PARTICIPATORY INTEGRATED PEST MANAGEMENT IN A SMALLHOLDER FARMER COOPERATIVE

Manejo Integrado de Plagas en una Cooperativa de Agricultores Pequeños

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Mission:
Contribuir a disminuir los índices de pobreza y pobreza extrema en las áreas rurales de nuestro país y por ende, la desnutrición infantil, a través del desarrollo e implementación del Programa de Granjas de Desarrollo y Producción Auto Sostenible - GRANDES PASOS.

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Time contributed: 34 days

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EXECUTIVE SUMMARY

Context - Integrated pest management (IPM) is a systematic approach to the management of agricultural pests. Based upon an understanding of agroecosystem ecology, IPM utilizes multiple coordinated methods to control pests to economically acceptable levels. The focus of IPM is pest prevention, and synthetic pesticides are used only as a last resort.

Pest problems affect all farmers, but can be especially challenging for smallholder farmers who have limited financial and technical resources at their disposal. Pesticides, though a potentially effective tool for pest management, can be damaging to human health and the environment. Partly driven by the goal of reducing pesticide use, IPM extension has been conducted worldwide. There has been a recent focus on participatory approaches in IPM extension in developing countries.

Objectives - In line with the goals of the Patronato de Nutrición (PdN), this project was intended to improve the self-sufficiency and nutrition of smallholder farmers, specifically the members of a cooperative in Capira, Panama assisted by PdN. The primary objective was to improve the farmers' ability to independently prevent and manage pest problems in their crops. Indirect goals were to reduce pesticide use, thereby limiting pesticide exposure and dependence on purchased chemicals. Another goal was to stimulate farmer experimentation based upon IPM principles and methods.

Approach **-** The project was conducted between February and April, 2011 at the Las Gaitas farm of PdN's Grandes Pasos program, located in Las Gaitas, Capira, Panama province, Panama. Informative and interactive workshops were used to transmit

information to farmers. Study of the pest problems affecting the farm and the farmer decision-making process was conducted to better assess the needs of the farmers, provide relevant examples for study in the workshops, and evaluate how IPM may be incorporated into the existing framework. Information on current practices and their origins was gathered through on-farm interviews and surveys, and interviews with PdN technicians. A participatory approach was applied throughout, including a group visioning session at the outset; dialogue-based workshops centered on practical field examples; and feedback periods after each workshop, which were used to select future study topics.

Results **-** Information was gathered on existing crops, accompanying pest management practices and origins, unresolved problems, and local management methods, all of which served to help plan the workshops. Four workshops were conducted throughout the duration of the project on the subjects of IPM approach, relevant biological and ecological factors, potential prevention and control techniques, and responsible pesticide use. The workshop content was tailored to local crops and pests, and adjusted to farmers' interests and preferred learning styles.

One result of the workshops was the creation of a plan to incorporate green manure cover crops (*Canavalia ensiformis* and *Mucuna pruriens*) into the annual crops on the farm. These methods are intended to improve and preserve soil, while reducing weeds, thus also decreasing labour and herbicide use. This plan was developed in collaboration with the farmers, to meet their needs, and using local knowledge of the agroecosystem.

Conclusions **-** The participatory approach was effective to transmit some fundamental aspects of IPM to the farmers at Las Gaitas. The farmers are equipped with the knowledge necessary to employ green manure cover crops, amongst a wide variety of other practical tools which were studied to various degrees. The basic framework of IPM and a greater understanding of pesticides and pest management in general, will help the farmers pursue better pest management options independently and with PdN technicians. Follow-up in Las Gaitas is recommended to reiterate or expand upon the workshop content and assess the project's impact. Other farms working with PdN could also benefit from the workshops, which may be adapted to new settings.

The research portions of the project may be useful for future agricultural research or extension. The information gathered on the practices at Las Gaitas serves mainly to understand the origins of practices and the interactions of farmers with PdN, as related to pest management. The discussion of extension approach stands to aid future agricultural extension practitioners.

RESUMEN EJECUTIVO

Contexto - Manejo integrado de plagas (MIP) es un enfoque sistemático para la gestión de las plagas agrícolas. Sobre la base de una comprensión de la ecología de la agroecosistemas, el MIP emplea múltiples métodos coordinados para controlar las plagas a niveles económicamente aceptables. El objetivo del MIP es la prevención de plagas y pesticidas sintéticos se usan sólo como la última opción.

Los problemas de plagas afectan a todos los agricultores, pero puede ser especialmente difícil para los pequeños agricultores que tienen limitados recursos financieros y técnicos disponibles. Pesticidas, aunque una herramienta potencialmente efectiva para el manejo de plagas, puede ser dañoso para la salud humana y el medio ambiente. Impulsado en parte por el objetivo de reducir el uso de plaguicidas, la extensión de MIP ha traído a mucho del mundo. Ha habido un foco reciente sobre los enfoques participativos en la extensión de MIP en los países en desarrollo.

Objetivos **-** En acuerdo de los objetivos del Patronato de Nutrición (PdN), este proyecto se proponía mejorar la autosuficiencia y la nutrición de los pequeños agricultores, especialmente los miembros de una cooperativa en Capira, Panamá que está apoyando de PdN. El objetivo principal era mejorar la capacidad de los agricultores para prevenir y manejar independiente los problemas de plagas en sus cultivos. Objetivos indirectos incluían reducir el uso de pesticidas, así limita la exposición a pesticidas y la dependencia de productos químicos comprados. Otro objetivo era estimular la experimentación de los agricultores basado en los principios y los métodos de MIP.

Enfoque - El proyecto fue entre febrero y abril de 2011 en la finca Las Gaitas de Grandes PdN el programa Pasos, ubicado en Las Gaitas, Capira, provincia de Panamá, Panamá. Talleres informativos e interactivos se utilizaron para transmitir información a los agricultores. Estudio de los problemas de plagas que afectan a la finca y el proceso de toma de decisiones de los agricultores se realizó para evaluar mejor las necesidades de los agricultores, ejemplos relevantes para estudiar en los talleres, y evaluar cómo MIP se pueden incorporar en el sistema existente. Información sobre las prácticas actuales y sus orígenes se obtuvo mediante entrevistas y encuestas en la granja, y entrevistas con los técnicos de PdN. Un enfoque participativo se ha aplicado en todas partes, incluyendo una sesión de grupo para visionar en el principio; talleres basados en el diálogo se centró en ejemplos prácticos de campo, y los períodos de comentarios después de cada taller, que se utilizaron para seleccionar los futuros temas de estudio.

Resultados **-** La información se obtuvo sobre los cultivos existentes, las prácticas de manejo de plagas adjuntas y sus orígenes, los problemas no resueltos, y los métodos de gestión local, todos que sirvieron para ayudar a planear los talleres. Cuatro talleres se llevaron a cabo durante toda la duración del proyecto sobre los temas de enfoque de MIP, unos factores biológicos y ecológicos pertinentes, unas técnicas potenciales de prevención y control, y uso de plaguicidas responsables. El contenido del taller se adaptó a los cultivos locales y las plagas, y se ajustó a los intereses y estilos de aprendizaje preferidos de los agricultores.

Uno de los resultados de los talleres fue la creación de un plan para incorporar cultivos de cobertura abonos verdes (*Canavalia ensiformis* y *Mucuna pruriens*) en los cultivos anuales en la granja. Estos métodos intentan mejorar y preservar el suelo, mientras reducen las malezas, por lo tanto también disminuye el trabajo y el uso de herbicidas. Este plan fue desarrollado en colaboración con los agricultores, para satisfacer sus necesidades, y utilizar el conocimiento local de la agroecosistema.

Conclusiones **-** El enfoque participativo fue efectivo para transmitir algunos aspectos fundamentales del MIP a los agricultores de Las Gaitas. Los agricultores desarrollaron el conocimiento necesario para emplear abonos verdes, entre de una amplia variedad de otras herramientas prácticas que fueron estudiadas en diversos grados. El enfoque básico del MIP y una mayor comprensión de los plaguicidas y el manejo de plagas en general, va a ayudar a los agricultores buscar opciones mejor para manejar las plagas de forma independiente y también con los técnicos de PdN. Seguimiento en Las Gaitas se recomienda para reiterar o ampliar el contenido de los talleres y evaluar el impacto del proyecto. Otras granjas que trabajan con PdN también podrían beneficiarse de los talleres, que podrán adaptarse a nuevos sitios.

Las partes de investigación del proyecto pueden ser útil para futuras investigaciones agrícolas o de extensión. La información recogida sobre las prácticas en Las Gaitas sirve principalmente para entender los orígenes de las prácticas y las interacciones de los agricultores con PdN, acerca del manejo de plagas. La discusión del enfoque de extensión podría ayudar a extensionistas agrícolas futuras.

INTRODUCTION

Host Organization – Patronato de Nutrición

Patronato de Nutrición (PdN) is a Panamanian non-profit NGO established in 1990, striving to reduce poverty and malnutrition in rural areas of the country. To achieve this goal, PdN trains subsistence farmers, or *campesinos*, to develop sustainable, self-sufficient production systems that are capable of providing the nutritional needs of the family, as well as producing a surplus of goods which may be sold to obtain income. Along with training and technical expertise, PdN also provides significant organizational support.

The primary program of PdN is its *Granjas de Desarrollo y Producción Auto Sostenible* (*Grandes Pasos*) program. Grandes Pasos provides groups of farmers with a small parcel of land, without any sort of deposit or interest, to work collaboratively to produce food and income for their families. The *granjas* (farms) of Grandes Pasos are diverse production systems, generally including various staple crops, vegetables, and animals. Over time, the farmers pay PdN for the land and eventually take complete ownership of the land. PdN seeks to have the farmers form a cooperative association to manage the operation and ultimately to function independently of PdN. The granja is also meant to serve as a place for learning and sharing ideas, which the farmers may then apply on their personal land. There are currently over 300 granjas across the country.

Though technically a NGO, PdN works in cooperation with the Ministry of Agricultural Development (MIDA), as well as a number of other NGOs, both national and international, to achieve its goals.

My supervisors at PdN are Administrative Sub-Director Danya Amores and Agronomist Engineer Eric Gonzalez.

Project Description

My project focused on developing integrated pest management (IPM) practices at the *Las Gaitas* granja, part of the PdN's Grandes Pasos program, utilizing a participatory approach. Through informative and interactive workshops, farmers learned about the fundamental aspects of the IPM approach, relevant biological and ecological factors, potential control methods, and responsible pesticide use. Simultaneously, study of the pest problems affecting the farm and the pest management decision-making process was conducted to better assess the needs of the farmers, provide relevant examples for study in the workshops, and evaluate how IPM may be incorporated into the existing framework. Farmer feedback played a central role in steering the direction of the project and the content of the workshops. Collectively, the group and I, applying the IPM approach, decided upon a set of management practices utilizing green manure cover crops (detailed in the results section) to test in the field. The farmers are now ready to conduct the field tests and follow them up with observation and adaptive management depending on their success.

The experience of attempting to conduct participatory extension with smallholder farmers in the field provided some interesting lessons regarding methodology, which may be of use to other agricultural interns and are summarized in the discussion section.

Integrated Pest Management

IPM is a comprehensive and systematic approach to the management of various types of pests, involving the coordinated application of multiple control techniques and based upon ecological understanding of the agroecosystem. The term *pest* has been used selectively to define different groups of organisms, but for the purpose of this project *pest* will be used in its broadest definition, to include all potential nuisance organisms, including plants (Radcliffe, 2009; EPA, 2011). The focus of this project is obviously on pest management in an agricultural production context, though there is also potential to examine IPM in other contexts (Haines, 2000).

IPM typically follows a stepwise program of monitoring and identifying pests, setting action thresholds (conditions beyond which efforts to control pests must be taken), and controlling pests when necessary (potentially using mechanical, biological, and/or pesticide methods), followed up by adaptive management (EPA, 2011; Menalled et al, 2004). Emphasis is placed on long-term preventative techniques, including cultural practices (manipulation of growth factors, such as genetics, timing, and the surrounding environment), biological control through conservation, and habitat manipulation. However, to deal with emergent issues, curative measures may be taken. Preference is given to, sequentially, target-specific biological controls (i.e. the introduction of natural pest enemies), botanical pesticides, and finally synthetic pesticides.

IPM was borne out of rising issues and concerns surrounding the prolific usage of synthetic pesticides that emerged during the 1940s and 50s (Dhaliwal et al, 2004). Though it is true that reducing pesticide use is often a goal of IPM, it is not *the* goal of IPM, that is, to safely and effectively manage pest issues (Castle and Naranjo, 2009; Morse and Buhler, 1997). IPM has been accepted widely throughout North America in the last 50 years due to the economic advantages to producers and the environmental benefits to the wider community, farmers included. Though the extent to which practitioners have followed the original sentiment of thorough ecological understanding is debated, it is best to see IPM as a continuum of less to more appropriate techniques, rather than a defined set of practices which must be adhered to (Castle and Naranjo, 2009; EPA, 2011). Variations in available resources, including technical expertise; project scope; plant, insect, and chemical availability; and financial capital all influence the type of IPM that is possible.

The case in developing countries, and for small-scale or subsistence farmers in particular, is as a result much different than that of developed countries. Pesticides may not be used as frequently by subsistence farmers because of a combination of their cost, limited revenue, and the complexity of cropping systems – yet many small farmers overuse or abuse pesticides due the influence of powerful agribusinesses and development agencies. The implementation of aforementioned "real" IPM, based on (often site-specific) scientific ecological knowledge, may be even more challenging in this context, due to resource limitations (Morse and Buhler, 1997) There has been some major success with IPM in developing countries in large scale, capital-intensive, commercial exports but much less so for small producers (Andrews et al, 1992). In spite of over 20 years of efforts to spread IPM in Central America, farmer adoption remains relatively low, attributed by some to poorly conducted extension (Labarta and Swinton, 2005; Andrews et al, 1992).

Nevertheless, IPM methods, such as prevention or biological control, represent valuable tools for subsistence farmers because of their limited cost (Bergvinson, 2004; EPA, 2011). Existing IPM-related research for common regional cropping systems, such as paddy rice, shade-grown coffee, and legume covercrops and intercrops, is transferable to the case at hand (Staver et al, 2001; Infonet-Biovision, 2011). Furthermore, local or traditional practices often fit the IPM label and may play a major role in IPM programs (Altieri and Nicholls, 1997).

Project Justification

Pesticides can bring economic and social benefits to farmers by reducing labour and damage to crops, and improving food supply for subsistence farmers and market value for commercial producers (Castle and Naranjo, 2009). In fact, pesticides can even bring environmental benefits. No-till farming, rapidly becoming the standard for field crop production in North America, helps to maintain soil, but is only made possible for many producers via increased herbicide application. However, the benefits provided by pesticides come with costs to farmers, surrounding communities, consumers, and society at large. Soil, water, and air pollution and bioaccumulation in living beings lead to losses in biodiversity and ecosystem functioning, both of which are essential elements for agricultural production and of great value to all. Continued use of pesticides eventually leads to the development of resistance, creating further problems (Atreya et al, 2011). Humans are directly impacted by pesticides by acute poisoning, environmental contamination, and consumption in foods (STRI, Office of Education, 2006).

In Panama, pesticide use is prolific, leading Central America (a region with very high pesticide use at the global scale) in pesticide use per cultivated hectare (Molieri, 1995; Labarta and Swinton, 2005). Although limited cash revenues make the purchase of even low priced pesticides somewhat prohibitive for smallholder farmers, as previously mentioned, this is not to say that campesinos abstain from pesticide use. In fact, many small-scale farmers misuse pesticides: a lack of training, proper equipment, money and illiteracy contribute to the overuse of powerful broad spectrum chemicals when better modern alternatives exist, and inadequate consideration of safety precautions when fumigating; limited legislation keeps dangerous dated pesticides, illegal in other countries, available in Panama; and poor government regulation allows even illegal chemicals to remain available on the black market (Bruce Hill, personal communication; Hilario Espinosa, personal communication; STRI, Office of Education, 2006). As a result of these circumstances, acute pesticide poisoning frequency is high in agricultural workers, pests are pushed to develop resistance and resurge, and communities suffer from environmental contamination (Labarta and Swinton, 2005; Molieri, 1995).

Integrated pest management recognizes the potential utility of synthetic pesticides, but seeks to reduce the human and environmental health risks by making use of a holistic approach and using pesticides as a last resort. Despite various development programs, IPM, or at least explicit and intentional IPM, is uncommon in Panama, even within PdN farms (Eric Gonzalez, personal communication).

When I selected my project theme, I had a rough idea of the general context in Panama and my supervisors agreed it was a good idea. My research has revealed that at Las Gaitas, the study site chosen for me, the farmers rarely use pesticides and understand many of the associated dangers. At any rate, IPM approach and techniques will aid them in the management of pests, which are nevertheless present. I also hope that the participatory approach I employed in my work has increased their confidence in their own knowledge and abilities.

OBJECTIVES

The principal goals of this project are to improve the self-sufficiency and nutrition of the families associated with Las Gaitas. Both of these objectives are directly in line with those of PdN. The independence of the farmers may increase through the development of their knowledge of how to prevent, monitor, and handle pest problems in future, which will reduce reliance on technical expertise provided by PdN and on purchased pesticides. Though it is likely that PdN technicians will continue to provide assistance into the coming years, additional knowledge will help farmers play a more active role in the pest management decision-making process. Nutrition and health may be improved via reduction of pest problems, which may result in reduced crop contamination, damage or loss; reduced pesticide expose; and less labour input, freeing time for other work. Also, new ideas about experimentation may encourage farmers to more rigorously explore novel innovations or practices.

With these ultimate objectives in mind, I sought to work in collaboration with the farmers to determine local needs and priorities. As well, work was conducted in an inclusive manner, by presenting information in a format accessible to all group members, and taking the time to ensure their understanding; and with consideration of local learning styles and language.

In line with the previously stated goal, my methods have evolved to best suit farmers' requirements and objectives. The process of creating my approach provided the impetus to develop another project objective: to create recommendations for future agricultural extension work, specifically in the IPM field and for science-backgrounded workers.

EXPECTED RESULTS (HYPOTHESIS)

In brief, it was expected that workshops would increase the ability of farmers at Las Gaitas to prevent pest problems and to critically analyze any such problems that inevitably will arise. The workshops were intended to familiarize with farmers with the range of possible preventative and control practices, some of which are already being employed on the farm, and the pros and cons of each. A better understanding of relevant ecological concepts may help avoid pests and also instill greater appreciation of the complexity and value of ecosystems.

Collaborative application of IPM methodology to the farm during the project may or may not prove successful. Even if a new management practice is effective, the results may not be evident prior to the end of my time working with the farm, if ever (i.e. pest prevention). Nevertheless, potential benefits may include reduced labour (i.e. by preventing or reducing weeds), improved human and environmental health (i.e. by reducing the use of harmful pesticides), and reduced expenses (i.e. reducing purchased pesticide use).

The skills gained during the span of the project will hopefully stay with farmers, allowing them to make more independent pest management decisions, and to more actively engage with PdN technicians. As the production system at Las Gaitas is complex, such general aptitude is especially applicable.

Documentation of the current practices on the farm will also be completed. The motivation behind this study is mainly to determine relevant points of study for the workshops and to understand farmer decision making for future planning. Still, this knowledge may be useful for new parties interacting with Las Gaitas or PdN.

STUDY SITE

FIGURE 1: LOCATION OF LAS GAITAS (GREEN ARROW)

The project was conducted at the Las Gaitas farm located in the town of Las Gaitas, Ciri Grande *corregimiento*, Capira district, Panama province, Panama, approximately two hours from Panama City by car. In this report, “Las Gaitas” is used to refer to the farm, unless otherwise specified. The town of Las Gaitas has a population of about 400, most of whom support themselves primarily through subsistence agriculture.

The Las Gaitas farm is part of the Grandes Pasos program of PdN. The granja is located on 5.5 ha of land owned by the association of *Productores Unidos de Las Gaitas*. Productores Unidos de Las Gaitas is composed of 22 members, mostly men, who collectively manage the farm. If the spouses and children of members are included, Las Gaitas has over 100 dependents. The farm’s land was initially lent temporarily to the group by MIDA, and then given to the group in 2000 when PdN began to be involved in Las Gaitas. After gradually paying PdN for the land, the association took ownership of the land in 2009.

Las Gaitas is a diverse production system, focused on a few staple crops. The main products of Las Gaitas are rice, yucca, coffee, plantain, banana, broiler chicken, and tilapia, all of which are produced year round. Various other horticultural crops are produced seasonally. A number of fruit and hardwood trees are also found on the farm. Most of the food produced at Las Gaitas is consumed by the associated families, though some goods are also sold locally and in the town of La Chorrera, located approximately an hour away by car. The most important commercial products are coffee, chicken, and tilapia, though it should be noted that chicken and tilapia are also consumed. Other goods of variable market relevance include cucumber, pineapple, yucca, celery, culantro, and an assortment of seedlings. A more thorough description of agricultural practices, including pest management methods, is found in the results section.

In addition to working on the granja, each family has their own personal parcel of land, usually of 5 ha or more, on which they produce food. Other income sources include wage labour on local farms, artisanal crafts, and trade.

Las Gaitas receives aid from a number of organizations aside from PdN, including MIDA (training, seminars), US Peace Corps, Global Brigades, and the Roberto Eisenman family and Coronado hotel management (agro-tourism development).

METHODS

To develop basic scientific knowledge of pests and IPM framework, a short series of workshops (4) were conducted. These workshops toke place at Las Gaitas, quite literally in the fields. The workshops were interactive, encouraging farmers to share their knowledge and experiences and to think creatively. Farm members identified practical value as essential for them to gain from the project, and so on-farm examples were incorporated into the workshops to demonstrate concepts. After each workshop, we would recapitulate the main learning objectives and I would ask the farmers about what topics interested them most and if they were interested to learn more. In this way, farmers directed the subject matter of the workshops. The basis for the content of the workshops was literature sources (journal publications; government, university, and extension internet sites; books), complemented by relevant local knowledge and examples (from farmers at Las Gaitas, PdN technicians, other agricultural practitioners). Local knowledge, bearing the benefits of being site-specific, time-tested, and familiar to the farmers, was incorporated whenever applicable (Bentley, 2006).

Information on current practices and pests was largely garnered on the farm, through observation and interviews with farmers (see semi-formal interview questionnaire in Appendix B), interspersed among visits to the farm for workshops. Talks with PdN technicians helped to understand how they create and communicate their recommendations, and to gather information on standard agricultural practices and the greater context of PdN farms and Panama at large.

Potential management options were evaluated on economic, social, and ecological criteria within group discussions, and the decision to implement practices was left to the group.

Ethical Considerations

This project was carried out in compliance with McGill's Policy on the Ethical Conduct of Research Involving Human Subjects. At the first meeting with the farmers at Las Gaitas, I informed them about the outline I had in mind for my project, but then took the time to hear their feedback and to adjust the project to their demands. This process continued throughout the project, with the farmers repeatedly steering the direction of our efforts. Attendance and participation in the workshops was encouraged by myself and some members of Las Gaitas, but was never mandated and people were free to come and go as they wished.

In the initial meetings, and when meeting new community members, I always explained my experience and intentions realistically, to ensure that people did not gain false aspirations of what the project might amount to. Due to my limited experience, I thoroughly checked all information I was preparing to share with the group.

Free, prior, and informed consent was obtained from all subjects surveyed to identify practices on the farms, and subjects were able to stop the interview at any time.

Copies of the workshop outlines were provided to the farmers at their request in sufficient numbers for the entire group. Electronic copies of these outlines were sent to PdN so that they might be used in other work in future.

The farmers and I planned some practices to implement on the farm. The decision to follow this plan is entirely the farmers, the plans we have created are based on a combination of their and my ideas. PdN technician Guillermo Eloy endorses the practices we plan to employ.

RESULTS

Workshops

Through the duration of the project, four workshops were prepared and conducted. Most workshops lasted between 1.5 and 2.5 hours and included a mix of concept introductions, active discussion of current or potential local relevance of these concepts in the field, and a final summary and feedback period. The content of the workshops is more fully presented in Appendix A.

On Feb 25 I conducted an introductory workshop with eight members of the association and a number of other interested family and community members. The meeting included group introductions, an outline of my vision for the project, a group discussion to identify the farmers' needs and preferred learning style, and an overview of the IPM process and general types of practices.

The second workshop took place on Mar 25 and discussed the key elements of IPM with respect to Las Gaitas, that is, preventative practices. As well, the project and IPM framework were reintroduced for participants who missed the first workshop, and additional emphasis was given to the ecological basis of IPM and action thresholds. This workshop was best attended, with over half the farm members present.

The Mar 31 workshop followed up on the topic of rotation, discussed in the previous workshop, and also touched on responsible pesticide use. On farm experiments and the experimentation process were discussed to help prepare for testing new methods.

The final workshop was held on April 19. Expanding on theme of rotation, we studied applications of green manures and cover crops within the agroecosystem and their relevance to pest management and soil maintenance, amongst other objectives. We examined how rapid growing legumes (specifically *Canavalia ensiformis* or *brasiliensis* and *Mucuna pruriens*) may be utilized for these applications by relay cropping along with annual crops. The farmers are now waiting to receive seeds for these crops from a nearby farm (via PdN) to plant as a cover crop beneath a taller-growing crop (most likely maize, yucca, or pigeon pea). The cover crop will be grown until seed, the seeds harvested so that there are seeds for future use, and the crop cut and applied directly as mulch or incorporated in the soil depending on the subsequent crop. We also covered IPM methods for dealing with mealybugs in pineapple and banana weevil, two of the most problematic pests at Las Gaitas.

Current Practices and Origins

Current practices - Information was gathered on existing crops, accompanying pest management practices and origins, unresolved problems, and local management methods, all of which served to help plan the workshops. Some of this information may be interesting in its own right: to understand some basic aspects of smallholder farming in Panama, farmer decision making processes, or PdN interactions with farmers.

A table listing the crops being cultivated at Las Gaitas this year, along with notes on major pests and management practices or recommendations for each, is found in Appendix C. Almost all of the crops found on the farm have been cultivated by families for decades and by the Las Gaitas cooperative since its inception, though varieties change over the years. The sale of seedlings from the farm is a more recent development, having begun in the last five years. Some of the 5.5 ha area of the farm is left fallow to recover fertility, as the farmers have enough productive capacity between the remainder of the land and their own private operations. Some land has also been left fallow for a several years since it was deemed too steeply incline to cultivate. Pest management-related practices are described in detail below.

Origins of practices – The majority of practices at Las Gaitas have origins deep in history, being influenced by a multitude of global factors that have led to the formation of local conventions in Capira and Las Gaitas, in particular. This study is more concerned with modern developments and the direct sources of these changes. One important practice that has been in place at Las Gaitas for some time is the ban of burning forest (and correspondingly, slash-and-burn rotation), a stipulation PdN has for all granjas it works with. Thus the farmers are dependent upon the productivity of land already cleared and under cultivation.

New practices on the farm may originate from neighbors or local innovation, but most stem from PdN technicians or other agricultural development programs or presentations. PdN technicians provide guidance in the management of pests, in addition to crop care in general. PdN often sources and transports agricultural materials to the farm, including seeds, transplants, fertilizers, pesticides, implements and construction materials. In doing so, PdN may introduce nutrient or pest resistant plant varieties to the farm. Practices such as tilapia aquaculture, intensive broiler chicken production, and the production of various composts and fertilizers, originated from PdN. PdN also has played a role in the commercialization of farm operations. Agricultural development organizations, in particular MIDA, influence practices via informative pamphlets they distribute and their presentations, which are attended by some farm members.

Pest management recommendation by PdN generally proceeds along the following informal process. PdN technicians (with training in agricultural engineering, animal science, and/or agronomy) regularly visit Grandos Pasos farms, though with long standing farms like Las Gaitas these visits may only be once or twice a month. Each technician has 10-15 farms they regularly work with, but other technicians or regional supervisors may also visit these farms. In addition, technicians may be called in for specific problems. On most visits, technicians tour the farm, evaluating all crops and checking for signs of pests. Technicians are usually able to visually identify problems, since the same diseases, weeds, and animals are found across regions. If problems are of sufficient severity, technicians will prescribe a pesticide treatment. This prescription is usually made on site, from existing knowledge, though occasionally pesticide packaging will be consulted to confirm dosage or timing. On subsequent visits, technicians will monitor the progress of the treatment and eventually terminate the treatment program. This process is mostly a one-way transfer of information, from technicians to farmers, and farmers usually take the prescriptions at face value and adhere to them.

The process detailed above was described by PdN engineer Eric Gonzalez and corroborated by Las Gaitas farmers. Though the process gives the impression of reliance on chemical control, PdN also promotes cultural control through soil maintenance and crop care, but with limited emphasis on the ecological underpinnings of pest management.

One local innovation described to me was the practice of growing crops in large sacks. Former feed or fertilizer sacks are filled with a 50-50 mix of sandy soil, drawn from nearby the stream on the farm; and compost, produced mainly from coffee husks. The improved nutrient content and structure of this soil have provided good yields to crops like yams and squash. These sacks are a form of raised bed. The inspiration for this method may have been the previous use of raised beds for seedbeds or transplants, where they ensure optimal conditions for seedling germination and development.

The Las Gaitas granja serves an essential role in the community, not only by providing food and income for member families, but by serving as a learning and resource centre. New practices, external and internal innovations alike, are usually tried first on the cooperatively managed land. That way, farmers are better able to work together and share ideas with each other and external agencies when testing unfamiliar or experimental methods, as well as reducing the risk that an individual family would face trying something new. Many practices which are successful employed on the cooperative farm then spread to members' individual lands, and from there to neighboring non-members. Examples include aquaculture, broiler chickens, and cultivation in bags, all of which are becoming increasingly common throughout the town of Las Gaitas. These experiments do not follow the western scientific method, often being multivariable, utilizing qualitative sampling, and rarely being recorded on paper. Nonetheless, the results are discussed amongst the cooperative group and then communicated throughout the community via actions (as noted in Wu and Pretty, 2004; Bentley, 2006). As well, the granja is an important source of materials like organic fertilizer and transplants for member farms, and the greater community to which the cooperative markets their products.

Current pest management practices and perspectives - Pest management at Las Gaitas is through a mixed regime of cultural practices, mechanical control, regular herbicide use and occasional pesticide use. As well, the agricultural landscape on and around the farm may be contributing to pest regulation.

Cultural practices include crop rotation, soil enhancement, utilization of resistant varieties and clean source material (seeds, transplants), water management, field sanitation, and mechanical barriers. The crop rotation varies constantly, with some fields being left fallow and others being utilized repeated for the same crop for a number of years. Still, plants are generally rotated after each crop amongst a set of sites with suitable edaphic conditions. Plant families, pest vulnerability, and nutrient demands are not given much consideration in planning the rotation; rather, crops are moved to sites where they are known to do well, and away from sites where they perform poorly. Soil is enhanced using organic compost amendments, composed mainly of chicken manure and coffee husks (though until a few years ago synthetic fertilizers were used). Most crop residues are removed and composted, while others, like banana and plantain fronds and trunks, are left in the field. Diseased plants may be composted or separated and burned. Raised trays are used to start seedlings and sacks are used for some crops to physically separate crops from pests. Ant, termite, bee, and wasp nests are generally destroyed when seen around the farm, though more caution is taken to destroy nests near the house and some nests may be left standing in the fields.

Cleaning weeds around crops is usually done using machete, hoes, or by hand. Clearing fields to prepare the land for a new crop is often done using broad spectrum herbicides (glyphostate or paraquat, depending on the weeds present), as fallow land rapidly gets overgrown, and even recent beds can get weedy in between crops. Weeding is also done mechanically, with machete or hoe, or by fire, but when weeds are heavy or fire is not viable (certain locations, wet season) herbicides are almost always used for their efficiency. This is the most common use of synthetic chemicals in crop cultivation at Las Gaitas. Cover crops are not currently utilized to reduce weeds, though *Canavalia* was utilized as a cover crop on fallow land over five years ago, upon the recommendation of a PdN technician, but since forgotten.

The use of other pesticides appears relatively limited to treatment for occasional severe pest problems that arise. Limited utilization of pesticides, the decision not to treat minor pest issues, and the adjustment of dosages to meet the severity of the pest problem reveal the utilization of action thresholds, a key IPM concept. Pesticides are often applied with the aid of PdN technicians, who may bring fumigation pumps or safety equipment.

Farmers understand the key concepts of safe and responsible pesticide use. The attitude of many farmers is that pesticides are dangerous and costly, and that “pure” or “natural” production methods are better, but they except pesticide use when deemed necessary by PdN technicians. The threats of human poisoning and environmental contamination are recognized. However, some concepts, for example pest resistance, aren't so familiar to farmers or they don't view as relevant, due to their limited use of pesticides, as well as their limited knowledge of pesticide chemistry. Farmers rely upon technicians to introduce them to chemicals and their use, though after a point, farmers may become acquainted with the use of a certain product and chose to apply it independently of PdN. Botanical pesticides, such as plant extracts, are not used, though some farmers have heard of them and are interested to implement them.

Another way pests are prevented at Las Gaitas is through unintentional management of pest and beneficial insect habitat. Conservation biological control is based upon the maintenance of indigenous natural enemy communities, unlike traditional biological control which involves the introduction of organisms to the agrosystem. High topographic and biological diversity within the farm, in both cropping and edge or fallow areas, provide habitat for natural enemies. Limited pesticide applications on the farm help maintain natural enemy populations, though the same may not be true for surrounding farms. Local landscape dynamics, beyond the farm level, are important for successful conservation biological control, so the practices on surrounding farms may be negating the effect of Las Gaitas' environment management (Tscharntke et al, 2007). Besides the aforementioned habitat management, biological control is not used on the farm.

Small birds, in past an insignificant pest, were a major problem this April. Almost all of the seeds of the current bean and corn crops were eaten by birds shortly after sowing.

DISCUSSION

Approach to IPM Extension

Though not originally part of my project plan, I soon realized that the methods employed when conducting extension play an integral role in determining the success or failure of the project, perhaps even more so than the information trying to be conveyed. Extensionists come from a wide variety of backgrounds, but often, like myself, are primarily educated in academic science, and live lives worlds away from the realities farmers are facing. Smallholder farmers in developing countries generally have had a rural upbringing, with little, if any, formal education (though, of course, this is rapidly changing). Yet, the mind of a campesino is far from an empty void, waiting eagerly to be filled with western scientific knowledge. Campesinos have their own set of agricultural practices, honed over generations, along with unique social norms, power structures, understandings of nature, and language. By continuously building upon my experience in the field, at Las Gaitas and elsewhere in Panama, and making reference to the literature, I iteratively developed my methodology and guiding principles. These methods may be of use to anyone conducting agricultural extension, but have specific relevance for untrained academic students or work in the field of integrated pest management.

Farmer participation - A key decision was to take a participatory approach in the project. This meant not only consulting with the farmers as to how to develop practices, but asking what sorts of practices to examine and at an even more fundamental level, working together to determine how to carry out this examination. Participatory methods have been used and discussed extensively in IPM extension, and for some organizations have become the standard approach (Andrews et al, 1992; Bentley, 2006; Bentley, 2009; Bentley and Andrews, 1996; Bentley et al, 2001; Bergvinson, 2004; Gladstone and Hruska, 2003; Stoll, 2003; FAO, 1997). The farmer field school (FFS) model in particular has been widely praised after a successful start in Asia with rice. FFS approaches usually involve teaching small groups of farmers the ecological fundamentals of IPM via field exercises, throughout a growing season, in order to communicate certain practices and encourage farmer experimentation (Gladstone and Hruska, 2003). Farmers naturally experiment, adapting to changing economic and environmental conditions, for instance the construction of roads, shifting market demand, or the available resources. FFSs are intended to enhance this natural course with new knowledge and techniques, which may then spread within a community (Bentley, 2006; Bentley et al, 2001). Various examples of FFS approaches guided my methods (Bentley et al, 2001; Gladstone and Hruska, 2003).

One driver behind the use of participatory methods in IPM extension in developing countries is the complex nature of smallholder and subsistence agroecosystems. With such a diversity of crops, these farms are not well suited to traditional system-specific IPM research that is applicable in larger, more homogenous agroecosystems. "Farmer protagonist" approaches empower the farmer, seeing them as better able to select and adapt exogenous technologies to meet local needs, whilst maintaining their own useful practices (Andrews et al, 1992; Stoll, 2003). Pest management technicians, such as the technicians of PdN, may facilitate such an approach by providing new techniques, but may also undermine farmer capacity building by nurturing dependency.

Farmers were once central to agricultural research, but scientists have now taken to conducting most of their work in the laboratory, where there is greater control and data recording (Bentley, 2006). Nevertheless, farmers are necessary for the implementation of many IPM technologies, such as biological inputs, inoculative releases, improved plant genetics, and classical biological control. Such an approach, if successful, can be cost effective, because it circumvents many of the complex human interactions of participatory research (Andrews et al, 1992; Bentley, 2006). However, the habitat and crop (cultural) manipulation and conservation methods focused on in this project demand farmer participation in the research stage as well, to determine how these methods may fit within the local context. At Las Gaitas, and at other small farms, experiments are often multivariable, measured qualitatively, and seldom recorded, somewhat contrary to the conventional scientific method (Bentley, 2006; Bentley et al, 2001). In spite of this different methodology, farmer experiments are still valuable, if not essential, to extension.

By involving farmers in creating the project goals, they are more likely to take on active roles in the workshops. On-farm experimentation is costly, requiring time, labour, land, and potentially also the purchase of materials or field inputs (Andrews et al, 1992). Though impossible to say for certain from my experience, I believe that the positive response from the group to the idea of testing green manures and cover crops was due to their pivotal role in pointing our studies towards these methods. Farmers initially expressed interest in reducing herbicide use and to improve the quality of their soils, so I mentioned these tools in an earlier workshop. They requested more information on the subject, so I conducted further reading and then we discussed the methods again and spoke of how they might be directly implemented on the farm. Whether the farmers will follow through is unknown, but I am hopeful, as they clearly recognize the value of these practices.

Finally, collaboration increases farmers' trust in the extensionist and methods. Biological control is not typical of most traditional farming methods, and the idea of beneficial insects is counterintuitive (Andrews et al, 1992). To begin seriously considering the value of biological control methods, farmers must have confidence in the extensionist, who is most often an outsider to the community. I admit the farmers were not immediately sold on the idea of beneficial insects, but the incorporation of this concept into their discourse was apparent in later workshops. As well, the FFS approach of providing farmers with basic information and having them come up with their own solutions makes farmers more likely adopt the general ideas and gain self-confidence, even if their solutions are the same as the recommendations of scientists, literature, or other external sources (Bentley and Andrews, 1996).

Participation is not a panacea however, and certain approaches like FFS are better suited to certain types of work. Bentley (2009) argued that FFS may be better suited to research; for producing coherent, field-tested messages, which may then by spread to a broader audience through other means like radio or larger workshops. The topic of information spread is address below in the Project Evaluation subsection.

As well, there were some obstacles to conducting an entirely "participatory" project, in that not all community members attended or participated in the workshops to the same extent. Complex social dynamics and cultural legacies underlie these issues, but due to limited time in the community, and social sensitivity, they were not genuinely addressed.

Bringing information to life - Perhaps the most important aspect I adopted in my approach was to focus on practical basics and to avoid getting caught up in theory or vocabulary. This is a special challenge for students learned in science at conventional post secondary academic institutions, where the pedagogy is usually the opposite and one acquires an affinity for technical specifics. I had initially thought of this point, and seen it mentioned in literary sources (Bentley et al, 2001; Cave, 1995) prior to the first workshop, but it was only after watching participants flip through magazines or doze off as I tried to explain the importance of understanding pest ecology that I fully grasped this reality. In the discussion of desired types of knowledge and learning styles during the first workshop, farmers reiterated the desire for practical knowledge, communicated through practical examples. Thus, the following workshop when reintroducing IPM fundamentals, I used the example of red wilt in pineapple, which had devastated the current crop on the farm. Red wilt is transmitted by mealybugs, but the farmers viewed the two pests as distinct. As well, ants tend to mealybugs and help maintain them, because the ants feed on the honeydew excreted by the mealybugs. The farmers were able to readily observe all of this behavior (though this is not the case for many pests) and began to think of new ways to combat red wilt, using the ecology of the pests as the basis of their approach, considering what conditions favor ants and how they might be reduced. Connecting each concept with a tangible example helped to “breathe life into information” (Stoll, 2003). Still, it was a constant battle to keep content relevant and captivating and not to slip into academic habits.

I also employed various other means to engage farmers and encourage their participation, some of which originated from or were supported by Bentley et al, 2001, an evaluation of IPM extension by CATIE in Nicaragua. To better communicate concepts and make workshops more active, almost all time was spent walking in the fields, using various crops or pests and other insects as the basis for examples of each idea. Writing and pictures were minimized, instead focusing on dialogue and field examples to engrain concepts in memory. Whenever I thought it was possible, I attempted to have farmers explain their knowledge of a concept before I gave my interpretation, keeping the workshops dynamic and promoting local knowledge and farmers' confidence. Also, presentations were kept short at 1.5 – 2.5 hours, about the limit of both my and their enthusiasm. At the end of each workshop, we would recapitulate the key concepts, giving farmers an opportunity to share their interpretation of the day's lesson, using local terms if they liked. Language proved to be an interesting aspect of my project. Farmers have many local terms, for practices, pests, plants, and most everything else, which are only occasionally the same as the dictionary translation and often are unique to a community or region (Bentley et al, 2001; Bentley and Andrews, 1996). Generally these terms are adequately descriptive, however they may occasionally lead to confusion without further definition; for example, at the outset of the workshops some farmers did not see a clear discrepancy between *hongos* (fungi) and *enfermidades* (diseases) (which may have a variety of causes aside from fungi).

The end of each workshop also served as a time for feedback and to direct future efforts. Asking for suggestions from the group after the workshops worked much better than doing so before. By providing the group with some potential topics gave them a better idea of where we could go, whereas prior to the workshops the farmers appeared lost.

Project personnel - A major obstacle, certainly for me but also for agricultural extension workers in many institutions, is a lack of technically training (Andrews et al, 1992; Bentley et al, 2001). It is advantageous to have farmers develop their own solutions, but a certain amount of supporting knowledge is required to answer farmers' questions and steer them in the correct direction. Due to my limited prior IPM knowledge and time in which to carry through the project, I focused upon basic concepts that have many potential practical applications, for instance crop rotation or natural enemy conservation, and adequately prepared myself in a subject before attempting to teach it. Many resources publicly available through the internet (Infonet-Biovision, USDA's Alternative Farming Systems Information Center, Radcliffe's IPM World, UMass IPM Plan Tool) as well as scientific articles, provide practical and theoretical information for IPM extension.

Another difficulty I had to face was working in a team of one. The FAO (1997) recommends a multidisciplinary team for agricultural extension to provide multiple perspectives, as well as multiple genders to better interact with different segments of the target community. Another advantage of working in a team is the ability to "triangulate" facts by cross-checking answers amongst the group (FAO, 1997). A useful role for one team member to take on is that of "para-anthropologist," to examine the adoption of techniques and why, and to aid in communication within the project and target groups through a third party perspective (Goodell et al, 1990). Working alone and without much formal training in any discipline, I found myself struggling to fill many ancillary roles at once.

Attendance - Due to the chaotic schedules of both the farmers and I, we were unable to establish a regular time for the workshops. When a time was selected for a given workshop, the entire group was not necessarily notified in time to make arrangements to attend, if notified at all. Thus, workshop attendance was mixed, with some people missing certain workshops. The large temporal spacing between workshops also disrupted continuity and led to members who had attended the meetings to forget elements of what we had covered. To compensate, at each meeting I had to a) reintroduce myself and the project; b) reiterate (or have participants reiterate, preferably) key concepts or term definitions; c) incorporate content not heavily dependent upon prior knowledge. With more grounding in the community, extensionists may be able to better schedule events with the participants. Nonetheless, extensionists should be prepared to work with inconsistent attendance.

Project Evaluation and Limitations

Through the course of the workshops, farmers learned relevant IPM practices and concepts, which they may apply in their crops in future to reduce labour, pest damage, and chemical use. We also made a more concrete plan for the utilization of green manure cover crops, which if implement, will also benefit the long-term productivity of the farm by improving soils. Still, due to the short time frame of the project and the lack of follow-up, it is not possible to assess what knowledge farmers retain or apply. Some of the concepts I introduced in the workshops were only supported by a couple of potential field examples and remained more-or-less conceptual. The interest created by the project may lead to farmer experimentation to develop functional techniques based on these concepts or requests to supporting organizations, like PdN, for more information, but it also may be lost with the passing of time, Farmers appeared eager to try some of the new practices, and changes in farmers' perspectives are visible, especially with regards to natural enemies. Many of the practices we have discussed have not been utilized at Las Gaitas. Even the most reliable practices in the lab, similar field tests, or even on the same farm may not be successful in a given application due to an infinite number of ever-changing variables. Thus, time will be the test of the practices we have planned. The farmers have a predicted set of results they expect to see over time from the implementation of green manures, cover crops, and some of the other practices discussed. Depending upon the results observed, farmers will adapt management practices accordingly, maintaining, altering, or discontinuing the plans we created (Menalled et al, 2004).

The approach I took to the work appeared to be effective in engaging the group and stimulating their exploration of IPM. Throughout the course of the project I had the opportunity to meet about three quarters of the members and discuss the project. By the end of the project, most members appeared interested in the subject of IPM, felt it relevant, and liked the teaching approach I had taken. However, when the last workshop had to be quickly rescheduled and I passed through the town with the president of the granja to tell them the new time, some individuals appeared to have little interest in attended; albeit, the meeting was rescheduled for 6PM that evening and it was already 5PM.

Limitations - One shortcoming of the project is its limited scale of impact, being more or less limited to the small community of Las Gaitas. Farmers often don't share information from FFS, not only because the information is complex and new, but because there is no place to conveniently do so (Bentley, 2009). Perhaps a project at a higher level within PdN administration could have had a wider area of impact, but given my limited resources, in terms of time and expertise, the scale applied may have been appropriate. Furthermore, as discussed in the Results section, the cooperative at Las Gaitas is a gathering place for people and ideas, and even if ideas are never communicated orally, farmers closely observe the actions of their neighbors.

A debatable issue is that Las Gaitas was already an exceptionally well-off farm, compared with many others in the Grandes Pasos program. In general, Las Gaitas is more organized, knowledgeable, and has higher membership, in part due its age and accessibility. As well, pesticides, though still used, were viewed negatively and alternatives were being sought. The farm was selected for me to work with because of their good organization, prevalence of horticultural crops well suited to IPM, accessibility, and experience with foreigners. All of these were good reasons for me to work there and seemed to help my project. Furthermore, the repetition of concepts the farmers may already be familiar with is not necessarily a bad thing, as was proven with *Canavalia*, which they had used years before but did not regard with much value at the time and forgot, only to be reminded of by the workshops and acquire a restored interest in.

The value of the research component of this project, outside of the purpose it served in developing the workshops, is also limited due to its small spatial scope. The agricultural practices of farmers vary household to household between members of Productores Unidos de Las Gaitas, and still greater variance exists across communities and geographic regions, so the description of practices at Las Gaitas is by no means universal, even for the community in Las Gaitas. However, the interactions between PdN technicians and farmers are similar on many other PdN farms, and so an understanding of this relationship may prove useful for future work by or with PdN. As well, the discussion of extension methods has broader relevance in Panama, Central America, and developing countries around the world.

The short and sporadic periods of time available to work on the project impair the continuity of the work. During the project, meetings with farmers were intermittent, and I only had limited time within the community, leading to somewhat hurried attempts to gather information and present the workshops. Additionally, the project lacks any sort of direct follow-up. Fortunately, long-standing ties between the farmers and PdN ensure some degree of continuity, as PdN technicians will be able to provide support for the implementation of practices discussed or planned for in the project.

The limits to my personal knowledge of IPM prior to the project hindered the pace of the work, and ultimately the depth of the project. I had to dedicate much of my time to secondary research on IPM techniques, whereas if I had already possessed this knowledge we might have been able to conduct more workshops and implement practices at an earlier stage.

Conclusions - Through participatory workshops, I have transmitted some fundamental aspects of IPM to the farmers at Las Gaitas. The farmers are equipped with the knowledge necessary to employ green manure cover crops, amongst a wide variety of other practical tools which were studied to various degrees. The basic framework of IPM and a greater understanding of pesticides and pest management in general, will help the farmers pursue better pest management options independently and with PdN technicians. The information gathered on the practices at Las Gaitas serves mainly to understand the origins of practices and the interactions of farmers with PdN, as related to pest management. The discussion of extension approach stands to aid future agricultural extension practitioners, including McGill/STRI Panama Field Study Semester students. Finally, this project has also provided me a truly interesting and practical educational experience.

RECOMMENDATIONS

Students working in any internship requiring coordination with other parties should try to plan and confirm events and meetings in advance, and to get the contact information of various potential connections, in case one is unavailable or unreliable. These points are particularly relevant when working with PdN, because technicians and administration are often in the field and out of cell phone service, as are farmers, of course.

Due to delays in arranging meetings and a field tour, my project got a slow start. Throughout January and the start of February, work days were spent trying to arrange meetings with PdN and meeting with CEASPA, as a potential backup internship. A prospective initial topic (IPM) was only selected on Feb 11, after a field trip to the Las Lajitas granja, also in Capira. The focus of my project and the site were selected over the following 10 days and the project proposal was only approved by PdN on Feb 22. Thus, I only really began my work almost two months into the program. All worked out in the end, but I would recommend finding a backup internship early in the semester, so that changing internships is not a huge issue, if necessary.

Though my project did incorporate some primary research, and lots of secondary research, it was not principally a research project. However, there are many interesting topics for scientific research in the field of pest management in Panama, for instance studies examining the relationship between pesticide use, yields, farmer income, and/or education, or surveys of human health and pesticide use, or of natural enemies in the agroecosystem. Such studies could be based in the community of Las Gaitas, or explore a greater geographic area by working with various communities with Grandos Pasos granjas.

For a student interested to work in a similar theme as my project, I would suggest conducting more research on existing extension projects and IPM in Panama. Though I was told there is little work on IPM in Panama outside of academia, this may not be the case, and other development agencies may be able to provide valuable resources. As well, following up on the effects of my project in Las Gaitas would certainly be useful, and perhaps the workshops could be continued there, or my workshops applied elsewhere.

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APPENDIX A – WORKSHOPS

The following are written outlines of the workshops given at Las Gaitas. The outlines were initially intended to help me guide the events, but after the 2nd workshop farmers requested copies for themselves, so some slight modifications were made for clarity. These documents are only outlines, and additional elaboration, and most importantly, responses from and discussion with the farmers, are missing. The project progression is visible in the changing plan and type of content through the workshops.

TALLER DEL 24 DE MARZO

Introducción personal

Introducción del proyecto

Objetivo

Desarrollar más sus conocimientos y capacidad hacer decisiones independientes para manejar problemas de plagas.

Proceso

Proyecto sobre manejo integrado de plagas (MIP), más específicamente:

1. A Las Gaitas qué tipo de manejo de plagas se aplican actualmente o en pasado
    - buscar el origen de las practicas
2. qué tipos de manejo de plagas existen (énfasis en practícales) y que es MIP
3. cuáles son los problemas de plagas que molestan mas en Las Gaitas
    - identificación de insectos y hongos
4. qué tipos de manejo de plagas puede aplicar a esas problemas
5. cuáles son los costos y beneficios de varios métodos específicos de manejo de plagas
    - análisis económico
    - salud
6. capacitación de los granjeros para implementar algunas prácticas y como a evaluar y/o educación ambiental
7. evaluación de cualquier practicas que implementamos

Principales

Quiero a hacer todo de esto con el objetivo final de mejorar la nutrición y la autosuficiencia de las familias que viven en la granja. Como parte de esto yo intento a:

- trabajar juntos con los granjeros en una manera inclusivo y personas otra parte de los lideres
- aprender los necesidades y valores de las familias y determinar sus prioridades
- trabajar principalmente a responder a esos necesidades, no solo a hacer un articulo académico

Evaluación del grupo y charlar de objetivos

¿Qué piensan de esto proyecto? ¿Está en acuerdo con sus prioridades? ¿Qué necesitan? ¿Qué tipo de conocimiento?

¿Qué es manejo integrado de plagas?

¿Qué conocen?

MIP es un acercamiento/enfoque controlar los problemas del producción que viene de las plagas. Énfasis de MIP es el control de plagas, no necesariamente el eliminación completo - ¿Por qué? Sano, barato, y menos trabajo.

Proceso tradicional:

1. observación
2. identificación
   a. ¿Qué tipos de plagas existen? Plantas, insectos, enfermedades (hongos, bacterias, virusas)
   b. Importancia de entender la manera de vida de las plagas
3. Control (nivel de daño aceptable)
   - practicas preventivitas (rotación, labrar, asociación de plantas)
   - métodos culturales
   - control mecánico
   - control biológico
   - pesticidas (natural y químico)
4. Observacion, proceso continuo

TALLER DEL 25 DE MARZO

(frases subrayadas son preguntas para ustedes)

1. **Repetición de introducciones personales**
2. **Repetición del introducción del proyecto**
    a. Objetivo principal: desarrollar más sus manera de pensamiento para aumentar sus capacidades a hacer decisiones independientes para mejorar problemas de plagas
    b. Plan del proyecto
        i. Talleres practícales sobre la tema de manejo integrado de plagas (MIP)
        ii. Estudio de las practicas de manejo de plagas y problemas de plagas actuales
        iii. También, estudio de los interacciones entre de los técnicos o organizaciones extérnales y los granjeros, sus estilo del aprender, sus innovaciones
    c. Descripción de MIP
        i. Acercamiento basado en ecología, énfasis en control – más fácil y eficiente
            1. ¿Qué es ecología? – el estudio de cosas viviendo
                a. Por ejemplo (p. ej.) en nuestro caso: como viven los plagas, como mueren, como es el ambiente en el campo
        ii. Normalmente conforme al proceso: observación, identificación, control y evaluación continuo
            1. Duro, enfocado en métodos científicos
        iii. Verlo como acercamiento holístico, para incluir todos los métodos de control
    d. Etapas del proyecto
        i. Talleres:
            1. Tiempo limitado - énfasis en ejemplos prácticas, y problemas y cultivos actuales en lugar de mucho conocimiento teorético
                a. Solo voy a discutir bastante teoría para comprender las practicas
    e. Comentarios del grupo
        i. ¿Qué piensan, sus prioridades, tipos de conocimiento?
3. **´Action thresholds´** – umbral/nivel básico de acción, solo responder cuando hay suficiente daño
    a. ¿Siempre hacen algo cuando veas un plaga?
    b. ¿Qué tipos de medición puede aplicar para identificar si control es necesario?
4. **Control** - Métodos preventivas
    a. Basado en buscando los puntos débiles que permiten el crecimiento de las plagas

i. p. ej.: eliminar comida o casa del plaga
1. Si no puede, a hacer distracciones o reducir el impacto
ii. Para hacer esas cosas, necesitamos a saber un poco del manera de vida de los plagas - es en este manera que MIP es basado en conocimiento ecológico

Métodos preventivos - ejemplos (en campo – ubicación en *itálicos*)

1. Creer condiciones optimas para el crecimiento de los cultivos (*culantro*)
    a. Porque: reducir el estrés → reducir vulnerabilidad a plagas
    b. Como: suelo saludable, suficiente (no demasiado) abono y materia orgánica, acidez (pH), sol/sombra, humedad
2. Creer condiciones malas para el crecimiento de las plagas (*mismo sitio*)
    a. tener cuidado con la locación y tiempo en que pone abono (especialmente nitrogeno)
    b. creer sombra para prevenir malezas
        i. **p. ej.** sembrar en triángulos, no filas
        ii. **p. ej.** intercalado con plantas de hojas anchas (Canavalia)
    c. **p. ej.** 'camas altas' para prevenir condiciones humidades que beneficiar enfermos, p. ej. mildiu en pepino
    d. **p. ej.** arroz de fangeo: para prevenir mosquitos drenar el agua para morir los huevos antes de nacen
3. Rotación (*guandu*)
    a. Porque:
        i. eliminar huéspedes (host) de plagas que necesitan el cultivo para vivir (ponen huevos, alimentan, refugio)
    b. Cuales plantas – no están estrechamente relacionados o similar tipo de planta, como papa y tomate (de la familia Solanaceae) o zapallo y pepino (la familia Cucurbitaceae)
    c. También, puede retornar fertilidad al suelo, no toman los mismos nutrientes
        i. **p.ej.** frijoles (legumbres) para nitrógeno
    d. ¿Es posible con yuca?
4. Eliminar plantas voluntarias (plantas que no siembran pero crecen independiente) (*plantas del maíz al lado de piña y frijole*)
    a. Pueden servir como hospedador a una plaga cuando el cultivo no está allí (el objeto del rotación)
    b. Beneficios? Cosecha adicional? Realmente no
5. Intercalado o policultivo – mescla de dos o más plantas en lo mismo sitio (*mismo*)
    a. Reducir malezas entre de los cultivos
    b. Agregar nutrientes (legumbres)

        c. Cultivo de cobertura para abono verde o cosechar
            i. **p. ej.** guandú (o muchos otros legumbres como frijoles de behuco) y maíz
6. Matar malezas antes de granar (granar = distribución de semillas) (*mismo*)
    a. Funciona bien con malezas duras a quitar
    b. Requiere observación
7. Siembran temprano o tarde
8. Utilizar buenas semillas o trasplantes (de semilleros) (*piña*)
    a. ¿Que son? Semillas sin enfermedades y/o con resistencia a plagas
        i. **p. ej.** limpio trasplantes de plátano, sin broma
    b. Si semillas limpias no están disponible, tratamiento de semillas es un opción
9. Minimizar daño a enemigos naturales (varios hormigas, avispas sociales, otros insectos, arañas, ranas, aves) que comen o matan los plagas (insectiles) (*al lado de la casa*)
    a. Como:
        i. Reducir el uso de pesticidas, especialmente ellos no selectivo
            1. Enemigos naturales son vulnerable a insecticidas también, a veces más que los plagas porque son pequeños
        ii. Evitar la destrucción de nidos de avispas, aves
    b. También puede atraer enemigos naturales
        i. Producir buen hábitat o alimentar
            1. Agua con azucar
10. Sanidad básico (*donde estuve pepino*)
    a. De herramientas
    b. Trabajar en zonas infectados ultimo para no propagar la plaga
    c. Abonar/composter bien materia orgánica
        i. Para matar malezas, huevos de insectos, hongos, bacteria

Ventajas:
1. Cuestan poco – puede aplica a cultivos de bajo valor
2. Poco riesgo
3. No matan insectos beneficios

Desventajas
1. Casi ningún
2. No tan efectivo a eliminar un problema actual
3. Requiere planificación a largo plazo
4. Requiere conocimiento de la ecología de las plagas, cultivos, enemigos naturales, ambiente

TALLER DEL 31 DE MARZO

Familias de plantas

Por un buen rotación, es importante que no siembra cultivos de la misma familia (genética) año a año. Frecuentemente, plantas de una familia tienen problemas con las mismas plagas. Un objetivo de rotación es eliminar huéspedes potenciales para una plaga. Papas y tomates parecen muy diferentes visualmente, pero ambos pueden sufrir del tizón (un hongo), y de hecho, los dos son de la familia Solanaceae.

También, plantas de la misma familia toman los mismos nutrientes del suelo. Si siembran diferentes tipos de cultivos año a año, darle la tierra la oportunidad de recuperarse.

Algunos granjeros dicen que es necesario esperar 7 años entre de siembran plantas de la misma familia en lo mismo sitio, pero es un poco extremo. Todavía, es esencial considerar la familia de planta.

Parte de esta tabla es solo para sus curiosidades (¡no puede hacer rotación con naranjo!)

- Poaceae
    - Arroz
    - Maiz
- Euphorbiaceae
    - Yuca
- Rubiaceae
    - Café
- Apiaceae
    - Apio
    - Culantro
- Musaceae
    - Plátano
    - Guineo
- Cucurbitaceae
    - Pepino
    - Zapallo
    - Chayote
    - Melon
- Bromeliaceae
    - Piña
- Fabaceae
    - Guandú
    - Habichuela
    - Frijol bejuco
- Rutaceae
    - Naranjo
- Alliaceae
    - Cebolla
    - Aji
- Dioscoreaceae
    - Ñame
- Anacardiaceae
    - Mango
    - Marañón
- Solanaceae
    - Tomate
    - Papa
    - Pimiento
- Araceae
    - Ñampi

Control químico – Uso responsable

1. Porque:
    a. la salud humana (muchos químicos son tóxicos no solo a plantas, insectos, o hongos, pero también a seres humanos – y algunas químicos quedan en el agua, el suelo, y el comida)
    b. el costo económico
    c. prevenir daño a enemigos naturales (insectos y animales que matan plagas)
    d. prevenir el desarrollo de resistencia en las plagas (plagas se acostumbran a pesticidas y los pesticidas no funcionan para eliminarlos)
        i. mantener la utilidad de los pesticidas (no hay un ilimitado cantidad de pesticidas efectivas)
2. Que es uso responsable (y elementos de seguro): a usar pesticidas:
    a. cuando necesario
        i. ¿ha explorado alternativas?
    b. leer la envase
        i. la mayoría de información importante está allá
    c. en la manera más eficiente, para reducir la cantidad requiere
    d. en la cantidad y concentración requiere
        i. no necesariamente el dosis recomendado en el envase, pero cuanto es necesario para prevenir daño inaceptable
    e. evitar zonas sensibles (como cerca de corrientes, casas, escuelas)
    f. aplicar pesticidas selectivos para prevenir daño a otros organismos (enemigos naturales, otros animales, los cultivos)
        i. metomil, permetrina no afectan mucho depredadores
    g. aplicar diferentes tipos de pesticidas para prevenir resistencia
        i. fungicida de contacto / sistémica
    h. solo utilizar productos legales
        i. productos son ilegales porque son demasiado peligrosos
3. Uso seguro: a usar pesticidas:
    a. de acuerdo a las instrucciones de seguridad (precauciones especiales, equipa de protección)
        i. ¿siempre es posible? ¿tienen el equipo?
        ii. Equipa de protección mínimo cuando aplican pesticidas: mangas largas, pantalones, guantes de goma, protección para los ojos, botas de goma
    b. conocer los síntomas de intoxicación (en envase)
        i. si tiene problemas, ir al hospital
    c. sanitación
        i. lavar la bomba después de cada uso

        ii. no utiliza envases de pesticidas para otras cosas
    d. evitar el consumo de pesticidas
        i. lavar manos después de la aplicación
        ii. lavar o pelar verduras antes de comer
4. Uso eficiente (ejemplos de posibilidades):
    a. Dar tiempo para secado del pesticida después de aplicación (planar alrededor de la lluvia y riego)
    b. Tratamiento de punto (solo en el sitio del plaga)
    c. Tratamiento del semillas o trasplantes

Experimentación

1. ¿Qué es un experimento? Es posible que cualquier cambio a las prácticas que aplican en su tierra es un experimento. El objeto de un experimento puede estar para:
    a. aprender algo, demonstrar la realidad de algo o probar un idea (como un método)
    b. Frecuentemente el objeto no es claro, y el experimento es inintencionado/inconsciente, pero para adaptar como es necesario para los circunstancias (como el tiempo/clima o la exigencia del mercado)
2. ¿Ustedes hacen experimentos, ahora o en pasado?
    a. ¿Donde hacen (p. ej. en tierra de la cooperativa o tierra privada)?
    b. Explícame el proceso:
        i. ¿de dónde viene las ideas de los experimentos? (programa de desarrollo como PdN, vecinos, tradiciones, observaciones personales, envase o vendedor de pesticida, sueños)
        ii. ¿escriben algo? (diseño, métodos, resultados, sus ideas personales)
    c. Después del experimento:
        i. ¿discuten o comparten los resultados?
        ii. ¿cambian sus prácticas de acuerdo con los resultados?
        iii. ¿hacen más experimentos en el mismo tema, usando los primeros resultados?
3. Creación de experimentos:
    a. ¿De los métodos o técnicas que hemos discutido hay alguno que están interesado en? ¿Existe algún método ustedes no están seguro de que les gustaría probar? ¿Podemos diseñar un experimento para probarlo?
    d. Proceso (posible – basado en método científico, pero no es perfecto):
        i. Objetivo – que queremos saber o probar
            1. Resultados esperados (hipótesis – explanación de porque esos resultados)
        ii. Diseño – como hacerlo

    1. Donde, cuando
        a. ¿Parte de los cultivos normales o separados?
    2. Cuantos variables

iii. Observación
    1. Medición – con números (de insectos, quintales o libras de la cosecha), palabras (‘muchos/pocos insectos’, bien/malo), fotos/dibujos

iv. Evaluación de los resultas
    1. Intentar explicar los resultas
        a. ¿Por qué fue en esta manera?
        b. Problemas posibles con el diseño
    2. Significancia de los resultas
        a. Aplicación en prácticas generales de la granja
    3. Preguntas y experimentos futuros

TALLER DEL 19 DE ABRIL

Intercalado / abonos verdes / cultivos de cobertura

1. <u>¿Qué es intercalado o policultivo?</u> – mescla de dos o más plantas en lo mismo sitio
2. <u>¿Qué son abonos verdes?</u> – plantas que cultivan no para cosechar, pero para cortar y poner sobre el suelo o arar y incorporar en el suelo o compostar
    a. <u>Objetivos</u>:
        i. aumentar **el suelo** (materia orgánica, raíces mejorar estructura, nutrientes de profundo en la tierra o del aire si legumbres)
        ii. reducir malezas
        iii. reducir daño de plagas
    b. **Mulch**: **mantilla** / cubrir con mantilla – cuando cortan y quedan materia de plantas sobre el suelo (hojas, partes verdes de un planta, residuos de poda)
        i. mantener humidad en periodos secos
        ii. mantener el tiempo del suelo
        iii. reducir malezas (hojas de bala / madera negro tienen químicos que reducen malezas y insectos)
        iv. bien hábitat para depredadores como arañas y escarabajos de tierra
        v. con algunas mantillas (*Mucuna*), puede sembrar directamente en la mantilla, sin labrar
3. <u>¿Qué son cultivos de cobertura?</u> – plantas que siembra para que no hay suelo desnudo
    a. <u>Objetivos</u>:
        i. reducir erosión del viento y lluvia
        ii. reducir la pérdida de nutrientes a la lluvia
        iii. reducir malezas (sombra, competición para recursos, emisión de químicos que previenen el crecimiento de otras plantas)
        iv. mejorar condiciones para insectos beneficiales (ambiente más constante)
4. <u>¿Qué es la diferencia entre de abonos verdes y cultivos de cobertura?</u>
    a. realmente, abonos verdes son cultivos de cobertura también, objetivos coinciden
    b. también en los dos es posible producir una cosecha para el consumo
5. <u>¿Cuándo utilizan abono verde o cultivos de cobertura?</u>
    a. juntos con un cultivo (intercalado)
        i. depende en las plantas si es necesario dar espacio adicional cuando siembran
        ii. produce sombra entre de los cultivos, entonces reduce malezas

b. durante un período improductivo / en barbecho de rotación
    i. más fácil limpiar el campo para el próximo cultivo
    ii. puede aumentar el suelo con legumbres y reducir erosión
6. <u>¿Qué tipos de plantas puede utilizar?</u>
    a. si no producen algo para consumo o vender, es importante que la planta es fácil y barato para producir.
        i. ya tienen o puede recoger semillas, o son disponible para comprar barato
        ii. cultivación es sencillo, no requiere mucho esfuerzo
        iii. crecimiento rápido es otro bien característica
    b. Guandú
        i. Raíz principal profundo, trae nutrientes y agua de profundo en la tierra → poco competición con otras plantas si usan intercalado
        ii. Planta perenne → puede sembrar con otro cultivo, cosechar el otro, y guandú queda para proteger el suelo
        iii. Puede cultivar para el consumo, o matar antes del floración y
    c. Caupí - cowpea (*Vigna unguiculata*)
        i. Bien para el consume
    d. Jack bean (*Canavalia ensiformis* o *brasiliensis*)
        i. Puede consumar
    e. Frijol terciopelo - velvet bean (*Mucuna pruriens*)
        i. Crece bien en suelos acidicos y arcillosos
        ii. Crece muy rápido, entonces siembra después del cultivo (con maíz normalmente siembran 45 días después, cuando el maíz es a la altura de rodilla
    f. depende en la planta, es necesario matar el cultivo de cobertura antes de granar o puede convertirse en una maleza
7. Experimento
    a. <u>¿Cuáles aplicaciones esos técnicas pueden tener aquí? ¿Probamos?</u>
    b. Nota que los beneficios al suelo no necesariamente van a aparecer inmediatamente, pero tienen efectos en el largo plazo
        i. Sin embargo, muchas personas reciben mejoras lo mismo año

<u>Notas sobre algunas plagas que hemos encontrado</u>

1. cochinilla harinosa en piña (el causa del marchitez):
    - inmersión de trasplantes en agua caliente (50-55°) para 30-120 minutos mata los insectos y huevos
    - controla hormigas que cuidan de las cochinillas
        - labrar antes de siembra

2. broma de plátano y guineo:
    - pelar el tranplante (la rizoma y la funda / parte bajo de la hoja)
    - inmersión de trasplantes en agua caliente (50-55°) para 20-30 segundos

- para 1 y 2: todavía, la cosa más importante es utilizar materiales limpios porque esos métodos no cien por ciento efectivo

APPENDIX B – QUESTIONAIRE ON PRACTICES

The following questions were asked to several farmers to gather information on the current and historical practices on the farm. When possible, the survey was conducted whilst touring the fields to make the experience more tangible for both interviewee and interviewer.

- ¿Qué cultivos tienen? – para cada uno:
    - Cuenteme de su trabajo con eso cultivo
- ¿Cuáles plagas afectan este cultivo?
- ¿Cuáles de esas plagas molestan más? – para cada uno:
    - ¿Cómo es?
    - ¿Qué danos hace?
    - ¿Cómo vive?
    - ¿Cómo se muere?
        - p.e. ¿Qué tipos de control usa?
- Cambios tecnológicos: ¿qué cosas hace ahora que no hacía antes?
- Origen: ¿cómo se le ocurrió hacerlo? (por ejemplo: vecinos, PdN, sus propios experimentos, padres, tiendas, envase)

APPENDIX C – CURRENT CROPS

Name (English) (Spanish) (binomial)	Pests, local management practices, notes
Rice Arroz *Oryza sativa*	-Always grown in paddies (though farmers in surrounding hills will plant upland varieties in slash-and-burn rotation), believed to promote disease. -3 harvests annually. -Most years, the crop is affected by stemborer caterpillars or bacterial leaf yellowing, which lead to reduced yields. When severe, fumigation is used
Yuca / cassava Yuca *Manihot esculenta*	-Hardy, requires little management. -Leaf-cutter ants (*Atta* spp. or arriera in Spanish) attack leaves, resulting in a hard and inedible root. Hormitox insecticide is sometimes applied. -Termites may attack roots, hard to detect or control.
Coffee Café *Coffea robusta*	-Shade-grown -Some mealybugs, may be due to insufficient shade, however does not majorly affect harvest as it only feeds on fruit pulp, not the bean -Not yet affected by coffee berry borer (broca) -Seedlings provide income
Plantain Plátano *Musa* spp.	-Banana weevil (broma), *Cosmopolites sordidus*, grub attacks rhizome and then moves up through pseudostem, weakening plant anchorage. Usually spreads from infected suckers – suckers further from mother are more often diseased. Suggested sucker paring and hot water treatment.
Banana Guineo *Musa* spp.	-Same as plantain
Cucumber Pepino *Cucumis sativus*	-Planted in better drained, upland sites to avoid mildew and leaf spot promoted by humidity -Minor problems this year with mosaic virus and leaf spot at end of season, likely because these plants were transplanted too small
Pineapple Piña *Ananas comosus*	-Have cultivated in past without issue, however either diseased transplants or repeated cultivation on the same land has led to widespread invasion of mealybug (cochinilla harinosa), *Dysmicoccus brevipes* which spreads red wilt (marchitez) and creating small, unmarketable fruits. Chemical control has been unsuccessful – prevention is needed. Suggested hot water treatment and deep tillage to reduce ants prior to planting.
Pigeon pea Guandu *Cajanus cajan*	-Mainly use perennial varieties -Potential for use in intercrops, green manure

Name (English) (Spanish) (binomial)	**Pests, local management practices, notes**
Green bean Habichuela *Phaseolus vulgaris*	
Various beans Frijoles Various spp.	-Potential for use in intercrops, green manure
Maize Maiz *Zea mays*	-Local climate is not great for available varieties
Onion Cebolla *Allium cepa*	-First year of cultivation -Seedlings provide income
Ice-cream bean Guaba *Inga edulis*	-Used as canopy tree over coffee, leaves provide nutrients to understory (N-fixing legume)
Soursop Guanábana *Annona muricata*	-Various pests attack ripening fruit on tree, usually ants. Suggested protection using sticky traps wrapped around limbs.
Chayote Chayote *Sechium edule*	-First year of cultivation
Culantro Culantro *Eryngium foetidum*	
Orange Naranjo *Citrus* x *sinensis*	-Seedlings provide income
Garlic Aji *Allium sativum*	
Yam Ñame / yampi *Discorea* spp.	-Sometimes grown in sacks
Squash Zapallo *Cucurbita* spp.	-Sometimes grown in sacks

Name (English) (Spanish) (binomial)	**Pests, local management practices, notes**
Taro Otoy *Colocasia esculenta*	
Celery Apio *Apium graveolens*	-Seedlings provide income
Coconut Coco *Cocos nucifera*	
Mango Mango *Mangifera indica*	
Peach palm Piba/pixbae *Bactris gasipaes*	