Field Assessment of Agricultural Practice and Pest Management in the Monkey River Watershed, Belize

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Introduction

Monkey River Village (MRV), situated where the Monkey River meets the Gulf of Honduras, is a small dot on the map of Belize, but the voices of the 200 residents can echo the concerns and beliefs of many similar Caribbean communities. One major issue which affects the standard of living in MRV, as identified by a community assessment conducted in 2004, is the status of agriculture in the region (Higdon et al. 2004). The waters surrounding MRV support large-scale commercial farming of shrimp and bananas, in addition to small subsistence farms (milpas). Using the principles of Integrated Pest Management (IPM) as a tool, we conducted an assessment of agriculture surrounding MRV and its effect on the lives of the villagers.

Agriculture constitutes about 70% of the total foreign exchange earnings of Belize, with sugar, bananas, fish, and cultured shrimp as some of the leading exports (Government of Belize). Along the Monkey River watershed in southeastern Belize, bananas, shrimp and citrus predominate. The intensive production of these crops is maintained through large inputs of labor, chemicals, and water. Smaller farms are also scattered along the river that are typically managed by individuals for family consumption or sold at local markets. These plots are slashed and burned annually to clear weeds and replenish nutrients and require little to no external inputs.

An increase in the efficiency of agriculture, in terms of crop yield per amount of inputs, can create substantial benefits for both the farmer, as increased profits, and nearby residents, as decreased environmental impacts. IPM can help to decrease the negative impacts of farming on society and the environment by employing a wide range of pest control tactics. By managing pests, such as pathogens, weeds, insects, and vertebrates that interfere with human activities, through a combination of biological, cultural, and chemical means, at or below a level that causes damage or loss (aesthetic or economic), IPM can reduce detrimental effects on the environment and/or society (Norris 2003). IPM "emphasizes ecosystem-based strategies that provide economical, long-term solutions to pest problems" (Flint and Gouveia, 2001) in addition to promoting the reduction of pesticide use while maintaining biodiversity (Norris, 2003).

Providing an IPM program to any group of people, without prior knowledge of their specific needs and concerns, would undoubtedly result in failure. Therefore, we chose to utilize a participatory approach to program development. Participatory Program Development is a method that encourages the involvement of diverse stakeholders in the construction process of a program, with intentions of influencing current behaviors or practices. Through this method, a program can be tailored to the needs and concerns of the stakeholders in order to increase the potential for successful implementation. (Rajotte, 1996).

We conducted a Participatory IPM Assessment, which included interviews and discussions to identify stakeholders and issues involved in the agriculture surrounding MRV. People involved in many aspects of both large- and small-scale farming in the region, from community members to farm managers, were interviewed to determine the

role of agriculture on lives in MRV. We also toured a diversity of farms, from small milpas to commercial banana and shrimp operations, to better understand the challenges faced and management techniques employed. The outcomes of our project are twofold: documentation of the concerns voiced by villagers and an assessment of IPM utilization and potential by regional farms. Our team designed this assessment as a tool for future projects in the MRV area, with the hope that other groups can utilize this information to eventually find solutions to these reported issues that will represent all the stakeholders.

Local perspective on agriculture

The history of Monkey River Village (MRV) is rooted in agriculture. The banana industry supported a town of up to 2500 from the late 1800s until the 1930s, when a blight took out plantations and sent people in search of new livelihoods elsewhere (Naturalight 2005). Those who remained made a living with fishing and subsistence farming. Today, agriculture has a very different effect on the lives in this small village of less than 200 residents. Numerous large commercial farms lay upstream and up the coast, producing vast amounts of bananas and shrimp for export. Bananas are a cheap food item in many developed countries, but the price paid by those living downstream from the farms is steep, with standard of living as the monetary unit. And while MRV is surrounded by big agriculture, food is not easily accessible or inexpensive. Small subsistence farms are scarce these days, forcing the villagers to travel to neighboring towns or to rely on outside food suppliers who charge a premium for transportation to this limited-access region. The few small farms (milpas) managed by MRV residents are profitable with very little input and, in the eyes of the locals, have virtually no negative impacts on the environment.

The major concern voiced by the residents regarding agriculture is the negative impact of commercial farms on the local environment. It must be noted that, although these environmental impacts are assumed to be effects of large-scale farming, there is no physical data linking the farms to the changes; research studies must be undertaken to elucidate the causes. However, the knowledge of locals who have lived in this village all their lives is immense, and should not be overlooked.

Impacts of commercial agriculture on MRV

As most residents are supported in some manner by fishing, whether as a way to feed their family, sell to markets, or attract tourists, MRV is intimately connected to the surrounding river and costal waters. The decline in several aspects of water quality over the years threatens the livelihoods of many, and is locally attributed to the presence of nearby commercial farms. According to an assessment of river characteristics conducted in 2000 by the Toledo Institute of Development and Environment (TIDE) and The Nature Conservancy, the major stresses on Monkey River were identified as high sedimentation loads, changes to the composition of trophic levels and thus to the river food web, and increased nutrient loading (Esselman 2000). Responses during local interviews place the effects of large farms on water quality into two categories: changes in water chemistry and modification to the morphology of the river channel.

Although not confirmed by actual chemical testing, the residents of MRV believe the water in Monkey River has changed for the worse over the past few years. The locals no longer use the water for cooking and cleaning based on a general belief of contamination by pesticides and fertilizers.[1,5] Chlorinated ground water which is now supplied to the town by a tower built by a non-governmental organization, but most residents rely on rain catchments for the majority of their water.[2,3] Fishermen from the village mentioned declines in general fish numbers and specific fish species which they attribute to both the agrochemicals in the water and changes to river morphology.[1,4,5]

One specific change to the water chemistry is increased nutrient load from fertilizers and pond discharge from banana and shrimp farms, respectively. This eutrophication of both river and coastal waters is blamed for noticeable changes in the surrounding vegetation and coral reef, especially in the last five years.[4] Local shrimp farms discharge nutrient-rich water full of algae and shrimp wastes into the thick mangrove ecosystems along the coast. This natural filtration system can retain organic matter before it flushes out to sea, but the vast amount of wastewater has overloaded the holding capacity of local mangroves. Residents claim mangroves in the region used to be "dwarf", as one could see for miles over the top leaves when standing in a boat.[2,4] Now, excess nutrients have caused the mangroves to reach heights well above water level that blocks visibility beyond individual plants. We witnessed sizable algal blooms along the coast just north of MRV at the discharge point of a large shrimp farm. Residents say these blooms can get much larger and drift out of the lagoon at certain times of the year.[2,5] Additionally, the water color in this area has changed dramatically.[5] The surge of nutrients into the ocean is also linked to bleaching of the coral reef outward from the shrimp farms.[5,6] In the river, vegetation has been taking over sand banks, which is ascribed to fertilizer runoff from banana farms.[5]

Many changes to the structure of Monkey River are noted by residents. Sandy beaches at the mouth of the river have been continuously shrinking over the years.[1,5] Replenishment of these beaches would naturally occur with periodic heavy flooding, something that has also been declining.[1] The river is also noticeably shallower these days, which has pushed out the big river fish.[5] The principle cause of these changes is thought to be the diversion of millions of gallons of water by banana farms upriver and along the Swasey Branch.[4] During the dry season, it is not uncommon to find five to six sandbag-dams pooling water for pumps used by the banana farms to irrigate.[5] A manager from a local banana farm stated that pumps bringing 3600 gallons per minute from the Swasey Branch were run continuously to supply adequate water to the plantations.[7] Another factor possibly contributing to the decrease in river depth could be the lack of riparian buffers at banana farms, as well as other places along the river, which could significantly increase sedimentation loads (Esselman 2000).

An underlying cause of the environmental changes brought about by large commercial farms is thought to be inadequate regulations and poor enforcement of those that do exist by the government.[5] Commercial farms are instructed to maintain a 66-foot-wide riparian buffer between plantations and waterways. However, many farms clear land all the way to the river, apparently without notice by the government.[5] Also, the

mandatory water tests for both shrimp and banana farms are said to be conducted by private contractors hired by the corporations.[5] In order to be confident in the validity of results, outside groups are needed to test the waters. One villager recommended the use of holding ponds for shrimp farm discharge water before wastes are drained to the sea.[5] And although the residents of MRV worked together in the past to close down a small tilapia farm that was contaminating the Monkey River fish supply, they feel generally powerless to impose any changes on the large commercial banana and shrimp farms.[5]

In addition to environmental impacts, the locals also expressed some social concerns about the nearby commercial farms. It is well known that many of the large farms hire immigrant workers, mostly from Honduras and Guatemala. The wages for these workers are well below what MRV residents consider acceptable for a hard day of work, plus, one nearby farm was infamous for garnishing wages until after harvests.[1,5] And although there seems to be a general disinterest in working for the large farms, one resident mentioned there are not enough jobs in the region and the closest large farm was not currently hiring.[8]

Local food supplies

The staple diet in MRV consists of beans, rice, fish, and chicken, which is supplemented by fresh produce when available. Most food purchased in town comes from local farmers and a farmer's market truck that comes by once per week.[1] The few residents who actively maintain small farms supply plantains, citrus, cassava, sugar cane, and beef to the village. Many locals prefer to make the trip to neighboring towns, such a Independence and Mango Creek (which are adjacent to one another), where items such as flour, rice, and sugar, are cheaper there due to the cost of transporting goods to MRV.[8] However, a trip to Mango Creek can cost $50 BZ.[8] The lack of refrigeration likely limits regular access to fresh, yet perishable, food items.[5] A community garden, which could be maintained by the school, was mentioned as a good way to offer a fresh supply of produce such as sweet peppers, carrots, and cucumbers.[1,5] Fruit trees used to be plentiful in the village until Hurricane Iris came through, and attempts to replant have not been made.[8]

Small, local farms

There appears to be only four locals in MRV who actively maintain small farms upriver, three with milpas and one with a milpa and livestock/ citrus farm. Non-farming residents view these farms as very low-input and having no negative impacts on the village. Typical crops grown in local milpas include sugar cane, cassava, and plantain, in addition to some pineapple and ginger, all of which are intermixed.[9,10,11] These farms are burned at least once per year to clear encroaching vegetation and replenish nutrients.[1,11] Other than burning and some weed maintenance with a machete, milpas are basically left to the course nature after planting. Most pests are mammals, such as bush dogs and peccaries, which are easily tolerated.[10,11] The livestock/ citrus farm includes cattle, sheep, chickens, and orange trees, all in the same area of land. Some outside inputs, such as

fertilizer and cattle feed, are added.[10] Overall, the farmers seem to enjoy the exercise and extra income produced.

Barriers to farming

One surprise encountered by our group is the small number of local farmers and the fact that all those who do farm are elders of the village. During interviews, residents of all ages said that farming involves strenuous labor and younger generations are not inclined to work quite so hard. Also, a resident from a nearby town said that it is almost impossible for small-scale farmers to get loans, since banks typically require a farm to already be established before lending any money.[12] Regardless of the reasons, valuable knowledge gained by these farmers from years of working the land is not being passed on to future generations. In coming years, the opportunities for others to learn how to farm will diminish, along with the self-sufficiency of the village.

Descriptions of some small local farms

Farm #1 – This farmer raises sugar cane, pineapple, and plantains on three acres of land. Sugar cane produces two crops per year and is sold in Placencia, while pineapple produced one fruit per plant per year. Peccaries and bush dogs are the major pests, which have become more intense since the hurricane took out most wild food supplies. Occasionally ants and termites will attack the sugar cane. The termites are managed by cutting the sugar cane close to the ground when harvested. No irrigation is necessary, and the land is slash-and-burned twice per year.

Farm #2 – Farming has always been a part of this villager's life, even as a child when her parents taught her to farm. Cassava and plantains, and perhaps some sugar cane, are grown mostly for personal consumption, but surplus is sold to the locals. No fertilizers or irrigation are utilized. New cassava plants are produced by cutting and rooting nodes of another plant, and mature in three months. The many years have not appeared to slow down this farmer, who paddles her canoe upriver often to check on the milpa.

Farm #3 – This farm, with five to six acres in use, is larger and requires more inputs than the others. Cattle, sheep, and chickens are raised in a cleared field also containing many orange trees. Waste bananas from a nearby commercial farm and molasses are feed to the cattle. The cattle drink from and cross Monkey River. Sheep are purchased from the Mennonite community at Spanish Lookout. Jaguars (referred to as "tigers") have killed 12 sheep and one dog in the past year. Orange tree seedlings, which bear fruit in three years, are purchased from a nearby commercial farm and are fertilized with urea. Citrus and meat are sold at MRV and Placencia. The farmer would like to clear more land to increase farm size in the future.

Large commercial farming

The corporate farms operating in Belize are important stakeholders in this community. Monkey River Estates claims to provide 4% of the economy of Belize, and therefore, not only do they have a large impact on the community ecosystems, but they also have a large impact on the sociology and economics of the country of Belize.

To assess the current degree of IPM implementation throughout the shrimp and banana farms within a 25-mile radius of MRV, we conducted interviews with several farm managers representing both Monkey River Estates (MRE), and Aqua Mar shrimp farms. The primary focus of the interviews included the general operations of the farms, the IPM or general pest management practices utilized, and the concerns and opinions of the managers. These data have been compiled and summarized in the text below:

Shrimp Farming

Shrimp have become an important commodity in the tropics due to the long growing seasons. Out team investigated the production and management of shrimp farms located within a 25mile radius of Monkey River Village. The purpose of our investigation was to identify the current practices of the shrimp farms, the pest management issues and the concerns held by the management of both companies.

There are two primary types of shrimp farming: semi-intensive, and super-intensive. Semi-intensive shrimp farming yields one crop per year, while the super-intensive farming yields three crops per year, the later using the same water over-and-over again in addition to maintaining a higher density of shrimp throughout the growth period, which can be hard on both the shrimp and the ecosystem.

While both of the farms we visited utilized super-intensive farming, the first farm mentioned that it was in the process of switching from semi-intensive to super-intensive methods due to a drop in the shrimp prices.

Aqua Mar shrimp farm

Aqua Mar shrimp farm has 75 shrimp ponds located on 1000 acres, each pond covering approximately 3-5 acres, and holding approximately 800,000 shrimp/acre. In addition to the shrimp ponds, they have their own breeding facility and a processing plant, where the shrimp are assembled (cooked or raw) and frozen before they are exported to other parts of the Caribbean, the United States, or Europe.

Destination of each shrimp crop is very important when calculating how many crops can be harvested on a yearly basis. The growth rates of shrimp and the market destination determine the harvest cycle, for example, it takes one week for a shrimp to grow a gram. While most of the shrimp harvested at Aqua Mar shrimp farms are between 18-20 grams apiece, the European market prefers shrimp that are 11-12 grams

apiece. Therefore, occasional shrimp crops must be harvested early, to meet European standards, occasionally allowing for an extra crop per year.

In general, it takes a little over four months for one crop of shrimp to go from egg to harvest, depending on final destination of the shrimp, and the conditions with which they are grown. While Belize is a tropical country and experiences a year round growing season for most crops, it becomes too cold in November and December to profitably grow shrimp. Therefore, the shrimp are harvested, the water drained, and the ponds prepared for the next season beginning in January.

The shrimp ponds at Aqua Mar are made of earthen mounds, lined with lime and baked by the sun. In early January they are sequentially refilled from the mangroves on the coast of Belize, with a salinity of 18-24% and one meter deep. However, during the dry-season, the water is drawn from a reservoir. Today, at Aqua Mar farms, the average water withdraw and discharge is 20 acres per day with an exchange of approximately 5%, however, in the past they have utilized a free flow system, where the water would flow freely from the ocean to the ponds and back to the ocean again.

What happens to the water before, during, and after harvest is a significant concern with respect to large production farming. Bi-weekly water checks for the Aqua Mar farms are conducted by the Department of Environment Parameters to ensure that the shrimp farm is following government regulations. However, checking water quality is in the best interest of the shrimp farm as well. Therefore, the water is checked daily for nitrite, nitrates, ammonia, sulfite, sulfates, oxygen, pH, turbidity suspension, and anything else upon request of the management. These factors, if not monitored, can have a detrimental effect on the growth rate of the shrimp and can even result in mortality. Oxygen deficiency, for example, is a constant threat to the survival of shrimp. At Aqua Mar they inject pure oxygen into the shrimp ponds using a compressor pump and circulators powered by a tractor, ensuring that the oxygen content is sufficient for the shrimp.

Aeration of shrimp farms, while necessary for the production of shrimp, promotes the growth of other organisms as well. There was no mention of taking any measures to test the organic matter or antibiotic content of the water. However, during harvest, the pond water is released through a drainage ditch, which then guides the water into the mangroves as a natural filtration system.

Aqua Mar farms feeds their shrimp three times a day in trays that are placed two per acre, using ADM Belize mills shrimp feed, a pellet feed containing 25% protein. In addition, fertilizers, such as urea and Nutraleek, and antibiotics, are added to the water to ensure quality shrimp harvests. It takes one man all day to feed a single pond, making shrimp production labor-intensive, yet beneficial, as a consistent monitoring program. As a result, Aqua Mar employs 400 people, primarily of Mayan decent, to run the shrimp farm, providing them with free housing and free food in addition to a small wage.

Monkey River Estates shrimp farm

There is little difference between Aqua Mar farms and Monkey River Estates (MRE) farms in terms of shrimp production management, however, MRE reported a 65% survival rate as compared to 70% for Aqua Mar. The differences that were observed are as follows: MRE does not have their own breeding facility, therefore, they procure their shrimp stock from Aqua Mar. Instead of feeding protein pellets, MRE buys organic matter to feed the zooplankton that will feed the shrimp, thus reducing feed costs overall. Furthermore, MRE claimed to feed their shrimp only two times a day instead of three, again reducing the cost of feeding the shrimp by reducing labor costs.

Pest management for the Shrimp farms in the Monkey River area: MRE and Aqua Mar

Both farms had similar pests and pest management strategies. The primary pests found on a shrimp farm include birds such as cormorants, Cameroons and Jaberoos, which eat up to 10% of all the shrimp in a single crop, the Taurus virus, which can kill an entire pond full of shrimp, and humans, who frequently steal shrimp from the processing facility.

Methods utilized to prevent pest damage include harvesting at night to avoid bird predation, breeding shrimp that are resistant to the virus, and large penalties for any employees caught stealing, all of which are cultural control practices. In addition, both farms use antibiotics as a precautionary measure against bacteria and microorganisms.

Concerns of the shrimp farmers in the Monkey River area: MRE and Aqua Mar

Most of the concerns of both farms were the same. Fuel is the largest expense above labor. Erosion along the banks of the ponds is a problem, especially in the rainy season due to the lack of vegetative cover. Both farms have switched to high intensive shrimp farming because they are concerned about the shrimp prices falling yet during intensive farming the high density of the shrimp create concerns about the cost of inputs and the greater risk of loosing entire ponds to disease.

Hurricane Iris had done a great deal of damage to both farms in 2003. Aqua Mar lost all their buildings, including the breeding facility with stock. Fortunately, they had drained the ponds to 50% capacity and as a result lost only one pond.

Banana farming at MRE

MRE has four primary banana farms totaling 1600 acres. Unlike the shrimp that maintain seasonality, bananas are harvested every week, continuously throughout the year. However, similar to shrimp, bananas are a labor-intensive crop, that requires excellent timing and management to ensure that they arrive at their intended destination in the prescribed condition. Our team had the privilege to observe banana production from start to finish, including a trip to the port, at which the bananas were loaded onto

barges, and shipped to Europe. Below is a description of how bananas are grown at MRE, the pest management issues and the concerns held by the MRE management.

The bananas at MRE are grown in a quad-configuration, meaning that the trees are placed in groups of four, and tied together with rope to maintain an upright posture, one tree standing in each corner. They are more similar to onions or vegetables, than to a tree, and reproduce by budding, which produces baby trees, or meristems, at the roots of the adults. If the meristems have broad leaves while they are still quite young, then they are hacked off and left to rot. The manager of MRE explained that the meristems with broad leaves were expected to mature sooner than needed and would put excessive energy in developing broader leaves and not in developing bananas. However, if they have narrow leaves then they are expected to grow as desired and are therefore, nurtured until the adult tree is no longer productive, at which time the adult tree is cut down and left to rot. As soon as the adult tree removed, then the primed meristem will begin to grow rapidly, as it is taking nutrients from the same root system utilized by the adult tree.

It takes six months for a banana tree to grow from a meristem to bloom, and another three months for the bananas to mature enough for harvest. MRE harvests bananas 52 weeks out of the year, and maintains 30 workers to complete 20 harvests on an 80 acre farm, totaling 800-1000 boxes per acre (41-48 lbs). During harvest, the bananas are brought in from the field at a prescribed time, cut down from their "bunches" and placed in water were the sap is drained from the cuts on the stems. Once the bananas are rinsed of the sap they are washed in mild detergent to remove pesticide residue and dirt, and from there they are weighed, bagged, boxed and prepared to go to the shipping dock, were they are placed on the ship in refrigerated compartments.

The initial banana stock consists of meristems that are from either Honduras, or Israel, however MRE has a good relationship with the University of Belize and occasionally received meristems from them. The two strains preferred by MRE are "Williams"; known for its height as it grows six feet taller than other breeds, and "Grandmaine", which is shorter but more resistant to pests.

The root systems of both strains are relatively shallow and while leaching causes tropical soils to be low in nutrients near the surface, it takes a large quantity of fertilizers to grow banana trees. MRE uses 46 mg of urea, 300-400 lbs nitrogen, 600-700 lbs potassium, 20-30 lbs magnesium, and 20-30 lbs calcium, per acre, in order to get the highest quantity/quality bananas for export.

Quality of bananas is very important for the European market. Fyffe's, the primary purchaser of MRE bananas, requires the bananas to be "clean", meaning no scratches or black coloration, and must be 7" in length with a minimum thickness. These requirements are so strict that the harvesters use a calibration tool for every bunch of bananas brought in from the fields.

In order to achieve the high quality standards of banana, it takes a lot of water in addition to the nutrients listed above. MRE takes 3600 gallons of water from the Swazy

River per minute through their irrigation system, providing the trees with a total of two inches of water every week, three during April and May, which are considered the dry season. This requires their irrigation system to operate 12-16 hours per day. While this seems like an excessive quantity of water that is extracted from the river, MRE claim to be within the federal regulations. Irrigation runoff is drained into large ditches and directed back to the creak. Furthermore, the river water is tested upstream and downstream by the Belizean Agricultural Health Authority to ensure that as the irrigated water is drained or leached back into the river that it is not contaminated beyond regulation.

Further testing, on all aspects of banana farming, is done by the Banana Control Board Inspector, who acts as the middleman between the MRE and Fyffe's, the Belize Agriculture Health Association (BAHA), (primarily water), or the European company that purchases the bananas from MRE.

Banana farming is very labor intensive, consuming 40% of the total operational costs. MRE employs 150 people a day to work an 80-acre section of the farm at $2.25 BZ per hour (time and a half after 8 hours) and commission for extra banana bunches that are harvested. Most of the workers live in a village situated at the entrance to the farm, which is provided with a school, a clinic, and a police station. In addition they have electric, water, telephone service and food. Retirement plans, social security, accident and sickness insurance, are all part of the fringe benefits provided by MRE to the workers. While the male female ratio is 70/30, 60-70% of the workers bring their families.

Pest Management for the banana farms of MRE

Pest management for bananas is primarily chemical control, however there is a limited amount of integrated pest management involved. Managers were knowledgeable about IPM, and the need for more IPM solutions seemed to be a concern of the persons that we interviewed, this is important in our assessment because it indicates that the commercial farms will be more receptive to IPM suggestions.

However, there are also some constraints to using certain IPM methods. An example of such a constraint is replacing some of the fertilizers with compost, which not only provides necessary nutrients to the banana trees, but also creates habitat for beneficial insects. According to MRE, it was the bank that would not allow them to use compost instead of fertilizers. This suggests a possible contract between a fertilizer company and the banks.

However, there are many regulations that protect employees as well as the consumer. Any persons required to purchase or apply pesticides must be Certified Pesticide Operators with a qualified license. In order to obtain certification, a pesticide operator must complete one day of training and a written test. During pesticide application operators must wear a mask and gloves. Furthermore, after a period of application, each operator must be tested for nematicide exposure.

There are several pests found on Bananas including: thrips, nematodes, the big black weevil, Sigatoka fungus (black and yellow) and several insignificant pests. The following section gives a general description of each pest and the primary management methods used by the managers of MRE.

- Black Sigatoka and Yellow Sigatoka is a leaf fungus that kills the leaves of bananas and reduces growth; it is considered the worst pest found on banana farms. This fungus is most prevalent in the rainy season, and requires serious monitoring, to ensure that it does not overwhelm the trees. Cultural control of this fungus includes cutting the contaminated leaves and depositing them on the ground where they become fertilizer. The farm managers said that the fungus cannot reach the remaining leaves from the forest floor. Additionally, the decaying leaves provide habitat to both beneficial organisms as well as other types of pests. Other control methods include fungicidal sprays, such as contact fungicides during the dry season, and systematic sprays during the rainy season with restricted cycles, five per year, to avoid resistance. Monitoring for this pest is conducted on a weekly basis and is reported to the Banana Control Board. Furthermore, the Banana Control Board conducts one aerial spray per year to ensure quality control of this serious pest and efforts to develop a fungus resistant banana are underway.

- Nematodes, found in the soil and eating the roots of the banana tree, are considered the second worst pest found on banana farms. They are such a problem that nematicide is used regularly every six months as an insurance for the crop. It cost $200 to $400 BZ per year per cycle, for organophosphate nematicide, which is applied in a one foot radius around the plant, early in the morning. ("Counter" and "Furidan" are the nematicides of choice at this time). Occasionally the farm will use an oil mixture, lacking chemicals, to help control the nematodes, and reduce resistance. Monitoring for this pest is conducted two times a year, during which Gallina Shaker Beetle is also monitored.

- Thrips are a problem, but only on the cosmetic appearance of the bananas. This, however, can cause significant losses when shipping to a European or US market. Therefore, bags with Durisban on them are placed around the banana bunch as soon as development of the fruit begins. These bags also protect the bags against birds and other pests that might scratch or disfigure the bananas, leaving them unmarketable.

- Black Banana Weevil is a minor problem associated with banana production. However, it is usually managed with all the other pesticides that are applied to control other pests.

- (Colespes?) Beetle is a pest that gets into the protective bags where it can increase the temperature significantly, making the bananas ripen four days faster than they are expected. While four days does not seem like a lot, it can disrupt

harvest, and potentially cause the bananas to surpass the point at which they can be shipped to Europe without spoiling.

- Cutworms eat the leaves seasonally causing crown rot, however, they are not considered a significant pest.

- Other pests, including tigers (jaguars), birds and snakes, do not cause significant problems to the farm and are therefore not controlled.

- Bush dogs are also pests of banana farms, however, because MRE maintains upright stalks on all their banana trees, the bush dogs cannot reach the bananas, and therefore are not a pest of the MRE banana farms.

IPM practices utilized by the farm included tying the trees upright, which not only protects the bananas from lying on the ground but it keeps certain pests (such as bush dogs) away. MRE utilized a great deal of monitoring, which is a primary IPM practice and is in the best interest of any large farm as it might reduce the expense of pesticides. Furthermore, placing bags over the bananas to protect them from scratches and insects is a cultural control tactic, as is removing the fungus infested leaves from the banana trees.

All of the farm managers mentioned a good relationship with the University of Belize, which indicates a direct rout to a quality source of information regarding IPM and environmental issues.

Concerns of the MRE banana farmers

Labor, pests and weather are the primary concerns for the banana farm managers of MRE.

- Labor is the largest expense on a banana farm, totaling 40% of the overall costs. Therefore, one of the primary concerns comes from the source of labor. The MRE management mentioned that the labor from outside countries such as Honduras and Guatemala were not only less expensive but that they worked harder. There was no indication that the MRE would not hire local workers to produce bananas, however, there seemed to be no anticipation that locals would come looking for a job.

- Hurricanes are another primary concern for the MRE, as it is located directly on the coast of the Caribbean. Hurricane Iris was much more destructive to the banana farms than to the shrimp farms, with damage of 100%, estimating in excess of $27 million BZ. While insurance was required to cover the loss it was at least a year before the money was available for repairs, which caused a great deal of conflict.

- At one time, the pesticides used were killing birds and bats in addition to the targeted pests. However, the farm no longer uses that pesticide. The manager of

MRE did mention that the pesticides that are available in Belize are usually the ones that are not legal in the US and Europe due to detrimental environmental effects, however this statement would need hard facts before it was used in any argument against pesticide companies or government agencies.

- Furthermore, the managers of MRE voiced a concern over the quantities of pesticides that are regularly used, specifically the nematicides, although they could see no alternative.

- Our team was interested to find that "Farm 4" had been a cooperative farm of 10 members separate from the MRE. One of the interviewees, the current manager of "Farm 4", explained how a period of colder temperatures (below 52°) turned the banana peels black, wiping out six months of production, and the coop was forced to sell the farm to MRE. While there are several perspectives to view this from, it appears as if MRE assisted these banana farmers by absorbing the failing farm and relieving them from the impending debt that was increasing beyond their means, additionally providing them with managerial positions within the larger estate. It was uncertain whether the coop would attempt the reestablishment of a banana farm.

Conclusions and recommendations

Through interviews and farm tours, our project provides documentation of the status of agriculture surrounding MRV and how it affects the standard of living in this region. This record can provide valuable background information for future development work in Central America and give a voice to residents that might not otherwise be heard. Future projects working with the large commercial farms have the potential to reduce environmental impacts, while projects involving MRV residents can give them a direct means to better their standard of living.

The connections established with the large commercial farms can pave the way for research towards development and implementation of IPM programs, which could reduce farm costs and negative environmental effects. The managers we spoke to were knowledgeable about the concepts of IPM, and may be receptive to research projects conducted on their farms. For banana farms, better solutions to major pest problems (Black Sigatoka, thrips, and nematodes) and excessive water usage are desperately needed. There is also a need to investigate potential for the use of compost instead of synthetic fertilizers, including possible limitations imposed by loan suppliers. Improved techniques for cleaning discharge water from shrimp farms, such as the creation of holding ponds, also need to be researched.

Future projects involving the residents of MRV could also be effective at improving the standard of living. Residents mentioned the potential benefits of a community garden to the local food supply. A project could provide help with the initial establishment of such a garden by providing information on crops suitable to the region, basic design techniques, and management. Once established, a designated community group, such as the school, could be charged with maintaining and selling the produce.

Another crucial need for this region is water testing along the Monkey River and along the coast. Tests for specific agrochemicals and dissolved oxygen could help determine the effects of major farms on the waterways. A project could establish a means to regularly perform such tests and then put the locals in charge of continuing the process.

One aspect of agriculture that remains to be examined is the governmental and regulatory roles in farming. Interviews with workers from the Belize Ministry of Agriculture and other groups that influence the face of farming in the country could shed light on some the questions not answered by our project. Also, these groups may be able to establish connections between the residents and the commercial farms and promote communication between the groups. Other organizations, such the Caribbean Agricultural Research and Development Institute (CARDI), and the Agroecology program at Penn State University, may be able to provide additional ideas and support.

Text References

Esselman, P. 2001. The Monkey River baseline study: Basic and applied research for monitoring and assessment in southern Belize. Masters Thesis. Athens, GA: University of Georgia.

Flint, M. L., P. Gouveia. 2001. IPM in Practice: *Principles and Methods of Integrated Pest Management*. Oakland California: University of California Publication 3481.

Government of Belize. 1999. "About Belize: Agriculture". http://www.belize.gov.bz/belize/agriculture.html

Higdon, F., Jason Bedford, Erin James, Mandy Kohler, Ben Weagraff, Jenn Logan, Tim McSheffery, Alicia McCormick, Jacqueline Moreno, Steve Torgerson. 2004. An Assessment of Community Development Capacity in Monkey River and Punta Negra Villages, Toledo District, Belize. University Park, PA: Pennsylvania State University.

Naturalight Productions Ltd. 2005. "Monkey River Town". http://www.southernbelize.com/monkeyriver.html

Norris, R. F., E. P. Caswell-Chen and M. Kogan. 2003. *Concepts in Integrated Pest Management*. Upper Saddle River, New Jersey: Prentice Hall.

Pedigo, L. 1989. *Entomology and Pest Management*. Macmillan Publishing Company, New York.

Rajotte, E. G., L. Garling. 1996. Proceedings of the Third National IPM Symposium/Workshop: *Teambuilding for IPM Research, Implementation, and Outreach/Education*. Washington, D. C.: United States Department of Agriculture Publishing.