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22 February 2008

Integrated Pest Management in the United States and Venezuela

The price of gas is on the rise as we continue to deplete our oil reserves at unsustainable rates. This has many severe consequences for our daily lifestyle, not to mention the negative effects on the environment. One of the factors that will be affected, upon which we are totally dependent, is our food. On average our food travels 1,500 miles to get to our dinner plates, meaning a significant amount of gas goes into the transportation of our food, therefore raising the price of food. For this and many other reasons, consumers and farmers alike have launched a food revolution that focuses on land stewardship and the cultivation of healthy foodstuffs for both humans and the environment. Another key component of this movement is an ever-increasing interest in sustainability and the desire to know the manner in which a crop was grown. Although, our nation fails to pay homage to the farmer, we cannot survive without him.

If we continue to farm conventionally we will incur the costs of restoring the health of the land. A surefire way to ensure that we have a future in food production is to adopt more sustainable farming practices. More often than not, sustainable farming involves organic agricultural practices. An important aspect of sustainable, organic farming is integrated pest management (IPM). IPM consists of a variety of methods

farmers use to control insect and weed pests in their fields. Vandermeer outlines the goal of IPM in laymen terms: “The key ideas, originally articulated by vandenBosch (179) were extremely simple: 1.) Don’t spray poisons unless it is necessary and 2.) Manage the ecosystem in such a way that it doesn’t become necessary” (Vandermeer, 203). Physical, biological and chemical controls are types of IPM practices used by farmers. Chemical controls are typically seen as a worst case scenario and are implemented as a last effort to eradicate pest issues. A few examples of these methods are crop rotation and row cover (physical), the introduction of beneficial insects (biological) and organic pesticides (chemical). This paper serves as a comparison of the integrated pest management strategies utilized by sustainable farming operations in the United States and Venezuela.

On sustainable, organic farms the objective is to avoid the use of chemical agents to control pests in the fields. The first step in addressing pest insect issues is to identify the pest affecting the crop, its life cycle and the conditions under which it thrives. The NOFA Handbook Series Vegetable Crop Health’s “Plant Pest Triangle” is a model for determining the susceptibility of a crop to damage from pests. The three factors involved in assessing the health of a crop and potential for pest damage are the susceptibility of the host, the environmental conditions and the presence and pressure of the pests (NOFA, 8). Once the pest and its characteristics are identified it is easier to address the problem by finding an appropriate solution specific to the pest crop and environment. The key component of IPM is having a solid understanding of the interrelationships between the environment, the crop and the insect. “For pest management to be effective, agricultural scientists must adopt an interdisciplinary approach to solving problems; this means

considering not only complexes of pests involving insects, pathogens, and weeds, but whole crop systems" (Giese, 1047).

In most circumstances, the best way to avoid pest issues is to maintain a healthy agricultural ecosystem. Some ways to ensure the health of an agricultural system is through the use of crop rotation, cultivating polycultures, maintaining soil health and fertility through the use of compost, the use of cover cropping, and encouraging the presence of beneficial organisms. A farm is a disturbed ecosystem and the closer it is to functioning like a natural system the less likely pest problems will persist. "Rudd (1964) urges pest control through ecological management and states that this 'depends on reversing the trend towards environmental simplification,' and that 'practical measures rest on the retention of diversity and conscious restoration of more complicated ecosystems" (Way, 30). The more a cropping system resembles nature, the less likely pest problems will arise. If an agricultural system resembles a natural environment and pest problems occur to a degree in which they have the potential to drastically affect the overall crop yield, it is necessary to employ one or more integrated pest management strategies.

Physical controls involved in Integrated Pest Management tend to alter the physical state of the fields. Crop rotations prevent pests from having a stable environment and host plant. It also helps rejuvenate the soil structure, which makes the plants healthier and thus less susceptible to pests. By rotating crops, the soil has a chance to replenish the nutrients it lost by being the host to a different crop with different nutrient needs. It also introduces new roots systems which helps combat soil compaction issues and contributes to soil fertility. Changing the crop sequence will also help reduce

pest issues. In the case of a monoculture the insects can return there every growing season knowing a certain crop will be there. When the crops are rotated it throws off the pest population because the new crop is no longer a suitable host and the population must relocate. Rotating crops also provides a buffer of time before other pests locate the new crop. When crops are rotated typically the soil is tilled again or disrupted in some way which helps to expose pests to birds and other predators (Fouche, UC). In many farming systems, crop rotation is one of the most effective means of pest control.

Diverse systems invite a variety of species to the field which encourages predators which will control pest populations. The use of trap crops attracts pests, keeping them away from the cash crop. The trap crop is planted specifically to deter pests from harming the primary crop. Figuratively speaking it is sacrificed for the sake of another crop. An example of a trap crop is buckwheat. Stink bugs are attracted to this crop when it is in seed, which if coupled with a cash crop like tomatoes, can deter stink bugs from feeding on the fruit of the crop. Another advantage of buckwheat is that its flowers' pollen attract bees and wasps, and more importantly, tachinid fly parasitoids. These parasitoids are predators of stink bugs and will also help control their population (Mizell, ufinsect).

The practice of seed saving and plant selection ensures the farmers that they are growing crops that are strong, healthy and are best suited for the conditions in a particular field. The seeds of the plants that produced the most fruit or the plants that seemed to withstand the effects of the pest insects best are collected and saved for the following growing season. In doing so, the seeds planted the next season have traits and characteristics that are best suited for the climate and soil type of the farmland. Seed

saving reduces the need to rely on more intensive forms of IPM. Maintaining good soil structure and fertility is another way to give the crops an added defense against pest insects because healthy soil means healthy plants. Just like healthy humans are more likely to fend off illness, healthy plants are more likely to be resistant to damage caused by pests. A key component of integrated pest management is striving towards sustaining a healthy system as the most basic and most important form of pest control.

In addition to planning methods of physical control, physical barriers can be emplaced to help defend crops. The use of row covering aids in preventing pests from reaching the plants. Row cover can be a type of netting or cloth that provides crops with a physical barrier from pests. The cover allows sunlight and water infiltration but does not allow the pest to have access to the plant. Colored sticky traps are another option as some insects are attracted to color. In a small scale setting sticky traps can be a successful means of pest control and scouting. Another method of physical control is the manual removal of pests. It is very time consuming but it is a guarantee that the insects have been removed from its host.

Scouting, also on a small scale operation, can be an effective way of eliminating pest issues. Scouting is a key component of integrated pest management. This technique involves the farmer observing his crops and the pests present on his crops. This is tedious and time consuming but it is really educational for the farmer. They are able to see firsthand the damage the pests are causing and based on the health of the plant are perhaps able to deduce why the plant is under siege. The farmer also gains a better idea of what specific pest is feeding on his crops and an estimation of their population. It also gives the farmer an idea of what method of pest control would be most successful given

the current situation. Scouting is crucial in the practice of integrated pest management because it helps identify the pest and thus enables the farmer to generate a plan of attack based on their knowledge of the pest's lifespan, eating habits, etc. This practice also helps farmers establish an economic threshold at which point they decide whether to pursue other means of pest control or to allow nature take its course.

When dealing with pests in an agrarian setting it is important to strive towards maintaining a stable environment. This is particularly important when discussing the biological controls of integrated pest management. It is important to keep in mind that, "stability is relevant to pest control by natural enemies because this control strategy recognizes that even local extinction of the pest is highly improbable, so it attempts to regulate the best at low densities by a continuously present set of natural enemies" (Murdoch (b), 796). As stated with regards to physical controls of pests, it is important to have a variety of crops and habitats on the farm in order to attract a variety of macro organisms that will keep insect pest populations in check. Growing crops favorable to pest predators is an easy way to prevent pest population explosions by attracting beneficial insects and organisms to a field space. By encouraging the presence of predator populations, another level of protection is established for the farmer's cash crops. Increasing the level of predators in a field will reduce the number of pests. This is much preferred to the use of chemical agents.

In some cases, a farmer must resort to buying predator insects from a lab to release in their fields in attempts to reduce the pest population. The farmer determines what type of predatory insect to purchase based on the pest insects present in his fields. The number of predatory insects the farmer buys depends on the pest population. This is

often times expensive and is used only in dire situations. There are many factors that go into the release of predator insects and therefore many things can go wrong, increasing the risk of an economic setback. Some factors include, the number of predators purchased, which relates to the number of pests present, and when they should be released in relation to the stage in the pests' lifecycle or weather conditions. The farmer must also keep in mind the eating habits of the beneficial insects to ensure their survival. The release of beneficials is more successful in a controlled environment because the farmer has a better understanding of the opportunity for a positive outcome based on their extensive knowledge of the fields and its processes.

Economic constraints play a major role in determining the type of control measures used on a farm. When considering the use of biological controls it is important to keep in mind that "an initial goal is to establish the agent efficiently and effectively in as many sites as possible" (Murdoch(a), 929). If predator insects are going to be purchased, it is necessary to use them as effectively as possible so as to prevent an economic loss. However, when used correctly releasing predator species as a form of pest control can be very successful in reducing pest numbers.

Often times the need to use a pesticide is a sign of mismanagement on the part of farmer. Most likely, there is an aspect of their farming system that can be improved upon and reworked to reduce their dependence on pesticides. When all else fails, chemical controls can be used as an absolute last resort. There are many reasons why chemical controls are used as a last effort to combat pest issues. The cost of pesticides often prevents farmers from using them, not to mention environmental concerns. Another issue with pesticides is that due to the short life span and rapid reproduction of insects, they

can develop resistance to pesticides over time. There are a variety of pesticides available including organic pesticides; however a farmer should be well educated in the pesticide chosen to use to ensure that it is used as effectively as possible with the least amount of environmental damage. "Target-specific, low-toxicity pesticides should be applied in a manner that will maximize the effectiveness of pest management and minimize the exposure to humans and other non-target species" (What Is IPM?). It is necessary to conduct thorough research prior to the application of the pesticide to make sure it will not cause more damage in the long run than enabling a quick fix to a temporary problem. The goal of integrated pest management is to avoid the use of pesticides, however in some instances it is a necessary evil.

The chemical control sector of integrated pest management is where the difference between organic integrated pest management and integrated pest management lies. As previously stated, there are organic pesticides available. Organic pesticides are those that are derived from natural sources, typically plants. Some of these natural pesticides include pyrethrum, ryania, minerals and diatomaceous earth (Bellinger, Clemson Extension). Microbial insecticides and biopesticides are the types typically used in organic integrated pest management. Biopesticides are advantageous because they have a narrow target range, are slow acting, suppress but do not eliminate pest populations, have a limited field persistence and a short shelf life. Furthermore, they do not have residue issues and are safer for humans and the environment (Bellinger, Clemson Extension). Microbial insecticides come from naturally occurring algae, fungi, bacteria, viruses and protozoans (Bellinger, Clemson Extension). Microbial insecticides are useful because they produce a toxin specific to a pest, and are specific to a stage in a

pest's lifecycle. Before a farmer chooses to use an organic pesticide is important to understand its effectiveness because in some instances it may need to be applied many more times than a non-organic pesticide. This may either be an economic setback or a detriment to the environment. Also, it is important to recognize that just because a pesticide is organic; it does not mean that it is incapable of causing harmful effects much like those of chemical pesticides.

Integrated pest management can be instituted in both organic and conventional agricultural systems. It can also be an important management technique in a farm's transition from a conventional operation to an organic system. The use of pesticides is the main difference between conventional and organic integrated pest management. The chemical aspect of pest control can involve the use of chemical pesticides or natural biopesticides. This is a relatively easy transition to make; it just requires a bit more effort on the part of the farmer. Understanding the concept of crop rotation is also going to be crucial when transitioning to an organic system because conventional systems tend to utilize monocultures. Integrated pest management is very malleable in terms of deciding what works best in one's system based on the standards and ideals they adhere to for their farming system. For this reason, integrated pest management can be helpful when shifting from a conventional agriculture system to an organic system.

With the ever-growing number of food recalls and threats of carcinogenic food products generated by the use of pesticides, there has been a growing trend of consumers caring more about where their food comes from and how it is grown. The leading agricultural movement is sustainable agriculture, more specifically sustainable, organic agriculture. There are many institutional issues with the agricultural industry and our

current methods of food production but the transition has begun. There needs to be a shift to smaller, more manageable sized farms to ensure the practices employed on farms are healthier for both humans and the environment. One way to reduce our impact on the environment is integrated pest management. The current IPM strategies practiced by farmers "has resulted in the reduced use of pesticides while in other instances it has not reduced the total amount of pesticides used but has changed the usage pattern" (Tweedy, 166). As sustainable agriculture gains popularity, practices such as integrated pest management will continue to make a positive impact on the environment.

The United States is not the only country concerned with the quality of their food and the health of the environment in relation to its how food is produced by current agricultural practices. After receiving the blood toxicity level test results of the people living in Quibor, the members of Monte Carmelo decided they needed to take drastic measures to improve their current methods of agriculture. Due to the high amounts of pesticides used in the fields, farmers were not the only ones that experienced adverse health effects as a result of the pesticides. Pesticides made their way into the soil, the food, women's breastmilk, the clothes washed by the farmers' wives and their children's blood even though they never set foot in the fields. The test results provided the motivation to reassess their current agricultural practices and prompted the Las Lajitas cooperative to transition from a conventional approach to agriculture to organic farming (Polillo, 7 Jan. 2009). This paper will outline the integrated pest management techniques implemented in Venezuela, focusing primarily on Las Lajitas and compare them with those of the United States.

Similar to the United States, physical controls are perhaps the most effective and prominent forms of integrated pest management utilized in Venezuela. There were many opportunities to learn about IPM techniques from farmers at Las Lajitas and other members of the Monte Carmelo community, by working along side them on the farm or their personal garden (conuco) and through personal interviews. Monte Carmelo is located in the state of Lara and is a rural, agricultural community. We also spent time talking to members of a cacao cooperative in Chuau, a coastal town. The cacao cooperative has been operating as a pesticide free operation for the past 400 years (Tomasita, 13 Jan. 2009) The overall sentiment expressed by all those we encountered was their feelings of stewardship and responsibility towards preserving and protecting their environment. This was the primary impetus behind the mission and work of many Venezuelan farmers we met, especially those involved with Las Lajitas. The IPM strategies of Venezuela discussed in this paper are primarily those conducted on organic farms because we did not have experience with conventional farms.

The fundamental component of integrated pest management, and the basis of sustainable agriculture, is encouraging biodiversity. As previously stated, establishing biodiversity helps to attract a variety of species which help maintain pest population, thus reducing their impact on the crops. Biodiversity is crucial for improving soil fertility, which in turn promotes good plant growth, making them stronger and healthier and more likely to fend off pests. When we worked with Gabriel at his conuco (personal garden that grows food primarily for the family), we had a chance to speak with him about a variety of subjects. He mentioned the importance of growing a variety of plants in order to try to mimic a natural system (Gabriel, 6 Jan. 2009). Also, when we visited the cacao

plantation in Chuau, the farmers discussed past pest issues and how they combated them. Their first attempt to resolve the pest issue was to introduce other varieties of cacao from the east and parts of the Andes with the native species (Tomasita, 13 Jan. 2009). Their hope was that in improving the species diversity, they would reduce their pest problems. Fortunately, improving the biodiversity of the cacao crops was enough to reduce the pests and avoid using pesticides. They now grow three different types of cacao beans as opposed to one, which originally contributed to pest infestations. Introducing other species of cacao not only reduced the impact of pests but it improved the overall health of the plantation. Not only is there a variety of cacao plant species, there is a plethora of other tree species that are grown with the cacao, such as bamboo and banana trees. A biodiverse systems is an inviting habit for beneficial insects and fauna that help to control pest insect populations. As a result of the farmers' dedication to maintaining a healthy, biodiverse system, they have yet to break the tradition of no pesticide application.

Inter-cropping is another important integrated pest management strategy utilized by the farmers at Las Lajitas. We encountered many instances of inter-cropping throughout our trip. The cacao plantation in Chuau stressed the importance of maintaining a biodiverse system, which they achieved by mixing different varieties of cacao plants but also by intentionally introducing banana trees, bamboo and many already existing tree species (Tomasita, 13 Jan. 2009). Again, a biodiverse system mimics a natural system which aids in pest control. It was apparent how successful they have been based on the overall health of the fields and how lush and green they were. The plantation has been completely pest-free since its beginning approximately 400 years ago which is a result of their knowledge and understanding of the importance of

maintaining as close to a natural system as possible. Another example of inter-cropping is Gabriel and Titia who allow weeds to grow in their corn fields. The weeds act as a deterrent for the corn, contribute to biodiversity by providing habitat for insects and improve soil fertility because they can worked into the soil where the weeds release nutrients as they decompose (Gabriel, 6 Jan. 2009). Gabriel was insistent upon the notion that all weeds have value like plants and they should remain in the fields (within reason) for the reasons stated above. When Omar walked us through the fields at Las Lajitas he pointed out some IPM planting strategies the farm was implementing. Plants with strong odors, such as onions in the strawberry patches and rosemary in the banana fields, act as natural repellants and are effective means to avoiding the use of pesticides (Omar, 5 Jan. 2009).

Crop rotation is an effective strategy for combating pest issues because it breaks up the soil strata, possibly destroying pest larvae and it forces the pests to relocate to find another food source. Las Lajitas rotates their fields after every growing season. An example of one of their rotations is alternating onion and strawberry crops. Gabriel explained the reasoning behind this technique because he utilizes the same approach on his conuco. Rotating “weak” and “strong” smelling crops helps reduce pest impacts due to the odors released by the plants (Gabriel, 6 Jan. 2009). As explained before, rotating crops is valuable because it improves soil fertility which encourages healthier plants, which enables plants to withstand damage caused by pests.

Soil fertility is at the root of IPM because healthy soil means healthy plants and healthy plants are more likely to fend off pests. Gabriel incorporates the weeds and cornstalks in the fields into the soil to promote decomposition and improve the soil

structure (Gabriel, 6 Jan. 2009). Las Lajitas uses some food compost in their fields but due to the fear of introducing disease and sickness to the crops they have perfected vermiculture compost. This is a type of composting where animal manure is combined with coffee bean hulls (to maintain the appropriate levels of carbon and nitrogen within the compost pile), is covered and monitored until it has decomposed to a certain level. It is then "fed" to worms that further breakdown the waste. The waste is a liquid that is captured and diluted with water and applied to the crops as a foliar spray (Polillo, 7 Jan. 2009). They have had great success with this "worm tea" and have even started to sell it as another product from the cooperative. Vermiculture compost is an excellent source of nutrients for the soil and also enables Las Lajitas to avoid using chemical fertilizers because the tea acts as a natural fertilizer by generating good soil structure and fertility.

Physical integrated pest management often times involves the use of actual "bug traps" or physical barriers that reduce pest damage. A good example of a trap used in Venezuela at Las Lajitas is a bright yellow plate in a slightly open plastic bag attached to a stake to attract pests. This type of trap was present in the Swiss chard field. The plates were covered in glue and the bag had a bit of gas in it to catch and kill the pests (Omar, 5 Jan. 2009). Often times yellow is the color of "bug traps" because insects are attracted to the color. A similar technique is also used at the cacao plantation. Jars with gas are hung from trees to catch insects as well as yellow plates. This has the same effect as the yellow plates used at Las Lajitas (Tomasita, 13 Jan. 2009). The yellow plates were about the only type of trap mentioned, as they rely on other forms of IPM to address pest issues

Las Lajitas is an extraordinary example of biological pest control. They have a unique facility where they raise their own predatory insects (beneficials) to control the

pest populations of Monte Carmelo. They raise two types of insects, trichogramas, which are parasitic wasps and grisopas, which are green lace wings. This facility is very advanced because it cultivates beneficials based solely on the needs of the fields in Monte Carmelo and the number they release is also based on the number of pests present. The facilities raise the hosts for the predators and once the beneficials reach the right maturity level they are released. There are not individual beneficial insect releases for each farm but a general release intended to control the entire pest population of Monte Carmelo. The parasitic wasps attack the caterpillars that eat the fruit of tomato plants. The wasps lay their eggs of the backs of the pest caterpillars. The green lace wings actually feed on the caterpillar eggs and the soft-bodied adult green lace wings feed on aphids and other generalist pests. They have experienced great success from the release of the beneficials. Other agricultural inputs have significantly decreased, for instance the use of traps, and the farmers have seen increases in their crop yields. They also have seen improvements in the area's biodiversity and the health of the population do to reduced reliance on pesticide use. Improvements such as higher crop yields and an increase in biodiversity were observed after the first few beneficial insect releases. The beneficial insect lab has also received governmental support. They provided workers to assist in the lab, and although the time they worked was not consistent, it was helpful nonetheless. The future hopes for the lab are to continue beneficial cultivation after a few recent setbacks with a mite infestation in the lab and to increase the production of beneficials with the intention of selling them (Carmen, 7 Jan. 2009). A mite attacked the hosts used to raise the predator insects halting current production of the beneficials. The issue is how to deal with the mites. They do not want to introduce pesticides to kill the mites because that

contradicts their organic mission. Those working in the lab are brainstorming ways to correct the problem and hope to get the lab up and running again soon. Once the lab begins producing again, they hope to improve and expand their methods of raising beneficial insects.

Fortunately, we did not encounter the chemical component of IPM, pesticides, in Venezuela. Las Lajitas is organic and many of the conucos are as well. However, there are still some farmers who are reluctant to transition from conventional farming to organic, due to its labor intensive nature. There was some mention of nitrogen fertilizer application to replenish the soil but the farms we dealt with were more or less chemical free. If the cacao plantation has serious issues with pest infestations they will apply lime to the affected trees to kill the pests (Tomasita, 13 Jan. 2009). However, they do not use chemical pesticides.

Venezuela's approach to integrated pest management is very similar to that of the United States. Both focus primarily on the physical aspects of IPM. The next line of defense against pests is biological control and chemical usage is avoided at all costs. The glaring differences between Venezuela and the United States are the government's support and advocacy of sustainable (organic) practices and the emphasis on locality. In the United States agribusinesses have caused our food production system to be unsustainable and unhealthy for the environment because everything is centralized. The fact that the beneficial IPM lab in Venezuela raises beneficials needed by the specific crops grown in Monte Carmelo and neighboring area is quite astounding, whereas we in the U.S. have bigger labs that raise a variety of insects and to be shipped to their respective parts of the country. Although, the focus of this research was not integrated

weed and disease management, in a nearby town, Bojo there is a lab where a fungus is cultured that attacks other types of fungi that plague crop fields. Again, a fungus is grown specific to the needs of the soil and crops in Monte Carmelo. We could take a page from Venezuela's Bolivarian constitution and focus on sustainable, *local* agricultural practices.

Farming in Monte Carmelo and Chuau is revered as a way of life, something that most everyone practices and participates in. In this way, everyone has a deep understanding of what goes into the food prepared on a dinner plate. There is a definite disconnect in the United States between consumers and the efforts and consequences of getting food to their plates. This may be in part due to the shift from the notion of farming as a profession in the United States. Yet, it is not uncommon for families in Venezuela to have small scale farming operations or simply gardens that subsists their households. Slowly, we in the U.S. are beginning to see the value in knowing where our food comes from and what inputs are used to grow it. We can certainly adopt the Las Lajitas adage, that bigger is not necessarily better and less is more.

Farming provides such a sense of community amongst the people of Monte Carmelo which allows for an exchange of knowledge and information. With such strong community-centered agriculture, farming is not as big a chore as it may seem because everyone participates in it together. Because the community is dependent upon the land, as it is their livelihood, they are concerned for its future and recognize the importance of preserving its health. Their practice of integrated pest management is a representation of their regard for the health of the environment.

Despite political differences, Venezuela and the United States, surprisingly, have very similar approaches to sustainable, organic agriculture. Both nations share farming philosophies that recognize the importance of crop rotation, soil fertility, and biodiversity. The United States and Venezuela at large, however, could improve certain aspects of their agricultural systems, and most importantly place a greater emphasis on locality as is the case with Las Lajitas. It is times like these when we are faced daily with the ever-increasing global environmental crisis that nations need to rally together to exchange ideas and practices in order to achieve a common goal: minimizing our affect on the environment in the hopes of correcting our past mistakes. Agriculture provides an excellent platform for this intercambio and exchange of information because all nations rely on farming for supplying their country with food. We, as Dickinson College students had the opportunity to be ambassadors between the U.S. and Venezuela and we returned to the States from our trip with a new appreciation for the potential to improve our nation's agricultural practices.

Images

Intercropping of coffee and corn at Las Lajitas.

Bug traps used at Las Lajitas.

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