggrass barriers), in addition to composting, vermiculture, biofertilizers, biopesticides, and hand-move sprinkler irrigation. They also raise roosters for authorized cock fights.

Victoria



Summary

Cuba MINAG and NRCS agree sustainable farming systems must integrate:

- **Soil Quality and Management**
- **Water Quality**
- **Nutrient and Salinity Management**
- **Diverse Cropping Systems, incl. Cover Crops**
- **Irrigation Water Management and Systems**
- **Integrated Pest Management**
- **Livestock and Wildlife**
- **Energy and Air Quality**
- **Economics**
- **Whole Farm Planning**
- **Watershed, Marketing Opportunities**

Summary

Keys to Achieving Sustainable Farming with Conservation Planning and Soil Surveys:

- **use integrated systems approach (ecosystem, whole farm, watershed)**
- **problem-posing, problem-solving approach**
- **actively seek resource, watershed, marketing opportunities**
- **resource efficient and resource conserving, utilize local resources**
- **technology "exchange" vs. "transfer"**
- **develop whole farm conservation; plan creatively and flexibly**
- **consider on-site and off-site effects**
- **focus on keeping energy flow through the integrated system**
- **reemphasize biological factors, improve biodiversity**
- **improving soil quality is key to improving soil, water, air, plant, animal resources**
- **case studies, field trials, on-farm research/demonstrations, farmer-to-farmer networks**
- **interdisciplinary teams including producers and partners**
- **recordkeeping is tool in decision-making and management of current and future resources**
- **need user friendly fact sheets, brochures on integrated systems**
- **NRCS can advise on developing soil survey and planning infrastructure**
- **National Soil Survey Center can advise on soil management and interpretations**
- **Kellogg Soil Survey Laboratory can advise on setting up soils lab, soil sampling, analyses and archiving**
- **Need comprehensive food security plan**

Summary and Future Plans

The Cuban delegation was very pleased with the information exchange and are interested to enter an agreement for collaboration between NRCS and MINAG's soils and irrigation departments.

Areas of interest for future collaboration

U.S. Conservation Programs and Field Assistance

- *Technical assistance and financial incentives for soil, water, and forest conservation*
- *GIS and Web Soil Survey technologies*
- *Systems for monitoring soil and water (want to visit Puerto Rico El Yunque Climate Monitoring Station)*
- *Reduced and no tillage soil management*
- *Sustainable agriculture practices for small land holders*
- *Soil quality kits – have seen NRCS soil quality kits and would like to use with their small holders and exchange soil quality indicators, interpretations, and soil management techniques*
- *Workshop for exchanging approaches to sustainable agriculture in US and Cuba*
- *Plant materials for conservation*

Irrigation and Drainage Engineering Activities

- *Subsurface (tile) drainage for managing high water tables and soil salinity – monitoring, design tools, and construction methods*
- *Soil moisture monitoring for irrigation scheduling (sensors and portable meters)*
- *Drones for studying topography, precision agriculture*
- *Survey grade GPS technology for land leveling, including laser control for earthmoving equipment, especially for water conservation in rice irrigation. (A University of California Cooperative Extension/ NRCS publication on conservation alternatives for rice irrigation was provided.)*
- Solar well pumps for small scale irrigation, livestock, and domestic water supply

Resources

- International Programs Division website https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/alphabetical/international/
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