Chapter 1: Introduction

I. Problematic Situation:

Since the advent of the Green Revolution, developing countries have used pesticides to expand agricultural production capabilities. Because of the lower cost of chemicals relative to labor costs, farmers in developing countries have favored pesticide usage over hiring labor for such tasks as weed removal and insect control. Governments in developing countries have supported the importation, and in some cases subsidization, of chemical inputs for farmers (Agne et al, 1995). The government support of chemicals and farmers' perceptions of chemicals as a cheap and effective means for pest control have resulted in widespread use and over-use of pesticides in small farm production in developing countries (Agne et al, 1995) including Jamaica.

In addition, monocropping methods of farming have been used in Jamaica since the late 1600's when the British seized control of the island and increased plantation production. Monocropping continues today and has led to increased amounts of soil erosion and nutrient depletion. Intensive farming of a single crop has increased the risk of crop failure through pest or disease infestations. Farmers run the risk of losing an entire year’s revenue from a few pests. To counter the risk and offset the depletion of soil nutrients, Jamaican farmers increased the quantities of fertilizers and pesticides they used (Chung, 1998).

The use of chemicals has also resulted in pesticide resistance, reduction of natural enemies, and the emergence of secondary pests (Chung, 1998). Pesticide resistance has emerged from adaptation by pests to specific chemicals. Pests are defined as any harmful species to a crop including, but not limited to: insects, rodents, fungi, disease, and weeds. One of the side effects of pesticides is to lower the

population of natural enemies of the pest as a direct result of the pesticides killing the natural enemies or as an indirect result from the pesticides killing the intended pests, leading to a food supply shortage for the predators of the pests and therefore reduces the predator population. When the pests gain resistance to the pesticide, they return but their natural enemies have been driven off. The lack of natural enemies can also lead to greater populations of secondary pests, which can be equally harmful to the crops.

There are also environmental and health hazards that have resulted from the use of chemicals by farmers. Water pollution as a result of non-point source runoff has become a major problem. "The most important non-point source of pollution for rivers and lakes is agricultural activity" (Tietenberg, 1992, p.479). Pesticides can result in harmful disruptions of the natural world. For example, the use of DDT contaminated the eggs of birds causing population reductions to near extinction levels. The pollution of water and land resources can affect whole villages if the local farming practices have contaminated the nearby water supply. In addition, humans can be directly contaminated by harmful chemicals if the farmer is spraying his crops. The chemicals can be inhaled by both the farmer and other people in the area.

Regulation of pesticides and the development of world wide safety requirements for both crops and pesticides have led to a growing awareness of the dangers of chemicals and new methods for lower usage levels. "Regulation is increasingly influenced by international standards and organizations such as FAO, GATT, NAFTA and the Montreal Protocol" (Scillhorn van Veen, 1996, p. 3). The USDA also influenced chemical use of farmers by prohibiting imports with high residue levels (Chung, 1998).

Because of the health and environmental risks, the Jamaican government has begun supporting Integrated Pest Management as a method for reducing the use of

pesticides and chemicals (Ministry of Agriculture, 1988, p. 5). A program of Integrated Pest Management (IPM) is being developed by the Caribbean Agricultural Research and Development Institute (CARDI) and the United States Agency for International Development (USAID) for hot pepper, callaloo, and sweet potato. IPM is a production system consisting of various components, such as pulling infected plants from a field, designed to reduce chemical usage by farmers while allowing them to maintain or increase the crop yields.

The goal of the IPM systems is to lower the pest population using the economic threshold as a guideline. The economic threshold is defined as "the break even point at which the value of loss in yield quantity or quality is equal to the cost of a control method that successfully eliminates pest damage and yield loss" (Scillhorn van Veen, 1996). If farmers do not see at least the same level of profit without chemicals as there was with chemicals, there will be no economic incentive for them to use Integrated Pest Management.

A farm level economic evaluation of the IPM systems is necessary to evaluate its appropriateness for farmers, particularly small farmers. Small farms are defined as farms with less then ten acres of land. Without such an evaluation, extension agents and decision makers responsible for the education of farmers will lack knowledge of the specific barriers to adoption by the individual farmers. These barriers may include low economic returns, lack of knowledge or lack of other resources for implementing IPM.

Adoption of IPM may also be affected by macroeconomic variables. In the late 1970's and throughout the 1980's, Jamaica's economy experienced a long recession (World Bank, 1993). The government responded with "subsidies on food, water, energy and agricultural inputs, price controls including interest rate ceilings; direct credit from the public sector; public monopolies on certain imports; export restrictions; high

barriers to trade; and a policy of state direction of the economy (World Bank, 1993, p.3).

These actions have resulted in numerous economic problems, including high inflation rates, under-valued resources, environmental degradation, slow gross domestic product growth, a falling value of the Jamaican dollar, and heavy foreign debt as a result of low exports relative to imports (EIU, 1992, vol.1). In addition, exporters of agricultural goods face problems such as "cost of capital and the inadequacy of research and development... [which] translates into deficiencies in technology in relationship to the operations of the subsector" (Jamaican Information Services, 1996, p.114). These factors can affect farmers' adoption of new technologies including IPM.

The Collaborative Research Support Program (CRSP), under the funding of USAID, is helping to implement the IPM program. One of the goals of the IPM-CRSP program is "to sustain or increase production of horticulture exports [mango, avocado, certain root crops and vegetables]" (Gebrekidan, 1997). Currently, the IPM-CRSP program is working with three crops: sweet potato, pepper, and callaloo (IPM-CRSP, 1997). The IPM-CRSP program is potentially affected by several obstacles to IPM adoption. These obstacles include, but are not limited to: rejection of exports into the United States as a result of soil, pests and disease on crops; lack of Jamaican farmer education regarding the dangers of pesticides and alternative pest control techniques; lack of information on insects and weeds affecting export crops; and lack of integration of specific pest and weed resistant crops into the Jamaican agriculture sector (IPM-CRSP, 1996).

Within the past decade, the Jamaican government has taken steps to reduce the level of government involvement in the economy and the agricultural sector (EIU, 1990-1994). The IPM-CRSP program, operating within the agricultural sector, is

therefore affected by the government actions. However, it is not known how much the program is hindered or helped by the recent government actions. The policies taken by the Jamaican government could potentially impact the adoption decisions by farmers.

II. Problem Statement:

High usage of pesticides can have negative external effects such as contaminated water supplies and other social costs. Economic cost of high pesticide use may include less efficient agricultural production methods as well as restricted exports due to pesticide residuals. Therefore, the adoption of IPM by farmers can decrease the potential social costs while increasing the returns to the agricultural sector.

However, the adoption of IPM has been shown to be influenced by the policies of the government with respect to the macro economy (Tjornhom et al., 1998). The macroeconomic setting, then, is important to the adoption of IPM. A viable IPM program requires information on barriers to adoption of IPM by farmers and empirical evidence of the effects of policies on IPM adoption.

The farmers interviewed for this study knew some of the dangers associated with pesticide usage but continued to apply the chemicals. The farmers were more concerned with their profits than the potential negative effects of pesticides. If farmers knew that IPM leads to higher profits, they would be more willing to adopt the alternative systems.

Presently, there are no studies showing the economic incentives for Jamaican farmers to adopt the IPM systems for hot pepper, sweet potato and callaloo. Time and money have been invested into developing IPM systems for hot peppers, callaloo, and

sweet potatoes, but no information has been collected regarding the returns to these investments when the systems are adopted by farmers.

The Jamaican government is working towards reducing government intervention in the economy by eliminating subsidies to the agricultural sector and reducing trade barriers. The impacts of barriers to trade, exchange rates, and Jamaican government policies on the profitability of IPM adoption have not been evaluated. Government policies could potentially affect the profitability of the IPM systems in three areas: input costs, input requirements and output prices. The lack of economic data regarding the IPM systems has prevented any evaluation of the effects, if any, of the government policies on IPM profitability.

III. Objectives:

Specific objectives of the research were:

1. Evaluate the net economic returns for small farmers as a result of adoption of the IPM systems for hot pepper, sweet potato and callaloo.

2. Determine the influence of the following government policies on the profitability of IPM for small farmers: preclearance, elimination of the concessionary water rates to farmers, lowering the duty concession rate to farmers, lowering the Common External Tariff, appreciation of the real exchange rate, elimination of the credit subsidy and a fall in the real interest rate.

The preclearance policy was defined as farmers completing farm level inspections of their crops before shipping them to the preclearance station in order to receive higher prices. The water rate policy eliminated the $JM11.39 water subsidy to farmers. The vehicle duty concession was eliminated and raised the price of

mechanical imports by 20%. A reduction in the Common External Tariff by 11.25% was evaluated by decreasing the price of all imports by 5%. A change in the real exchange rate was defined as an appreciation of the Jamaican dollar by 5% which caused the price of imports to fall by 5% and the price of exports to fall by 5%. The credit subsidy was a subsidy of 22.51 percentage points for farmers borrowing financial capital. The real interest rate policy was evaluated by reducing the real interest rate by 25 percentage points.

IV. Conceptual Framework:

A mathematical programming model was developed for a Jamaican farm in Ebony Park, Clarendon and used to evaluate the economic incentives for farmers to adopt the IPM systems for sweet potato, callaloo and hot pepper. The model was also used to analyze the impact of government policies on the potential profitability of IPM.

Mathematical programming models optimize an objective function with a set amount of resources, called constraints (Alston, 1994). The activities of the farm were the export crops in the IPM program (sweet potato, callaloo, and pepper) as well as other crops that the farm could potentially grow such as non-export crops and other trade crops. The constraints on the amount of input resources available to the farm forced the farm to allocate the resources between the possible activities. The objective function was to maximize net returns above variable costs for the farm given the constraints, the relative prices, and the policies facing the farm.

The trade and domestic policies were incorporated into the model as exogenous variables, modifications of existing parameters, or as new constraints. Policy changes were simulated by changing the parameters associated with specific policies for evaluation of the effects on the farm enterprises and profit.

The time horizon for the farm model was one growing period. The crops grown were annuals and a year time frame encompassed the entire production process. A time horizon less than a year was determined to be too short to capture all of the effects of a specific policy. Callaloo, which had a shorter growing season than one year, was allowed to be harvested more than once.

Econometrics was not chosen as the appropriate model to use because most econometric models reflect a specific sector of the economy. In the case of this study, the entire sector would include the whole agricultural sector of the Jamaican economy or the whole exporting sector of the Jamaican economy. Since the IPM research program is working with only a few select farms, this aggregated information would not be as informative as a farm level analysis. A farm level evaluation is possible through a mathematical programming approach. In order to facilitate the analysis, specific assumptions were followed.

V. Assumptions:

1) Farmers compete in a perfectly competitive setting and seek to maximize profit subject to crop diversification constraints.

2) Only monetary values concern the farmers. Social costs, benefits and family farms have no bearing on the output mix.

3) Input and output prices do not change within the specified time period of the model and prices are exogenous.

4) All coefficients of both the constraints and the activities are non-negative.

5) All activities on the representative farm are separable (Alston, 1994).

6) All farmers have perfect information regarding IPM costs and benefits.

VI. Hypotheses:

1) Farmers adopting the IPM systems for hot pepper, sweet potato and callaloo will increase their returns above variable costs.

2) The initiation of preclearance practices by farmers will compete with the IPM technologies for the scarce labor supply and result in reduced profitability of IPM.

3) The elimination of the current water rate subsidy will reduce the profits from the IPM systems because of the importance of irrigation in controlling the sweet potato weevil as a component of the sweet potato IPM system.

4) Eliminating the duty concession rate for farmers purchasing farm vehicles will increase the cost of machinery services and cause farmers to reduce machinery use and increase labor use. The profitability of IPM will be increased due to its higher labor use.

5) A reduction in the Common External Tariff will lower the cost of chemical inputs relative to labor which will lower the profitability of the IPM systems.

6) An appreciation in the real exchange rate will lower the export price of crops, reduce the cost of chemicals, and decrease the profitability of IPM.

7) The elimination of the credit subsidy will lower the cost of labor relative to mechanical and chemical inputs and will increase the profitability of IPM.

8) A fall in the real interest rate will lower the cost of labor relative to mechanical and chemical inputs and will increase the profitability of IPM.

VII. Procedures:

The research was divided into two main phases. The first phase was to gather information regarding production practices and resource constraints of farmers in Clarendon and the production systems of the IPM program for hot pepper, sweet potato

and callaloo. The information was used to assemble a representative farm model. The second phase of the research was to integrate the government policies into the model and to evaluate the impact of those policies on the adoption of the IPM technologies.

Chapter 2 discusses the economic conditions in Jamaica, both historically and presently. A discussion of the agricultural sector leads into an explanation of the role of government, particularly with respect to IPM. The components of the IPM systems are elaborated followed by a description of the previous literature on IPM and on policies affecting IPM adoption. The policies chosen to be incorporated in the model are detailed. Finally, the policies not integrated into the model are explained with a discussion of why each was not included.

Chapter 3 begins with a discussion of the representative farm approach. Components of the representative farm are detailed and followed by a description of the cropping and IPM systems of the farm. The empirical framework is described in detail including the activities and constraints facing the representative farm including crop acreage constraints. Finally, an in-depth description of the policies incorporated into the model explains how the parameters changed as a result of the policies.

Chapter 4 presents the results of the model. Four base scenarios are defined and then evaluated to estimate the economic incentives of the IPM systems. Two of the four scenarios are then used to analyze the impacts of the seven policies on the profitability of IPM adoption. Finally, a discussion of the potential impacts of the non-modeled policies concludes the chapter.

Chapter 5 describes the conclusions that can be drawn from the results and the policy implications. Recommendations for the IPM program are included and evaluated for potential impacts to the program. The chapter concludes with a brief summary of the possible future uses of the study results.

VIII. Benefits of Research

Currently, there are no studies showing the economic returns to the IPM program in Jamaica. The political or economic obstacles the program faces have not been analyzed. An economic study regarding the economic incentives to IPM adoption and how policies affect IPM adoption would help policy makers, researchers and educators better understand the effects of government policies on adoption of IPM by farmers. With more information about IPM adoption, CARDI could more efficiently direct research of the IPM systems. Since CARDI is a Caribbean organization, the research and conclusions of this study can be used when implementing research of other IPM systems throughout the Caribbean.

The Jamaican government, through the Rural Agricultural Development Authority (RADA) of the Ministry of Agriculture, provides the extension of the IPM technologies to farmers. The evaluation and results of this study can provide RADA with a better understanding of potential profitability of IPM adoption. With this knowledge, the decision makers of RADA could more effectively direct their extension efforts to farmers.

Finally, the IPM-CRSP program can benefit from this study because the conclusions provide the information necessary for greater efficiency in the investment of resources of the IPM-CRSP program. IPM-CRSP is working in both the research and extension areas of the IPM systems. By knowing the potential profitability of IPM adoption and the effects of government policies, the IPM-CRSP decision makers can make more informed decisions on the direction and emphasis of the IPM program.