ONIONS OR PAPAYA:
THE DILEMMA ON THE GROUND IN BELIZE

Results of Soil Nutrient Analysis for Subsistence Farmers on the Periphery of the Rio Bravo Conservation and Management Area, Orange Walk, Belize

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In the later part of the 20th century agricultural development in Belize was focused on export crop diversification. U.S. International Development (USAID) has in the past granted funds to facilitate the production of exports such as cocoa, spices, and mangoes. While there is undoubtedly still a very real need for agricultural diversification, many critics believe that the Belizean government's current emphasis on nontraditional exports is failing because of small farmers' lack of commercial experience (Barry, 1991). Many believe that a more balanced approach--one that focuses on both local and foreign markets--would be most effective. The struggle between these two approaches is precisely what I encountered during our December 2006 initiative in Belize.

A little background will perhaps clarify some of the problems that Belizeans face in their struggle to maintain a subsistence level of agricultural production. Belize imports nearly 25% of the food it consumes, a vast amount given the current number of Belizean farmers and the amount of arable land available in Belize, only 10 to 15% of which is being used (Barry, 1991). Belize's external dependence on importing consumables is a remnant of the country's economic base as a British colony. While the economy of Belize consistently suffers from an annual trade deficit, agricultural exports account for 70% of the country's foreign trade (Barry, 1991). These numbers clearly illustrate that the agricultural emphasis is on the production of export crops, such as sugar and citrus fruits, which are largely grown by large mechanized producers (some of which are foreign) on Belizean soil.

This is the second year that I have had the privilege to work with small-scale farmers on the periphery of the Rio Bravo Conservation and Management Area. It is obvious from our interactions that these indigenous milpa farmers, who are mostly Mayan and Mestizo, are not the major beneficiaries of Belize's new agricultural development programs that promote an increase in export production. These subsistence farmers have little access to credit, technical assistance, or basic information about soil condition and nutrient levels in their own fields. There are more than 6,000 subsistence or sub-subsistence farmers in Belize (Barry, 1991). Traditional slash and burn methods of farming that once allowed for somewhat effective soil nutrient restoration are no longer sufficient. Fallow periods have rapidly decreased as the amount of available land has decreased and the population has increased. The fallow period that was once 30 to 40 years has been in some cases reduced to a single growing season, less than one year. This abbreviated fallow period prevents natural soil nutrient restoration and requires chemical or organic input to maintain even minimal yield from the post fallow plantings.

I also have had the opportunity to work with individual Mennonite farmers who run small-scale unmechanized operations and are struggling at a subsistence level, as well. In contrast to these small farmers, there are mechanized Mennonite agricultural communities that have developed thriving businesses based on supplying local Belizeans with dairy products, vegetables, beans, and poultry. The contrast in agricultural focus—farming for export or supplying local markets—is more complex than it appears on the surface. The large-scale mechanized farmers have true options, many of whom grow for the local markets as described above and others who plant corn and soybeans for export. The subsistence farmers have fewer options. They cannot afford to make an incorrect decision due to their limited resources in terms of land, equipment and capital. They have to know where the greatest potential for profit lies. During the McMaster group's visit in December 2006, the decision came down to onions or papaya.

The stories of two farmers, Mr. Redecupp and Mr. Hernandez, best illustrate the dilemma. I first visited Mr. Jakob Redecupp, an unmechanized, very small scale Mennonite farmer, who most recently began planting and harvesting papaya. Ivan Gillett, Programme for Belize (PFB), had insisted that Mr. Redecupp could benefit greatly from the type of soil nutrient testing that I could provide. Mr. Redecupp had, along with a number of his neighbors, contracted with a papaya processor to grow a field of papaya. Mr. Redecupp proceeded to explain to me just how this contract worked. The papaya processor sells the farmer the papaya seedlings and fertilizer. Application methods and amounts of fertilizer that he used were recommended by the processor. The processor then purchases the fruit once harvested. The processor, in simple terms, has complete control over the input costs (expenses) and the farmers' output income. Mr. Redecupp, without reservation, detailed the fertilizer he was using and the method and timing of applications. He also was excited to tell me that he was actually harvesting papaya from the trees in just four months. He was amazed that he could produce fruit in a time period that was nearly half of the normal maturity rate for the papaya. I sampled from multiple sites within his papaya field and from an adjacent field that had been fallow for the past six months.

Tests of his fields indicated that he had been over-fertilizing his fields,[1] using a triple application protocol, fertilizing before the seedlings were introduced, spraying fertilizer at the base of each tree at regular intervals, and running a continuous drip of liquid fertilizer through the field. The input costs associated with this much fertilizer application could not be offset by an increased output because the nutrient levels were above that which is optimal for papaya, though they did have the potential to advance the maturity of the fruit and thus explained Mr. Redecupp's four months harvest period for this field. The overall potential for profit for Mr. Redecupp could be increased by a more effective input to output expense ratio resulting from a more strategic application of fertilizer. Mr. Redecupp received these soil results after the testing was completed, followed shortly by annotations about the actual nutrient levels that would allow him to reduce fertilizer input if he so chose.

The lure for Mr. Redecupp and no doubt his neighbors is the complete package offered by the processor. These farmers are located in remote areas and have only rough access to markets beyond their immediate community. The dilemma they face, however, is even more dire when one considers the eventual degradation of their natural capital, the soil, from over-fertilization, which makes the relationship between their livelihood and the papaya processor a tenuous alliance.

Shortly after sampling at Redecupp's farm, I was able to visit the village of San Carlos, which lies on the New River Lagoon very close to PFB's research station at Hillbank. In 2005, I visited this agricultural community of approximately 150 residents. I was anxious to see Mr. Hernandez, a farmer who I had previously worked with. Although the previous year I had been received with some apprehension, I was delighted to find that I was not only welcomed, but expected. Mr. Hernandez was waiting for me in his field when we arrived and his daughter insisted on driving me out to the fields immediately.

Mr. Hernandez had an agenda. He and several other farmers asked me to sample soil from their fields. The information I had supplied him with in 2005 had helped him greatly. As a result, he had eliminated the varieties of onions that my research indicated were not appropriate for the soil and climate in Belize, targeting those most likely to thrive. He had had one bumper crop since then and appeared to be well on his way to a second. With his daughter Wendy acting as translator, he told me that onions were currently selling in the market for $3 U.S. per pound. He had fields of potatoes and carrots for me to sample, as well as a fallow field that he was planning to plant with cabbage.

Then he asked, "What do you know about papaya?" He wanted to know what it would take for his fields to be able to grow papaya. The papaya package deal and the lure for rapid money albeit lower profits had even reached San Carlos. Wendy expressed worry because when her father grew a variety of crops, they had food even if they couldn't sell them. If he grew papaya and didn't make enough profit, they would not be able to afford to buy food.

The results from the tests of Mr. Hernandez's fields showed that he had been able to maintain medium levels of macro-nutrients in all of the cropped fields tested. Specifically nitrogen, phosphorus, and potassium were at levels that produced an 80 to 90% yield if all other conditions, such as weather, were optimal. There was no indication from the tests that any micro-nutrients were limiting yield or that any were detrimentally excessive. The fallow field I sampled showed that a minimal application of fertilizer would support the next season of planned cropping. All the results of these tests were sent to Mr. Hernandez. In addition, I sent him a comparison of the macro-nutrient levels in Redecupp's papaya field and the fallow field tested in San Carlos, indicating that the fertilizer input cost to Mr. Hernandez to convert his fallow field to one that the processor considered optimal for papaya would be substantial.

The village of San Carlos collectively owns arable land. They are trying to pay off the mortgage on this property. To do so, each family contributes a portion of their profits to the debt. When the mortgage is paid, the land will be divided among the families of the village. Thus the preservation of this collective natural capital is critical to the long-term sustainability of this community. The decision I characterized earlier as one between onions and papaya is in reality one of agricultural focus between local or foreign markets. These farmers have access to soil nutrient analysis through the McMaster initiative, but they have no access to market trend information or crop-specific data other than that which they acquire out of experience.

While the bigger question about the future direction of truly effective aid programs for rural subsistence agricultural communities continues to be debated in both the United States and Belize, my focus will be on these farmers and their livelihood one growing season at a time. If the real needs of the rural poor in developing countries are to be met, then science must deal directly with the natural resource system that is their livelihood--their agricultural base (Berkes, Colding, & Folke, 2000). "Effective research should link seamlessly with the knowledge of these clients. If scientists continue to operate in a simple technological world, they will fail to achieve the potential pay-offs that could be obtained by linking modern science to traditional knowledge and practice" (Sayer & Campbell, 2004). The partnerships that have developed between the farmers on the periphery of the Rio Bravo and McMaster School at Defiance College allow for the research we conduct to be responsive to an expressed need. Our goal is to extend the array of options available to the farmers through the dissemination of information. Providing the soil analysis information that these farmers need not only has the potential to increase their profit and increase yield, but to limit soil degradation from chemical inputs and reduce the negative impacts on the conservation area that borders these fields.

In December 2006, I was able to double the number of fields tested in 2005, reaching a few more farmers. I hope that through testing slated for December 2007, I will be able to determine trends in fertilizer usage for those fields that I have been sampling for three years. But the effectiveness of this initiative can already be gauged qualitatively from the requests I received while in Belize. Can you test these fields? Can you tell me how much fertilizer I need to apply here? How soon will you get these results back to us? Are you coming back next December? The level of trust I felt when asked, "What do you know about papaya?" both excites and humbles me.

Protocol and Test Results

This year's testing was completed using LaMotte Smart2 Electronic Soil analysis apparatus. This newly acquired equipment is a significant improvement in the ability to quantify soil nutrient levels compared to what I used in December 2005.[2] In addition to the laboratory testing, I conducted an onsite physical assessment of soil quality with a modified version of the observational approach to soil health (Romig, Garlynd, Harris, & McSweeney, 1995). Criteria for modification were synthesized using information provided by Assessment of Soil Quality by Maurice J. Mausbach and Cathy A. Seybold (Lal, 1998). A Munsell assessment of soil type based on soil color was made onsite. A texture analysis was also completed and plotted for each field sample. All of the above information for each of the fields tested (not limited to those of Mr. Redecupp and Mr. Hernandez) was returned to the farmers in the spring of 2007.

Endnotes:

1 Macro-nutrient levels for the soil sampled from Redecupp's papaya field were in the medium to high range for nitrogen and high to very high range for both potassium and phosphorus. Micro-nutrient levels were high to very high in manganese and iron. The micro-nutrient levels in the fallow field were very similar, indicating that the high levels for manganese and iron were normal for his soil if in fact the fallow field hadn't been excessively fertilized when previously cropped. The levels of macro-nutrients in the fallow field were at low-medium to medium ranges for nitrogen, potassium, and phosphorus. Comparatively, the field currently planted with papaya had nitrogen levels 4 times that of the fallow field, phosphorus levels more than 2.5 times that of the fallow field, and potassium levels 2 times that of the fallow field.

2 The following chemical reactions were completed to allow for digital analysis of the soil extract to quantify nutrient levels to hundredths of parts per million or pounds per acre.

Macro-Nutrients (LaMotte, 2004)

Nutrient	**Protocol**	**Range of Results**
Nitrate-Nitrogen	Cadmium Reduction Method	.00-300.00 lb/acre
Nitrite-Nitrogen	Diazotization Method	0.00-40.00 lb/acre
Phosphorus	Ascorbic Acid Reduction Method	0.00-99.0 lb/acre
Potassium	Tetraphenylboron Method	0.0-500.0 lb/acre
Calcium	Schwarzenbach EDTA Method	0-4000 lb/acre
Magnesium	Schwarzenbach EDTA Method	0-2400 lb/acre

Micro-Nutrients (LaMotte, 2004)

Nutrient	**Protocol**	**Range of Results**
Manganese	Periodate Method	0.00-75.00 ppm
Iron	Bipyridyl Method	0.00-30.00 ppm
Chloride	Direct Reading Titrator Method	0-1000 lb/acre
Copper	Diethyzdithiocarbamate Method	0.00-30.00 ppm
Ammonia-Nitrogen	Nesslerization Method	0.00-200.00 lb/acre

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