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Future IPM Trends in Trinidad and Tobago: A Qualitative Study of Farmers' Perspectives

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Abstract

Agriculture plays a fundamental role in the infrastructure of many developing economies. Trinidad and Tobago depends on food imports for over 90% of its domestic food supply making agriculture a politically sensitive sector. Technology adoption, specifically Integrated Pest Management (IPM), is one method used by the government to help enhance food security. The purpose of this study is to evaluate factors affecting IPM program adoption in Trinidad and Tobago, to describe current practices used by farmers, and to identify future perceptions of IPM technology. The theoretical framework for this study was constructed using Rogers' diffusion of innovations as it pertains to agriculture. Twenty-one farmers were purposively selected to participate in this study. Economics, progressive ideology, mixed control methods, pest management practices, traditions, and a holistic approach to agriculture were identified as the key elements of IPM programs by farmers. Practitioners seeking to influence the adoption of IPM in this country should be knowledgeable of IPM program elements. Future research should seek to enhance information communication and dissemination.

Keywords: Diffusion of Innovations, Integrated Pest Management, Small Scale Farmers' Perceptions

Introduction

Agriculture has become an increasingly more important and yet smaller component of the global economy over the past two decades (Swanson, 2006). Population increases, climate change, and economic factors have been cited as primary drivers of agriculture's increased importance (Pretty et al., 2010). Developing countries are particularly sensitive to changes in agriculture as the historic food import/export practices become less reliable (Fritschel, 2003) and jeopardize food security. Many of developing countries have focused domestic policy toward increasing domestic agricultural production and reducing reliance on food imports. A common approach to the problem of food security has been the utilization of technology to enhance production practices.

Hutchins (2009) asserted that an adequate supply of food is paramount to population survival, fundamentally making agriculture a first-level priority. Technology has enabled human civilization to leave the "hunter/gatherer" paradigm of existence and concentrate labor and land to the sole purpose of more efficient food production (Hutchins, 2009). The need for technological development in agriculture was recognized by the United Nations as key in the ability to meet future food needs. An increase in technological use within developing countries will be critical to ensure prosperity and growth (Food and Agriculture Organization of the United Nations [FAO], 2009).

Developing countries typically experience more rapid population growth than developed countries and are also more susceptible to fluctuations in food prices (Rosen, 2008). According to Lutz (2010), the global population is estimated to reach in excess of 9 billion people by the middle of the twenty-first century. Most of the population growth is expected to take place in developing countries. The issue of food security combined with a rapid population expansion makes food security a more acute problem in developing countries. Countries in the Caribbean region have a vested interest in improving agricultural output and sustainability, since most Caribbean countries are classified as developing (Rosen, 2008).

The Republic of Trinidad and Tobago is classified as a developing country in the Caribbean region (International Monetary Fund, World Economic Outlook, 2012). Trinidad and Tobago relies heavily on food imports with current levels in excess of 90% (Ministry of Food Production, Land and Marine Affairs, 2012). Agriculture in Trinidad and Tobago is generally confined to rural areas and is a primary source of revenue for farmers and agricultural laborers in rural households (Rosen, 2008). Currently the Ministry of Agriculture, Land, and Marine Resources is attempting to reduce reliance on foreign imports of food sources by introducing a new National Food Production Action Plan (NFPAP). The NFPAP is an attempt to secure safe food sources that are grown locally in Trinidad and Tobago (Ministry of Food Production, Land and Marine Affairs, 2012). To accomplish this task, the NFPAP identifies target issues in agriculture in order to enact specific programs to target problems. A key element of the NFPAP plan revolves around technology in agriculture (Ministry of Food Production, Land and Marine Affairs, 2012).

One technology that can promote improved sustainable agriculture is Integrated Pest Management (IPM). Wilen, Lazaneo, and Parker (2011) identified IPM as a term that describes the concept of biological and minimal chemical use to control for pests, in a way that would offer the least amount of disruption to ecosystems. One of the primary goals of IPM is to control destructive pests and diseases while simultaneously eliminating or reducing the use of synthetic pesticides (Erbaugh, Donnermeyer, & Kyamanywa, 2002). IPM offers farmers the advantage of a safe alternative to the chemical pest controls. Excessive chemical usage can threaten food and consumer safety, the environment, and also the export of agricultural products to global markets (Erbaugh, Kibwika, & Donnermeyer, 2007). Yorobe, Rejesus, and Hammig (2011) found that farmers utilizing IPM practices experienced significantly lower input costs. Higher commodity prices have also been found to result from farmer IPM implementation (Muller, Guenat, & Fromm, 2010). Research has shown that farmers will transition away from pesticides to an IPM-based management system when commodity prices are low due to economic factors (Lamine, 2011). Farmers in Trinidad and Tobago currently equate pest management with pesticide use, in the belief that a direct relationship exists between an efficient product yield and the amount of pesticide applied. Access to pesticides is unregulated, with attendant risks of accidental exposure or intentional poisoning (Pinto Pereira, Boysielal, & Siung-Chang, 2007). To achieve more successful IPM implementation, there is a need for further research to facilitate communication of these technologies and management practices.

Members of the Association of International Agricultural and Extension Education (AIAEE) have studied facets of IPM across the globe. Bunyatta, Mureithi, Onyango, and Ngesa (2006) researched the perceptions of farmer field schools on IPM practices on rural farmers in Kenya. Farmer Field Schools were found to be effective in improving farmers' IPM knowledge in Uganda (Erbaugh, Donnermeyer, Amujal, & Kidoido, 2010). Tripp, Wijeratne, and Piyadada (2005) recommended agricultural policy makers ensure IPM practices are supported to improve sustainable agricultural practices and disseminate the information to farmers. Erbaugh et al. (2007) further suggested that farmers' perceptions of IPM practices should be routinely studied to better understand educational and training needs for farmers.

Theoretical Framework

There is a gap in the literature surrounding the transfer of technology from the researcher to the producer in Trinidad and Tobago (Smale, 2009). In his seminal work, Rogers (2003) proposed a diffusion framework that outlines a process through which innovations or concepts are disseminated over time to and through members of a social system. Within Rogers' framework, innovations are evaluated based on the characteristics of the innovation itself, the communication channels used, the time elapsed since the innovation's introduction, and the social setting in which the innovation is being diffused (Rogers, 2003). Rogers (2003) further classified the properties of innovations that contribute to its adoption. Rogers' classifications have been shown to be useful in comparing the costs and benefits of adoption versus non-adoption and thus the likelihood of adoption (Chigona & Licker, 2008). Diffusion framework provided a unique context to evaluate technology transfer in Trinidad and Tobago.

The first component of the diffusion of innovations framework consists of the properties of the innovation itself. Rogers (2003) discussed the applicability of the framework to evaluate technological innovations. Rogers (2003) defined technological innovation as "an idea, practice, or object perceived as new by an individual or other unit of adoption" (Rogers, 2003, p.36) that can mitigate some of the uncertainty in achieving future outcomes. Five key elements identified by Rogers (2003) pertaining to adoption rate and associated with the innovation itself are: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage is a measure of how much improvement an innovation supplies as compared to current practice. Relative advantage can be measured in both social and economic terms. Compatibility measures how compatible an innovation is to existing societal values, experience, and practice. Complexity addresses the degree of difficulty that the adopter has in understanding and using the innovation, while trialability assesses the ability of the innovation to be tried at smaller or incremental scales. Observability evaluates the ability of the results of an innovation to be noticed by others within the social system.

All of the elements outlined by Rogers (2003) are beneficial in effectively evaluating the diffusion of innovations within the context of a developing country as innovations are bounded by a common societal structure. Technology diffusion relies on human interaction. Diffusion requires the individuals to have the inclination to share information with others (Palis, Morin, & Hossain, 2002).

The second element of the innovation diffusion theory revolves around communication channels. A communication channel is the means by which an idea is transmitted between individuals (Rogers, 2003). Communication channels have been shown to revolve around the idea that individuals generally evaluate ideas not so much on scientific validity but moreso on peer opinions and the evaluations of those peers who have already adopted (Rogers, 2003). Peer evaluation relies on two primary attributes: homophily and heterophily (Rogers, 2003). Homophily relates to the similarities between individuals with respect to beliefs, education, social status, and other similar attributes, whereas heterophily describes how individuals are opposite in these regards. Rogers (2003) found that there must be some degree of heterophily between individuals in order for the diffusion process to succeed. Palis et al., (2002) concluded that the individuals relied on group communication in order for knowledge sharing to occur.

The third component in the diffusion process regards time. As defined by Rogers (2003), this component is composed of three elements: the formation of attitudes by the adopter regarding the innovation, the innovativeness of the adopter, and the relative speed at which the innovation is adopted within a system. Adopter attitude is usually classified using the innovation-decision process (Rogers, 2003). Adopter innovation was classified by Rogers (2003) into five general categories that typically follow an S-shaped curve: innovators, early adopters, early majority, late majority, and laggards. According to Lapple and Van Rensburg (2011), farmers do not necessarily adopt technologies at the same time or uniformly. There is an importance to be able to distinguish the characteristics and classification between adopter categories and groups (Lapple & Van Rensburg, 2011).

The final element of diffusion theory revolves around social setting. Social setting refers to a group of individuals working toward a common goal or problem (Rogers, 2003). Social setting is important since the social system in which the innovation is located can influence diffusion (Chigona & Licker, 2008). Social setting relies heavily on the concept of opinion leaders and change agents. Opinion leadership is defined as "the degree to which an individual is able to influence other individuals' attitudes or overt behavior informally in a desired way with relative frequency" (Rogers, 2003, p. 27). Opinion leaders tend to be community leaders, and the respect and credibility that opinion leaders command is fundamental in enabling the leaders to aid in the diffusion process. Change agents are individuals who seek to effect change based on a predetermined direction from an external source (Rogers, 2003). Change agents are often professionals from outside of the community. Having a single repository of information, like the government, has shown to be insufficient for producers to learn new technologies (Hartwich & Scheidegger, 2010). Much like the adopter categories, opinion leaders play a significant role in the diffusion of innovations in developing countries.

Purpose and Objectives

The purpose of this study was to evaluate the adoption of IPM practices by farmers in Trinidad and Tobago. Specifically the objectives of this study were to:

1. Identify farmers who were practicing IPM,
2. Describe the IPM practices used by farmers at the production level, and
3. Identify farmers' perceptions of future trends in IPM.

Methods

A qualitative research design method was used for this study. Qualitative research was selected due to its ability to provide unique insights into the interactions within a particular context (Patton, 1985). The study consisted of nineteen farmers (*N* = 19) from Trinidad and Tobago. Farmers were selected using a purposive sampling technique parallel with the study's objectives. University and Ministry of Agriculture (MOA) staff assisted in farmer selection based on farmer adoption of IPM practices and farmer roles as opinion leaders within the agricultural community. Purposive sampling allows the researcher to gain a more robust insight into the data by purposely selecting a sample from which the most can be learned (Merriam, 2009).

Farmers were selected based on agricultural experience, job capacity, and the role played in communicating with other producers. Eighteen (*n*=18) were male and one (*n*=1) was female. Fourteen (*n*=14) of the farmers were determined to be progressive, and five (*n*=5) were classified as traditional farmers. Progressive farmers were defined for this study as agricultural producers who were adopting practices that would reduce or eliminate the use of chemical pesticides, while traditional farmers were defined as those agricultural producers who still used customary chemical applications and cultural practices with no plans to alter the currently used pest control methods.

A semi-structured interview method was employed in this study. Interviews utilized the informal conversational interview as described by Patton (1985) and further refined by Denzin and Lincoln (2008). Semi-structured interviews rely on the natural flow of the conversation, allowing the researcher to be responsive in the conversation and thus collect more contextually rich data (Lincoln & Guba, 1985). The interviews were conducted in the spring of 2012 in the Republic of Trinidad and Tobago. Each interview lasted approximately thirty minutes and was conducted at each individual's farm. Interview data were recorded using researcher field notes.

The constant comparative method was used to analyze data, which consisted of recording conversations through note-taking and categorizing the data. Farmers' names were altered to preserve anonymity (Denzin & Lincoln, 2008).

Trustworthiness of the data was established through persistent observation, data triangulation, and member checking (Tuttle, Lindner & Dooley, 2007). Persistent observation, according to Dooley (2007) is a process that gives the researcher more relevant data. Data triangulation is a method that allows the researcher to assess the validity of the data by examining data for convergence and contrasts (Trindade Leite & Marks, 2005). Member checking was also used during the interview process to ensure accuracy (Merriam, 2009). Given the qualitative nature of this study, the results may not be generalized beyond the described population.

Results

Several fundamental themes emerged from the data. To better achieve the objectives of this study, the data was separated by objective to illuminate the underlying themes characteristic of small-scale farmers practicing IPM in Trinidad and Tobago. Economic incentives and progressive ideology were the dominant constructs that emerged from the first objective. Farmers' current adoption of IPM practices was best described by the use of mixed control methods, pest management practices, and tradition. Farmer perceptions of future trends in IPM were characterized by a holistic approach to crop production and economic influences.

Significant constructs that emerged from the data identifying farmers currently practicing IPM techniques were *economic incentives* and *progressive ideology*. Farmers' names were altered to preserve respondent anonymity (Lincoln & Guba, 1985).

Economic Incentives

Nine (*n*=9) of the nineteen farmers indicated that economic incentives were a primary driver in the choice to employ IPM practices. Jack's perception was, "Farmers will not adopt additional practices unless sufficient economic incentives are presented as a viable alternative." Cutler added that, "What drives the farm is what is in the pocket not Mother Nature." Cutler further stated that, "It's not agriculture, it's economics. And at the larger scales, it's too expensive to economically produce." Will added that he believes, "Agriculture can be a viable and sustainable business." Farmers further indicated that higher levels of positive economic incentives would increase the degree of usage. Gillette explained, "Economic incentives were not sufficient to generate IPM compliance among farmers." Davy added, "Of the major issues facing farmers, one of the main ones is the rising input costs, which can be lowered by reducing dependency on imported goods (chemical pesticides)."

Other farmers elaborated on the economic incentives behind adopting IPM practices. Farmers observed that non-adopters had reasons as well. Joshamee commented, "Many farms will not go to IPM because of the cost." Gillette further stated that due to a lack of knowledge, non-IPM farmers will "not grow more than is economically feasible for themselves." Scarlett noted, "Most farmers do not have the capital required to implement the new technologies and are thus resistant to change."

Progressive Ideology

Twelve (*n*=12) of the farmers identified with the characteristics of a progressive ideology as contributors to the IPM adoption decision. Sustainability was found to be a primary component contributing to IPM adoption. Will noted that, "I believe that I cannot grow more without having to put more toxins in the soil." Bill elaborated, "I am constantly looking for new technologies to learn and try, to preserve the land for the next generation." Cutler added that to avoid contaminating the land with chemicals his farm uses, "organic mulches such as bamboo leaves and newspapers in addition to manure-based fertilizers."

Positive health benefits associated with IPM was another element of progressivism that adopters reported as influencing the adoption of IPM practices. Scarlett added that, "The organic nature of the personal farm stems from the desire to stay healthy and free of chemical contamination-related illnesses." Theodore stated, "I have been phasing out chemicals, because they can cause health problems."

Dominant themes that emerged from the data describing current IPM practices used by farmers in Trinidad and Tobago were mixed control, scientific pest management practices, and traditional practices.

Mixed Control Methods

Eleven (*n*=11) of the nineteen farmers identified the use of mixed pest control methods as elements of the current IPM program. Cutler elaborated on mixed control methods by reporting, "I am utilizing bamboo leaves and newspapers around my crops to keep out weeds, instead of spraying any herbicides. " Jack also added that, "I am constantly turning the soil to prevent weeds from sprouting up and growing." Cutler stated that, "I place plastic bags over the young plants to act as physical barriers; they remain on until the plant is strong enough with thick stems to resist insects." Mullroy said, "I place cardboard down to prevent weeds from emerging." Mullroy was also using plant stacking and succession to maintain constant production, and keep weeds pressure down. Hector said, "I use both mechanical weed control and chemical control."

Crop rotation was another element of control that was used in conjunction with chemicals. Hector, a farmer utilizing crop rotation, said, "The crop rotation that I use will actually improve the soil and also have pest management benefits." Bill added, "I rotate in cabbage and bouti, which is known to improve the soil, and look for new technologies that I can use to help my farm be better." Mullroy stated, "I am using plants such as tamarind, flamboyant, and glyceridia to fix the nitrogen-depleted soil on." Theodore said, "I use crop rotation, planting up the hill each year by type, and then will go in reverse order."

Scientific Pest Management Practices

Twelve (*n*=12) of the nineteen farmers identified knowledge of proper pesticide use as a current IPM practice. James uses a multipronged approach saying, "Insects become resistant to certain sprays, so I have to change out the spray." James also noted that it was possible to "mix sprays together for a better control." Barrett commented that another approach was to, "utilize pest population thresholds I obtain through field transects to determine timing and application rate." Davy stated, "I do not use chemicals on my land, but look for alternative methods to incorporate." Jack was utilizing the method of over cropping.

Traditional Practices

Ten (*n*=10) of the nineteen farmers identified themselves as using methods inherited from previous family generations. Scarlett stated, "Most farmers are traditional growers with traditional methods; they do not like younger, non-farmer individuals trying to tell them how to operate. The younger farmers are the more progressive ones with university or extension experience." Murtogg believed that the perception of farming tradition was a function of farmer age, saying, "The average farmer is between 45 and 60 years old, and this makes them highly resistant to change." Bill explained, "Our family's practice has been to change up plants."

The leading constructs that emerged from the identification of farmer's perceptions toward future trends in IPM were a holistic approach toward agriculture and an economic focus toward production.

Holistic Approach

Five (*n*=5) of the nineteen farmers identified a holistic approach to IPM as an emergent future trend. Hector indicated that adoption is beginning to take place as, "The farm is homogeneously representative of the surrounding valley." Hector further added, "Farmers perceptions are that more is better when related to fertilizer and pesticides, but this mantra can be changed through further education." Davy elaborated this point by noting, "When pesticides are used, people only utilize one or two chemicals without looking at all the options." Cotton commented that production on the farm is "holistic, and everything is connected."

Economic Incentives

Six (*n*=6) of the nineteen farmers remarked that economic incentives would provide for increased future adoption of IPM practices. Cotton commented that, "We are in agriculture to make money; not all people in Trinidad are willing to pay the money it takes to buy organic." Joshamee further stated that, at current levels, "farmers will not use IPM, because it is too costly." Will opposed the view that farming was exclusively economic indicating that, "I'm adding value to the state land." Will elaborated that "farmers are too worried about profit; they do not see adding value to the environment." Bill said, "I have tried to utilize alternative practices, but they typically cost more money and time."

Conclusions

The data indicated that farmers practicing IPM techniques were focused on maintaining economic viability and held a progressive ideology. Farmers utilizing the IPM technology recognized the importance of economic sustainability for future generations. Progressive ideology characterized the farmers currently using IPM, as well as indicating that farmers continually seek out better practices consistent with operational goals. Farmers employing IPM techniques tended to be more informed and eager to test new theories to accomplish the economic and progressive goals. Farmers also sought to use multiple methods of pest control, ranging from traditional methods to newer IPM techniques. The use of a wide variety of pest management practices indicated a lack of consensus and reflected hesitance in fully adopting IPM. IPM as a technology can thus be regarded as still early in the adoption process in Trinidad and Tobago. Attitudes toward future adoption of IPM suggest that the technology must become more reliable and scalable while maintaining farmer economic profitability and preserving the land.

Farmers in this study depended heavily on the opinions of respected leaders in the community. Government and other external sources of information were found to be held in less esteem within the farming communities. Information flow through the existing channels was identified as inconsistent as a result of the low level of trust exhibited by farmers. Communication barriers between farming communities and outside sources were found to hinder uniform adoption of IPM practices in Trinidad and Tobago. A fundamental knowledge of the basic elements of IPM practices by farmers was inconsistent throughout the study. Knowledge and perception inconsistencies were attributed to a lack of governmental standardization and farmer education. While the qualitative nature of the research limits its generalization to the specific population, the study does provide some insights into the effects of the diffusion framework in developing countries.

Recommendations and Implications

The farmers in this study were found to implement varying degrees of IPM. Based on economic, social, and ideological motivations, the data indicated that the participants characterize many of the adopter categories as presented by Rogers (2003). A high concentration of innovators and early adopters were identified among farmers, indicating that the IPM technology was still in the early phases of adoption. The variation in age and ideology between the farmers in the innovator classification suggested that the innovator profile in Trinidad and Tobago is deviant from Rogers' (2003) classical theory. The data also indicated that the gap between innovators and late majority is narrow. The narrow gap between the innovator and late majority group implies that a successful implementation by the innovators will lead to a quick adoption through the late majority classification. Faster adoption of the technology by farmers implies a strong relative advantage in using IPM, which is also consistent with Rogers' (2003) findings. The data further indicated that economic incentives were a motivation for IPM adoption, which supports the findings of Lamine (2011) and Muller et al. (2010). The rapid adoption and strong relative advantage suggest that critical mass can be attained more quickly within this bounded system.

Opinion leadership also plays a large role in the diffusion of IPM technology in Trinidad and Tobago. The data concurred with Rogers (2003) in that opinion leadership represents the primary dissemination function within this sample population. As such, the dependence on external sources of information has not developed to the point of efficacy. The results of the study are consistent with the work of Chigona and Licker (2008) as well as the findings of Erbaugh et al. (2010) in demonstrating the influence of social setting on diffusion factors. Farmer reliance on opinion leadership in this study also reinforced the findings of Palis et al. (2002) regarding innovation diffusion within a group setting.

Practitioners of diffusion are recommended to develop a structured educational system that incorporates farmer non-formal education and IPM practices to provide more continuity in IPM application. Direct dissemination of information to farmers can enhance not only the ability of the individual practitioner to impact dissemination but also the consistency of the information being distributed. By enhancing education and awareness, diffusion practitioners will be better prepared to effect change in the agricultural areas of Trinidad and Tobago. Additional hybrid crop development is another area in which practitioners can enhance the impact of IPM technology. The introduction of more targeted hybrid plant species will help to improve the adoption rate of IPM technology while simultaneously preserving the fundamental holistic and sustainable needs of the farmers. An accountability system through which IPM practices can be standardized would enhance the adoption rate of this technology by farmers as well.

Future research in this area should be conducted with a focus on delineating the communication barriers between farmers currently using IPM and viable information sources. By defining the communication barriers, change agents can more effectively develop programs and materials to accelerate the adoption process. Future research should also seek to identify effective information distribution channels. The data suggests that the current information dissemination network relies on opinion leadership and private industry. As the government of Trinidad and Tobago assumes a more active role in the implementation of IPM practices, communication difficulties between the government and farmers may prove a hindrance. Research focus should strive to establish the long-term impacts of an IPM program in Trinidad and Tobago. As IPM becomes more heavily adopted, the sustainability and environmental factors surrounding IPM will have a lasting effect on the country's economy.

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