

Chapter 2: Economic Background and Description of Policies

I. Introduction

The purpose of this chapter is to describe the economic environment of the Jamaican agriculture. The recent as well as historical conditions of the economy, and the agricultural sector in particular, are described in the beginning of the chapter. The background information is followed by a detailed discussion of Integrated Pest Management (IPM). A literature review is presented next to support the evaluation of policies affecting adoption of IPM. The chapter concludes with a detailed description of the policies chosen for this study. The various policies are detailed in two sections: policies incorporated into the model and policies not incorporated into the model.

II. Economic Background

Jamaica is an independent nation in the Caribbean. Although Queen Elizabeth II is the head of state, she is represented by a governor-general who is appointed by the Prime Minister. The Prime Minister is chosen from the House of Representatives while a Senate is appointed by the governor-general.

Jamaica is approximately 11,000 square kilometers (4,400 square miles) and has a population of 2.5 million people (World Bank, 1997) with an average annual growth rate of 1%. The life expectancy of an average citizen is 74 years and the adult illiteracy rate is 15%.

The World Bank ranks Jamaica among the lower-middle income economies (World Bank, 1997). The GDP in 1995 was \$US4,406 million and the average per capital income was \$US1,510. The average annual GDP growth rate between 1985 and 1995 was 3.6% with real GDP growth rate declining from 1987 to 1995. Since

1995, the annual growth rate of GDP has hovered around stagnation and led to a total growth in GDP of 2.9% between 1990 and 1997 (World Bank, 1997).

II a. Historical Economic Conditions

Great Britain gained control of Jamaica in 1660. Slaves were encouraged to grow small patches of plants, but sugar plantations provided large quantities of exports for the British. Slavery was abolished in 1838 and the fall of plantations was imminent due to lack of workers. In the early 1900's bananas had taken over as the chief export crop, though sugar and traditional crops, such as cocoa, citrus and coffee, were also exported. In 1943, Jamaica was granted a constitution that allowed for a House of Representatives and a Legislating Council which had the power to plan their own economic growth. In 1962 Jamaica gained its status as a fully independent nation.

From the 1950's to the early 1970's, Jamaica experienced an economic boom as a result of a rise in the bauxite and tourist industries. The real average annual growth rate of GDP was "more than 6 percent a year, one of the best growth records in the world" (Stone and Wellisz, 1993, p. 140). The high growth allowed the government to finance infrastructure projects. However, the unemployment rate, 22.8% in 1972, continued to be problematic.

In 1972, the People's National Party (PNP) was elected to power on the promise of redistributing income and reducing unemployment. The policies undertaken by the Manley administration combined with the fall of bauxite demand and the rise of oil prices repressed Jamaica's economic growth to such a degree that GDP fell continuously from 1973 to 1980.

Policies of the Manley administration included: trade restrictions such as quotas and import bans on items including luxury goods and foreign travel, a fixed exchange

rate to the US dollar, and socialist reforms such as the government taking control of industries (Stone and Wellisz, 1993). These reforms were not only financially costly but also resulted in heavy deficit spending and increased indebtedness to the IMF. The PNP attempted to compensate for the debt and large trade imbalance but this proved futile. After failing an IMF performance test in late 1977, the government, drastically short on funds, was forced to sign a \$US 240 million agreement with the IMF and follow strict guidelines for bringing the economy back under control.

Figure 2.1 shows the average annual percent change in GDP from 1955 to 1980. Although the average fell between 1955 to 1970, it was still positive. In 1970 the average annual percent change in GDP was 4.47%. After the 1972 elections, however, the percent change, with only three exceptions, fell continuously from 1973 until 1980. During this time the GDP growth rate was also negative with the sole exception of 1978 when the percent change was .51%. Because of the failure of the People's National party to alleviate the economic hardships, the economy was a major issue in the 1980 elections.

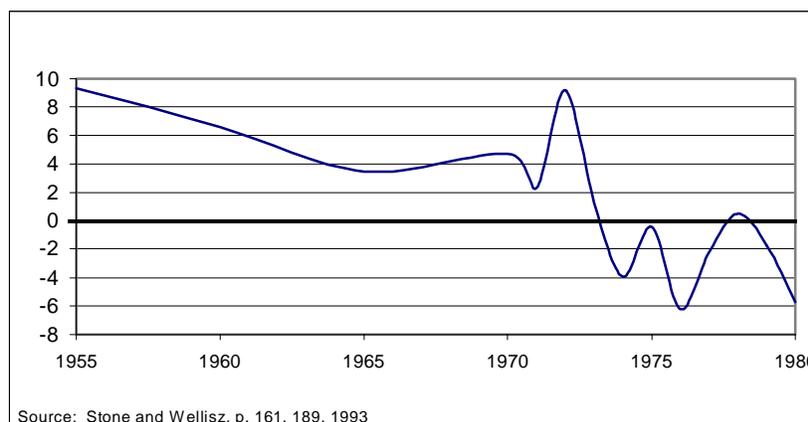


Figure 2.1 Average Annual Percent Change in GDP

With the elections in 1980 the opposition party to the PNP, the Jamaican Labor Party (JLP), swept the polls. The JLP had inherited an enormous economic problem. Unemployment still hovered about 20%, the budget deficit was around 20% of total GDP, sugar and banana exports were at their lowest levels ever, and manufacturing was stifled by the strict import restrictions. The economy, however, only recovered marginally between 1980 and 1987. Unemployment remained high, public debt continued to rise (in 1987 it was 140.4% of the GDP), and GDP annual growth fluctuated between a low of -4.6% in 1985 and a high of 5.2% in 1987. Exports, though increasing in diversification, fell in value relative to the value of imports. In 1978, the value of exports was 114.8% of the value of imports while in 1986, the value of exports was 84.4% of the value of imports (Stone and Wellisz, 1993).

Elections were held in 1989 and the PNP regained power with Manley once again at the helm. Having seen the pressure from the world community for the previous government to take a market approach to economic reform, the Manley administration continued in this trend. Increased pressure from the IMF and reconstruction efforts after the disaster caused by Hurricane Gilbert in late 1988 shaped the economic course of Jamaica for the early part of the 1990's.

The government began to seriously cut back the public sector in an effort to bring fiscal policy under control which, when combined with a tight monetary policy, was designed to help lower inflation. In 1990, prices rose an average of 29.9% due mainly to the rising food prices caused by Hurricane Gilbert. A General Consumption Tax was implemented as a way of simplifying the tax code. Economic liberalization continued with the free floating exchange rate policy adopted in September of 1991.

From 1991 to 1997, Jamaica continued to be plagued with persistent economic hardship. Real GDP growth hovered between -2.4% and 1.4%. Inflation ranged from

80.2% in 1991 to 9.2% in 1997. Nominal interest rates remained high in the range of 40% to 60% and the rate was 44.17% in 1997. A high nominal interest rate presents a significant barrier to borrowers due to expectations of continued high interest rates, particularly farmers facing uncertain markets. The low GDP growth rate, the high interest rate and declining inflation were a result of reduced investment by US due to the North American Free Trade Agreement (NAFTA) as well as tighter monetary and fiscal policy by the Jamaican government and the Bank of Jamaica in order to lower inflation (which has skyrocketed out of control caused by the massive debt that accrued in the 1980's) and stabilize the exchange rate. Figures 2.2 and 2.3 below show the inflation and nominal interest rates in the 1990's and the average annual GDP growth rate over the same time period.

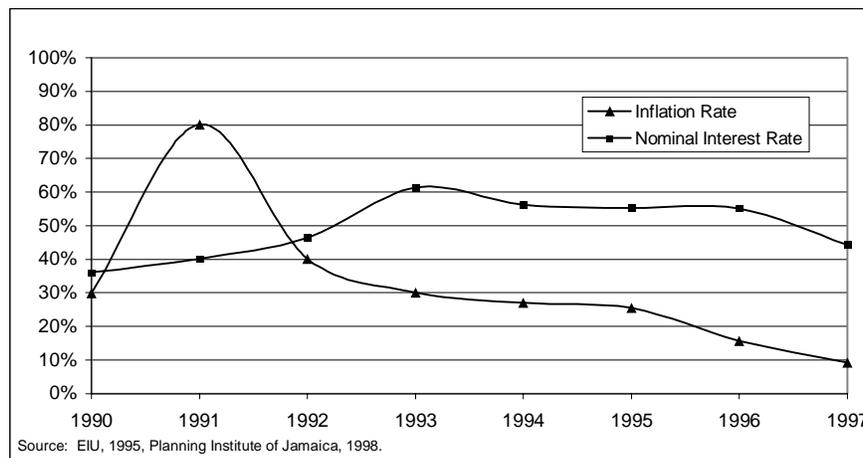


Figure 2.2 Inflation and Nominal Interest Rate Over Time

The average annual GDP growth rate fell during most of the 1990's and, indeed was negative for 1996 and 1997 at -1.7% and -2.4% , respectively. The falling GDP growth rate presents a difficult situation for government officials attempting to address the high inflation or interest rate. Figure 2.3 shows the declining GDP growth rate from 1990 to 1997. The heavy black grid line marks the 0% average annual growth rate.

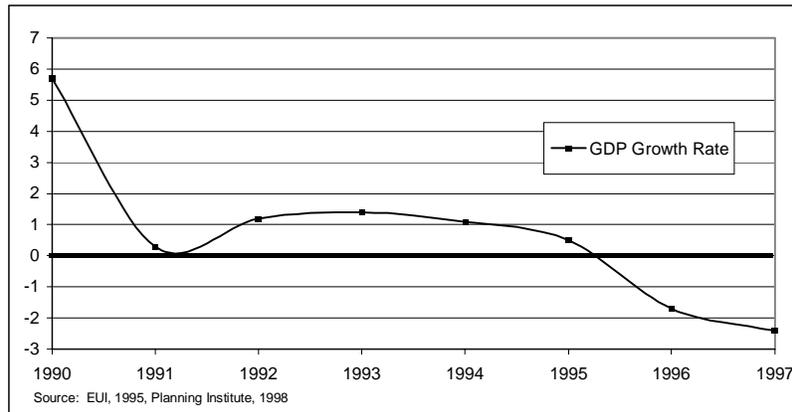


Figure 2.3 GDP Growth Rate Over Time

The nominal exchange rate continually declined from \$JM12.12:\$US1 to \$JM35.14:\$US1 in 1995. Since 1995 to early 1998, the nominal exchange rate has remained fairly constant as a result of the monetary and fiscal policies of the Bank of Jamaica and the Jamaican government. The stable exchange rate, along with the high real interest rates and growing confidence in the economic stability of Jamaica, has resulted in increased foreign investment from 0% of GDP in 1980 to 7% of GDP, \$US308.42 million, in 1995 (World Bank, 1997).

The real exchange rate¹ has risen from \$JM9.8:\$US1 in June 1992 to \$JM5.3:\$US1 in March 1998, a 45.9% appreciation. Jamaican goods on the foreign exchange market became more expensive from 1992 to early 1998 and the value of exports has decreased relative to the value of imports. The balance of goods and services for Jamaica has been increasingly negative throughout the 1990's. In 1994, the balance of goods and services was -\$US457 million and in 1997 it was -\$US971.7 million. Figure 2.4 below illustrates the appreciation of the real exchange rate along

¹ The real exchange rate is calculated as (nominal \$JM/\$US) X (nominal inflation rate US/JM). A common-year pricing index is used for the nominal inflation rate calculation. For a pricing index where 1988 = 100, the Jamaican consumer price index (CPI) for 1998 was 1115.9 and the US CPI was 162.2. The real exchange rate for 1998 was (36.51/1) X (162.2/1115.9) = 5.307. For more information see Krugman and Obstfeld, 1994, p. 424.

with the Jamaican CPI (where 1988 = 100) from May 1990 to March 1998. The vertical line on the graph delineates the date of September 1991 when the last exchange rate controls were lifted.

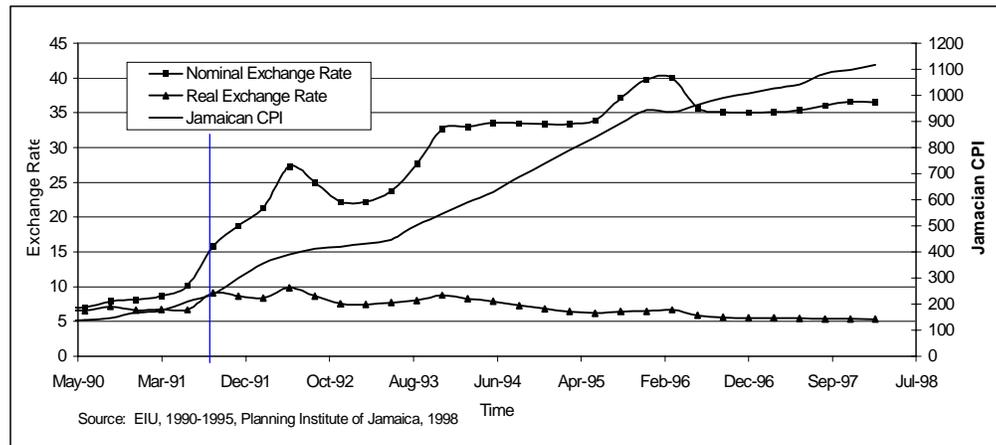


Figure 2.4 Real Exchange Rate 1990-1998

Jamaica has taken many steps in order to have a more market-based economy with minimal government interference with the goal of achieving long run economic growth. In addition, Jamaica has signed trade agreements designed to help promote trade and specialization within the country. The most recent trade negotiation was in 1994 when Jamaica joined 13 other CARICOM members to ratify the Association of Caribbean States. In addition, Jamaica participated in the Uruguay Round Agreements of the General Agreements on Tariffs and Trade. Trade agreements could have positive effects on the agricultural sector including higher growth rates. The specific agreements that Jamaica made will be discussed later in this chapter.

The macroeconomic history is important to the adoption of IPM because it influences the production methods of the farms and, therefore, their willingness to adopt alternative production systems. The current chemical usage by farmers is a direct result of increased effectiveness of chemicals as a result of research as well as

lower prices on chemicals relative to other inputs. The elimination of the subsidies to the agriculture sector is a result of a drive towards a more liberalized economy and a function of the past economic stresses. The attitudes of farmers towards IPM adoption as well as potential future policies can both be evaluated as a result of data on the macroeconomic history.

II b. Historical Agricultural Conditions

The Spanish arrived in Jamaica in 1494 and established large sugar cane, banana, citrus and cocoa plantations. The English seized control in 1655 and shortly thereafter introduced coffee growing to the island. To provide labor for the new plantation production and for the increase in production from the existing plantations, the English increased the slave population.

By the early 1800's, the sugar industry was on the decline and in 1838 slavery was abolished. Plantations continued to produce exports with the help of free men for labor. Most of the plantation owners held their land and were reluctant to give it to former slaves. The former slaves, then, had no choice but to work for their former masters. Those former slaves that did have small plots of land produced crops for the local market. The mixed cropping on the small plots gave farmers some income and also reduced the risk associated with monocropping for export.

From the 1840's to the 1960's, the pattern of large landholdings by a small number of land owners continued to persist, even when large amounts of land were under-utilized. Small plots became over utilized, especially on marginal land on hillsides which caused severe soil erosion. Small farms moved towards a market economy in the 1960's. However, higher transportation and distribution costs,

combined with continued over-utilization of the land, prevented domestic suppliers from satisfying domestic demand for agricultural goods.

In 1895 the Jamaican Agricultural Society (JAS) was founded with a mission to "collect and spread useful information, encourage the improved cultivation of products and better the breeds of stock, and to watch over the interest of the agricultural industry in general" (Hoyte, 1961, p. 9). The JAS was funded by the Jamaican government and grew to have several branches throughout the island.

In World War One, the Society organized food growing drives to establish permanent crops and to become competitive at the end of the war. The JAS also sold cattle insurance, worked to secure irrigation for the farmers by investing in irrigation systems, and helped the marketing boards of such crops as cocoa by suggesting marketing schemes to boost profits.

In 1951, the Jamaican government decided that the technical extension work of the JAS should be transferred to the Department of Agriculture. The new role for the JAS changed and the Society had four new objectives: to represent the farmers to the authorities, to organize group action among farmers, to continue to educate farmers, and to distribute input supplies when needed to farmers. The influence of the JAS has continued to decline from the early 1950's.

In the early 1990's the Jamaican government decided to reestablish research and extension services for farmers and created the Rural Agricultural Development Authority (RADA). One of the goals of establishing RADA was to bring back the connection between the Jamaican government and farmers. For instance, RADA supplied farmers with mechanized land preparation services.

The Jamaican government has also attempted to institute land reform. In 1963, when Jamaica gained its independence, the government began a land reform program

designed: to accelerate and extend the settlement of suitable agricultural land with provision of soil conservation, to introduce an appropriate basis for settlement including the choice of settlers, the size of farms and the terms of tenure, to reduce the quantity of idle agricultural land, and to take necessary action to develop appropriate land reform.

The government began leasing land to farmers. The over all objective was to increase the agricultural sector's contribution to GDP and to improve the rural welfare. The government is continuing to change land from lease to free holding and to distribute more free holding land to farmers.

Government officials recognize the need for conservation of natural resources and research in the agricultural industry as a way to improve rural incomes. However, there is no direct official policy towards Integrated Pest Management as a way to achieve higher incomes among farmers and to increase the agricultural sector's contribution to GDP. Nevertheless, the government does support the research of CARDI including IPM research and assists with extension of IPM through RADA.

III. Components of Integrated Pest Management

Integrated Pest Management is a collection of options available to a farmer with regards to a specific crop allowing the farmer to substitute away from pesticides. "IPM is not a prescription [for reducing pesticide use] but a philosophy of a way of thinking not just doing" (Reid, 1998b). IPM gives farmers different methods for controlling pests that will reduce the quantities of chemicals used by the farmer. There are two main thrusts of IPM: research and evaluation, and technical assistance to farmers (Reid, 1998b). Both of these areas are designed to give farmers short-term as well as long-run options for pesticide substitution.

The research aspect of Integrated Pest Management looks at identifying the pests affecting the crops, evaluating techniques to use against the pests (which will later be used in the technical assistance phase), and monitoring the pesticide usage. Researchers work to understand the pests affecting the crops. What are the pests? What damage do they do? How do they spread? After the pests have been identified and monitored, different options for reducing the pest population are evaluated. Are there natural enemies of the pest? How can they be released and monitored? What are the economic thresholds of the pesticides used? Finally, information is gathered regarding resistance levels of pests to specific pesticides and the exact population killed for a given level of pesticide used for particular pests. Research determines the levels of pesticides that can be applied while minimizing the harmful effects to humans and the environment and the economic loss to the farmer.

The research stage also develops a series of four component areas: mechanical, cultural, biological and chemical, which can then be presented to farmers as alternatives to only pesticide usage. Each of the recommendations in the areas are developed and tested in the research phase of IPM.

The second phase of IPM is technical assistance to farmers to assist them in adopting technologies within the four components areas: mechanical, cultural, biological and chemical. These components give the farmer different options from which to choose in order to substitute pesticides for pest management (Reid, 1998b). These components were developed through the research phase of IPM and are taught to farmers, usually through extension agents, in the second phase.

The mechanical component includes different physical adaptations for the farm. Screens are used to protect seedlings of such crops as hot peppers. The screens prevent early infestations of pests that mature plants can withstand. A farmer can also

substitute labor for pesticide use. Hoeing can be substituted for herbicides against weeds. Overhead sprinklers can be installed to disrupt the mating of specific insects such as the *plutella xylostella* on the cabbage plants of Barbados (Chandler, 1994, p. 19-20). Installing irrigation in a field can have a similar effect as overhead sprinklers. Traps, both sticky and mechanical, catch insects that would otherwise attack the crops.

Biological components for Integrated Pest Management include pheromone traps which use female pheromones to attract and capture the male pests (Chung, 1994, p. 57). If pests are known to infest multiple crops or travel by hosts, then those alternative crops or hosts can be removed from the field. Natural enemies of the pest can be released, particularly in cases where the enemies have previously inhabited the area but have been driven out by lack of prey. Finally, pest resistant crops can be biologically engineered or brought in from other parts of the world. Pest resistant crops allow the farmer to continue to grow the same crops with only minor adjustments.

Extension agents also seek to change long standing cultural practices of farming. Some pests will avoid a field during the wet season as opposed to the dry season. Therefore, delaying the planting season can reduce the quantities of pests on a particular crop by shifting when during the year a crop will be harvested. Field sanitation is accomplished by totally removing old plants and disposing of them by burying or burning which helps reduce the pest population by not giving the pests places to nest and breed. Quickly harvesting crops reduces the chance of attracting pests which would destroy a crop ready for sale. During planting season, farmers using clean planting material reduce the chance of spreading pests. Clean planting material is defined as any pest-free plant part used for growing crops such as the potato slips used for transplanting sweet potato. Plastic mulch can help provide covering for crops and reduce the need for herbicides. Farmers can use plant barriers to reduce the

spread of pests. For instance, corn can be planted between rows of hot pepper. Finally, researchers can show farmers that by planting crop rows farther apart, infected rows will have a harder time contaminating clean rows.

The last component of IPM, the chemical component, is developed through evaluation of the economic threshold of pesticide use in order to reduce unnecessary pesticide application. Chemical components of Integrated Pest Management include basing the quantities of pesticides used on the economic threshold of the particular pests on the specific crop. Since many farmers time the application of pesticides to a calendar schedule such as a weekly or even daily use, chemical components of integrated pest management focus on pesticide spraying according to the economic threshold. Alternative chemicals with lower toxicity levels are also researched and suggested to the farmer. In some cases, reducing the level of fertilizer usage reduces the chances of attracting pests (Chandler, 1994, p. 19).

Although many of the IPM components overlap between crops, each package developed is unique and tailored for a specific crop. The crops in the Jamaican IPM-CRSP program: callaloo, sweet potato, and hot pepper have different packages with some similar components. The details of the IPM packages are discussed in the next chapter when the farm production system is presented.

IV. Previous Economic Studies of IPM

Economic literature on IPM can be categorized into two main areas: economic evaluation of IPM and the economics of adoption of IPM. Government policies and practices have long been known to affect the economy, including the agricultural sector and have been shown to affect IPM adoption among Third World farmers (Tjornhom, 1995). The effects of government policies are studied as either a part of the evaluation

of IPM or a part of the barriers to adoption of IPM. This study analyzes the affects of government policies on IPM adoption by Jamaican farmers.

Economic evaluations of IPM have been undertaken for many years. Baum and Tillman (1978) discussed in the mid 1970's "The Economics Behind Integrated Pest Management". In this article, they explained how economics plays a role in IPM. They concluded that economic injury levels should play a key role in an IPM package offered to farmers.

Other articles have discussed various ways for evaluating IPM packages. Norton, Mullen, and Rajotte (1996) discuss these ways in their article, "A Primer on Economic Assessment of Integrated Pest Management". They describe the different methods for the economic evaluation of IPM at the farm level including: payoff matrix, budgeting analysis, stochastic dominance, economic thresholds, damage functions and optimal use of pest management practices that include mathematical programming. They also discuss aggregate level evaluation of IPM including economic surplus and cost benefit analysis.

The "Tar Heel Economist" devoted an entire issue to economic evaluations of IPM (September, 1981). In the first article, Larry Gholson defined economic evaluation as being dependent upon "information concerning costs of production and profit with and without IPM" (Gholson, 1981, p. 1). He reported on some of the limitations that constrain economic evaluation including: obtaining an unbiased sample between IPM and non-IPM farmers, variations in pest populations and differences in farm managing abilities. The second article discussed the empirical experience of IPM in specific crops in North Carolina including: coastal plains crops, cotton boll weevil, and apple IPM. The last article written by Gerald Carlson talks about guidelines for economic evaluation of IPM. These guidelines include: assessing off farm and on farm benefits and costs

of IPM, changes in yields, inclusion of farm management time, accounting for extension and other public resources, and returns to IPM investment.

Economic evaluation literature also examines the concept of economic thresholds. Fohner, White and Schwager (1982) examined the factors influencing the value of the economic threshold decision making rule. The authors concluded that economic thresholds contribute to IPM in three ways: "the analysis may contribute at a conceptual level as a framework for evaluating decision rules", "by illustrating the interdependencies among decision rules and quality of information", and "the framework may coordinate and improve the acquisition and use of information about pests" (Fohner, White and Schwager, 1982, p. 31-32).

Economic evaluation of IPM also took the form of direct calculations of costs and benefits of the IPM program. Antle and Park (1986) evaluated the IPM package for tomato production for the state of California. "The economics of the program can be understood in terms of the various benefits and costs associated with the program...benefits are due to the effects of the program on expected yield and revenues, pest management costs and the production risks due to worm damage... costs can be divided into insecticide costs and labor costs for sampling the fields" (Antle and Park, 1986, p. 4). The authors concluded that farmers using the IPM techniques had revenues increase by \$7.70 per acre where costs increased by \$.58 per acre. These revenue and costs changes led to an increase of profits by about \$7.10 per acre. The authors assumed that average yield per acre stayed constant at 25 total tons and the farmers received a constant price of \$52 per ton. For farmers using the IPM system marketable tons increased as a result of less preharvest damage from pests which increased profits by .5%.

The second main category of literature on economics and IPM is economic barriers to IPM adoption including analysis of government policies. Several studies have analyzed the various barriers to adoption from the problems with measurement of adoption rates (McDonald and Glynn, 1994) to farmers' attitudes regarding the consequences of adoption (Musser et al, 1986).

An early article (Reichelderfer, 1983) described what IPM is and touched on the topic of adoption. The author explained the growing numbers of farmers in the Cotton Belt of the United States using IPM technologies. The package given to farmers included scouting for pests. Since scouting is a labor intensive practice, scouting could have been a potential barrier to IPM adoption because of the higher labor costs. The study showed that "professional pest scouting services" (p. 23) became available to farmers which decreased production costs, relative to farmers scouting for themselves, and increased yields. It was noted, though, that "IPM doesn't always result in decreased pesticide use" (p. 23).

Another article from the 1980's examined how preconceived notions regarding IPM techniques and the risks associated with using them influence adoption rates for Georgia peanut farmers (Musser et al, 1986). The article presented "an interdisciplinary study of the relationship between risk and other perceptions of farmers and their adoption of IPM" (p. 35). One of the conclusions was that "users of IPM hold more positive beliefs about [the consequences of IPM use] than non-users" (p. 41). The exception to this finding was with regards to risk of losing profits from IPM and the authors concluded that "risk is not important in the IPM adoption decision" (p. 40). Finally, implications of this study suggest that education has a major role in adoption of IPM. "Assessing IPM beliefs would be helpful in identifying incorrect beliefs of non-

users so as to develop educational programs" and "changing these beliefs may help encourage adoption" (p. 41).

Recent articles analyzing the economics of adoption have focused on the institutional framework of IPM (Zalom, 1993), the definition and measurement of adoption (McDonald and Glynn, 1994) and on the effectiveness of IPM demonstrations in changing farmers' attitudes (McDonald, Glynn, Hoffman and Petzoldt, 1997).

From the procurement of funds for research to the task of extension of new components, organizers of an IPM research and extension program need an institutional framework (Zalom, 1993). Zalom asks: given the goals of IPM, what is the institutional setting which will best facilitate reaching these goals? Zalom concluded that three areas could use improvement. First, "greater investment in research and extension, while, necessary, should be accompanied by mechanisms which would address both short and long term problems associated with conversion to an agricultural production system based on lower pesticide use" (p. 253). Second, "degree programs which would lead to professional accreditation in plant health and pest management should be supported at Land Grant universities" (p. 254). These degree programs would allow for greater information flow in pest management consulting. Third, "certification.. would require establishing a set of crop specific IPM standards which a grower would need to follow in order to meet requirements and might be similar to those regulations defining and certifying organically grown products" (p. 254).

McDonald and Glynn (1994) sought to explain the challenges of measuring IPM adoption and the implications of those particular challenges to a case study of New York apple growers. The authors define the obstacles to adoption in three categories: systematic obstacles, individual factors and personal characteristics of farmers. They then discuss varying measures of adoption from a single measure adoption statistic to

a multi-level scale of adoption of IPM techniques to "measure a number of components of the innovation and determine the interrelationships between the components so that various innovation factors can be determined and described" (p. 222). The authors found that growers use IPM techniques because the techniques address problems that are already important to the grower. "The problem then becomes one of separating out those [farmers] who actually follow the practice [of IPM] from those who merely adopted the terminology" (p.228). By using an IPM index level, the authors concluded that there were three considerations when measuring IPM adoption. First, IPM adoption needs to be divided into specific categories of techniques such as scouting and pesticide use and second, that extension agents should "provide social and psychological benefits or rewards to those using IPM" which would "serve to strengthen growers' self-esteem if they feel their contribution makes a difference to society" (p. 229). Lastly, "further research into IPM has to center more specifically on the economic... motivations for those who have adopted IPM... there is some evidence that economic benefit may be the initiator, but that environmental concern may be a product of the change and that... becomes a sustaining factor" (p. 229).

Nowak, Padgett and Hoban (1996) discussed some considerations for assessing barriers to IPM adoption at the Third Annual IPM Symposium. The authors defined three ways to measure adoption: with accounting measures such as counting audience response, with proportional measures of the extent of adoption and with accuracy in use measures to account for "the nature and level of pest pressure or for the risk of significant crops damage if inappropriate actions are taken" (p.100). The authors then classified barriers to adoption according to two areas: being unable to adopt IPM or being unwilling to adopt IPM. The conclusions of these listings were that "increasing the adoption of IPM practices is dependent on first addressing reasons why

farmers are unable to adopt", "many of the factors causing farmers to be unable or unwilling to adopt are beyond their control", and " a shotgun approach to using technical, financial or educational assistance is not the answer" (p.104). The authors instead recommend "more effort needs to be spent trying to understand the reasons why a farmer may be unable or unwilling to adopt" (p.104).

One of the reasons found by Nowak, Padgett and Hoban for farmers' unwillingness to adopt IPM was the "belief in traditional practices" and preconceived notions about IPM (Nowak, Padgett and Hoban, 1996). This reason for farmers' unwillingness to adopt IPM was analyzed by McDonald et al (1997). The authors looked at IPM demonstrations to onion farmers in New York and asked if the demonstrations influence the knowledge, attitude or behavior towards IPM adoption. The authors concluded that IPM knowledge is growing regardless of the demonstrations. They also found that "among the clearest effects of the demonstration is in the area of biological controls" (p.137). A final comment from the authors touched upon the externalities of IPM adoption saying that "this study suggests that such spillover effects may also be important considerations [to decision makers] when designing any program in which evidence is to be gathered on the effectiveness of IPM" (p. 137).

The literature on the impacts of specific policies, in particular trade policies and relative price distortion policies, towards the adoption of IPM is limited and nonexistent with regards to Jamaica. As previously mentioned, Tjornhom, Norton and Gapud (1998) examined the impacts of price and exchange rate policies on IPM in the Philippines. By calculating the effective rate of protection, the authors used the data to analyze the changes in economic surplus associated with changing pesticide prices as a result of eliminating the rates of protection. The authors showed that exchange

rate policies can have a significant impact on pesticide prices and therefore IPM adoption.

Policies affecting pesticide use were also evaluated by Stefan Agne (1996) in his analysis of Costa Rica's agricultural sector. He looked at pesticide trade, pesticide policy formation and implementation, agricultural credit, agricultural research and extension to farmers. He also examined the indirect negative effects of pesticide use such as the health impacts and the environmental residues.

Some of the conclusions of Agne's study included that institutional and information constraints hindered the adoption of IPM. A lack of clarity regarding legislation towards the agricultural sector results when too many institutions are responsible for the same task. While the government was promoting education about pesticide danger, the pesticide industry was advertising the benefits of usage creating confusion for farmers. Finally, the external cost of pesticides "such as environmental pollution was tolerated by society" (p. iv).

The article recommended further research on: pesticide productivity, economic evaluation of the externalities of pesticide use, cost-benefit analysis of IPM, and "analysis of the effects of alternative policy scenarios on pesticide use, productivity and farmers income" (Agne, 1996, p. 46).

In general, the results of the IPM studies from outside of the US agree with the studies done on IPM within the US. The previous literature suggests that IPM systems lower the cost of chemical inputs and raise the total opportunity cost of the farm manager's time by increasing the time required on the farm. Over all profits, though, are higher with the IPM systems adopted.

Two of the major barriers in the development and adoption of IPM systems are: lack of knowledge among farmers about the IPM systems and lack of evaluation regarding government policy effects on the adoption of the IPM systems.

The literature reviewed for the effects of government policies supports the idea that policy can assist or hinder the adoption of IPM by farmers through direct measures, such as credit subsidies to farmers, or through indirect measures, such as funding for research. Direct measure are actions that the government takes to directly affect IPM adoption. Indirect measures are actions the government takes that affect the support systems for IPM adoption. The literature, however, failed to cover the effects of a wide range of policies or the effects from a combination of policies. This research covered a total of fourteen policies, direct or indirect, and the affects of policy combinations on the profitability of IPM.

V. Policies Affecting Adoption of IPM Systems

The policy areas were examined for potential affects on IPM adoption and included: trade policies, water and credit subsidies, inflation policy, minimum wage laws, research and extension allocations, and pesticide regulations. Information about the policies in Jamaica was obtained through interviews with officials at the Ministry of Agriculture, RADA, the Pesticide Control Authority, Animal and Plant Health Inspection Service (APHIS), the National Irrigation Commission (NIC), Plant Quarantine Division, and the Bank of Jamaica (BoJ). The policies were categorized by their potential effect on the profitability of IPM: policies affecting inputs costs, policies affecting input requirements, policies affecting output prices, and policies not incorporated in the model. Table 2.1 is shown below and lists: the policy category, the policy areas, the current policies, and the policies' potential effects on IPM adoption.

Table 2.1 Policies and Potential Effects on IPM Adoption

Policy Category	Policy Area	Current Policy	Potential Effects on IPM Adoption
Policies affecting input costs	Water Rates	Farmers pay from \$JM7.50 to \$JM.42 per cubic yard of water used. Non-farmers pay a flat fee of \$JM33.17 per thousand US gallons or \$JM8 per cubic yard.	Smaller subsidies will raise irrigation costs and could induce farmers away from adopting IPM systems that promote irrigation.
	Credit Subsidy	Farmers borrow capital funds at a nominal passbook rate of 13% in May 1998. The nominal commercial rate of loans in February 1998 was 35.51%.	If the farmers were forced to pay the nominal commercial rate for loans, they might have less incentive to borrow. Since farmers do not borrow for labor, they might use more labor instead of physical capital. The higher interest rate could support IPM adoption.
	Real Interest Rate	The real interest rate is affected by the inflation rate and the nominal interest rate. The nominal interest rate is market determined. The inflation rate policy is explained below.	If the real interest rate falls, farmers are more willing to borrow operating capital and less attracted to low operating capital requirements of IPM.
	Vehicle Duty Rates	Farmers can receive a 20% duty concession on purchasing new farm vehicles.	If this duty were extended to all physical capital, farmers might substitute physical capital for labor usage which would discourage hiring labor for production using the IPM systems.
	Common External Tariff (CET) and the Uruguay Round Agreements	In June 1998, the CET was 40% with a Stamp Duty of 15% - 50%. The Uruguay Round agreements made by Jamaica were that the CET could be no more than 100%, the customs duty would be a maximum of 80% and these would be reduced in 7 years to an unknown percentage.	If physical capital becomes cheaper as a result of a lower CET and customs duty, farmers might substitute physical capital for labor. The substitution could cause farmers to shift away from adopting labor intensive IPM systems.
Policies affecting input costs and output prices	Real Exchange Rate	The nominal exchange rate is floating against the US dollar. The Bank of Jamaica is attempting to control inflation which would potentially appreciate the real exchange rate.	With an appreciation in the real exchange rate, there will be two potential effects on IPM adoption. First, there will be a fall in the relative export price received which discourages crops exports including those produced with IPM. Second, there will be a fall in the relative price of chemicals. Farmers might shift production away from IPM technologies and continue using the conventional systems.

Table 2.1 Policies and Potential Effects on IPM Adoption (continued)

Policy Category	Policy Area	Current Policy	Potential Effects on IPM Adoption
Policies affecting output prices and input requirements	USDA Preclearance Stations	Agricultural products imported into the US must pass a preclearance inspection to be free of pests.	Farmers can inspect the crops before shipping them to a preclearance facility. The inspection increases the labor necessary for the production practice. The increase in labor requirements will compete with the increased IPM labor requirements and could shift production away from IPM.
Policies not included in the model	Inflation Rate	The BoJ is attempting to lower the inflation rate to 5% - 6% at a maximum. In 1997, the inflation rate was 9%.	Indirectly, the inflation rate affects IPM adoption through its effects on the real exchange rate and the real interest rate. Directly, if farmers have expectations for higher inflation, they might shift to production of short term crops such as callaloo as a prevention of risk against unknown returns. The shift to callaloo might also include the IPM system developed for the crop.
	Pesticide Import Restrictions and Tax	All pesticides are imported into Jamaica where a .5% tariff is imposed. Some pesticides are banned from the country.	Raising the import tariff will raise prices of pesticides. Higher pesticide prices might induce more adoption of the IPM systems.
	Income Tax Relief	Qualifying farmers pay none of the 25% personal income tax.	Farmers need to qualify for the relief. If part of the qualification is mandated IPM adoption, this can increase the rate of adoption among farmers.
	Land Taxes	Farmers receive a 50% land tax reduction for land in agricultural use.	If agricultural use also implied IPM adoption, farmers might be more willing to adopt the IPM systems to get the tax reduction.
	Minimum Wage	The current minimum wage is \$JM800 per week. Farmers currently pay \$JM400 to \$JM600 per day for hired help.	A raise in the minimum wage would cause a decrease in the wage paid by farmers relative to urban wages. The relative decrease could shift hired help away from farms and into cities. Farmers might not have the necessary labor for the IPM systems.
	Research Allocation	Current funding for all research, including IPM, for the fiscal year 1998/99 is \$JM57,361,000 of the total Ministry of Agriculture budget of \$JM725,000,000 or about 7.9% of the total budget.	Only a few of the crops available for a farmer's production are being researched with IPM systems. None of these crops has a complete system. More funding to research would hasten the completion of the IPM systems.
	Extension Allocation	Current funding for all extension activities, including IPM, for the fiscal year 1998/99 is \$JM207,302,000 of the total Ministry of Agriculture budget of \$JM725,000,000 or about 28.6% of the total budget.	Education of farmers is a main obstacle to IPM adoption. If more resources are allocated to IPM extension, more farmers would understand the benefits to adoption.

Table 2.1 lists the most likely policies to affect IPM adoption. In order to incorporate the policies into the farm programming model, new activities needed to be generated. Given the nature of the different policies not all could be simulated by parameters added to the conceptual framework. The policies are detailed below with reasons for the incorporation or omission from the model. Descriptions of the model parameters are included in the following chapter. Policies not incorporated into the model will be discussed for influences on IPM adoption after the results of the model are analyzed. The exact parameters included in the model to simulate the policies will be discussed in the next chapter.

V a. Policies Incorporated into the Empirical Framework

USDA preclearance stations: The USDA Animal and Plant Health Inspection Service (APHIS) requires that all agricultural imports to the United States pass phytosanitation inspections for pests, soil and disease. A country's agricultural exports must pass inspection before being allowed into the US market. Owners' of agricultural goods that fail to pass inspection have two choices. The cargo can be fumigated and reinspected or it can be shipped back to the country of origin. Either choice is costly and holds no guarantees that all of the cargo will be sold.

To help prevent shipments from being rejected, exporting countries can choose to build a domestic facility, called a preclearance station, to allow the agricultural goods to be inspected before they are exported to the US. Goods that pass through the facility can directly enter the US market upon arrival. Preclearance saves one half of a day to a whole day delay for the food to reach the market. This means that the goods are fresher and more likely to be sold at a premium price.

There are two preclearance stations in Jamaica: one in Kingston and the other in Montego Bay. They were built in the 1980's and began to service the agricultural exporting sector of Jamaica shortly thereafter. The stations were funded by both the Jamaican government and USAID. In September 1996, USAID ceased its assistance in funding the facilities. The agency thought that the Jamaican government was not providing the necessary financial assistance. Funding for the facilities presently comes from Jamaican Exporters Association (JEA). The JEA is working with the Ministry of Agriculture Phytosanitary and Plant Quarantine/Product Inspection Unit and the USDA APHIS to coordinate a One Stop facility where preinspection, fumigation and transportation are located. By late 1998, the Jamaican government will require all agricultural exports to pass through the preclearance station.

Growers of the goods to be exported are identified on the packaging which allows authorities to identify farms who do not pass preclearance. If a shipment fails preclearance, the inspectors know where the agricultural products originate and can visit the farmer to help solve the problem.

By using the IPM systems, a farmer increases his labor requirements in his production practice. If he inspects his goods before shipping them to the preclearance station, he will have a greater chance of passing the station. However, the inspection will use additional labor. The additional labor needed for inspection will compete with the additional labor needed for the IPM systems. Preclearance also allows the farmer to receive a higher price and to sell a higher quantity. The exporters who buy from the farmers can afford to pay the farmers a higher price for their goods because of the higher chance of passing the preclearance station on the first inspection. The farmer also increases his exported harvest because of the confidence of the exporter. These changes could be represented in the model by additional parameters.

Real Exchange Rate: Before September 1991, Jamaica fixed its nominal exchange rate to the US dollar and since 1991 the nominal exchange rate has been free floating. The real exchange rate has fluctuated before and after the fiscal policy was implemented. The real exchange rate is influenced not only by the nominal exchange rate but also by the relative inflation rates in both the importing and exporting countries. To farmers, the real exchange rate is what is important for exporting their crops. An appreciation in the real exchange rate means that importers of Jamaican agricultural crops will face relatively higher prices and will purchase a smaller quantity. Farmers will be lower the export price received to compensate for the appreciation.

Changes in the real exchange rate could likely affect the profitability of IPM because the fluctuations would change the input prices in addition to the output prices. If labor becomes more expensive relative to the price received for hot pepper, farmers would have less incentive to adopt the labor intensive IPM package for hot pepper.

Fluctuations in the real exchange rate were incorporated into the model because altering existing parameters would simulate the changes in the exchange rate. Changes in the real exchange rate were done on a percentage basis in order to better understand the impact to farmers. A one dollar change can seem like a small absolute amount but can be a large percentage change which causes resources to shift dramatically.

Real Interest Rate: The real interest rate is a function of both the nominal interest rate and the inflation rate. As the real interest rate falls, farmers can borrow the same quantity of capital from banks at a lower real cost, even if the nominal interest rate is rising. The Jamaican government has no direct policy towards the real interest rate. Instead, the Bank of Jamaica concentrates on the inflation rate while the Agriculture Credit Bank is in charge of the nominal interest rate.

The farmers interviewed for this study did not take out loans for labor costs. Loans are for operating capital and investment capital. If the real interest rate fell, farmers might be induced to take larger loans. The cheaper capital reduces the advantages of the less capital intensive IPM systems.

The model assumes that there is no inflation over the one year period. Because of this assumption, the interest rate used was a real interest rate calculated by subtracting the inflation rate from the nominal interest rate². By varying this rate, the real interest rate was effectively being varied as well.

Common External Tariff and the Uruguay Round Agreements: Goods imported into Jamaica from the US face two different tariffs. The first is the Common External Tariff which is a general tariff applied to all goods imported from non CARICOM countries, including the United States. In June of 1998, the CET was 40% of the value of the goods imported. In addition to the CET, Jamaica applies a customs duty, called the Stamp Duty, of 15% to 50% depending on the good imported. Therefore, goods imported from the US into Jamaica are taxed at a total rate of 55% to 90%.

The Uruguay Round negotiations of the General Agreement on Tariffs and Trade (GATT) ended in December of 1993. Jamaica, along with the other CARICOM nations, made concessions limiting the CET. Jamaica also made agreements on the Stamp Duty. CARICOM agreed to set a maximum to the CET of 100%. In addition, the maximum percentage would be reduced over the next seven years. Jamaica agreed that the Stamp Duty would be limited to 80% of the value of the imported good. The limit on the Stamp Duty, too, would be reduced over the next seven years. However, no final percentage was agreed upon for either the CET or the Stamp Duty.

² A more precise calculation can be found in Boehlje and Eidman (1984, p. 137). The exact nominal rate can be calculated as $(1+r)(1+i) = (1+n)$, where n is the nominal interest rate, i is the inflation rate and r is the real interest rate. If $n=13\%$, $i=10\%$, then $r=2.72\%$.

The changes in the CET and the Stamp Duty were included in the model by the manipulation of the relative prices of the inputs used by farmers that are imported into the country such as machinery services and pesticides. As with the real exchange rate, the analysis of the changes in the CET and Stamp Duty was done by percentages as using the absolute values might give a false impression as to the potentially significant impact of small nominal shifts.

Duty Concession: Farmers who submit an application are allowed a 20% duty concession on farm vehicles. The farmers must prove that the vehicles will be used for agricultural purposes and can not sell the vehicles within three years of purchasing. The representative farm model is maximizing total revenue and is concerned with the variable cost within one growing season. Vehicle purchases are rare according to the farmers interviewed and payments for purchases will be spread out over several years.

Machinery services are rented by farmers. When the land needs to be prepared for a crop, farmers rent tractor services. The price paid by farmers will be a reflection of the ownership and operating cost of the tractor to the owner and the owner's labor. As the duty concession changes, the ownership cost of the tractor will change which will affect the price paid by farmers for the service. Manipulation of the machinery service price reflected changes in the duty concession rate.

The duty concession elimination reflects a worst case scenario. The elimination of the concession would, in fact, only affect the cost of new imported farm vehicles and not the vehicles already in the country. Therefore, the assumption on the duty concession policy is that further tractor services after the concession elimination would be accomplished with only new tractors. The duty concession elimination would affect the profitability of IPM because if machinery services became more expensive, labor would become relatively less expensive and the profitability of IPM would rise.

Water Rates: Farmers are given concessional water rates that are set by the National Irrigation Commission (NIC). Until 1996, the demand rates charged by the NIC were divided into three categories: nonagricultural use, small farm use and large farm use. Small farms were those establishments with less than ten acres while farms with more than ten acres were considered large farms. Agricultural users were charged an additional service rate which was not applied to the nonagricultural users.

In 1996, the NIC redefined the water rates. From September 1996 until August 31, 1998 non-agricultural users were charged a constant rate based on use. Domestic users receiving water from the National Water Commission are charged a usage rate of \$JM33.17 per thousand US gallons used. Industrial users are charged \$JM40 for every thousand US gallons used.

Rates for agricultural use include a service charge and a demand charge. The rate schedule from September 1996 until August 1998 is as follows. A service charge is applied to farms in three sizes: less than five acres, between five and ten acres, and more than ten acres. The service charge is \$JM12.11 per acre per month, \$JM24.23 per acre per month, or \$JM30.29 per acre per month depending on the farm size where the smaller the farm size the less the per-acre, per-month charge.

The demand charge for the farms is based on the quantity per hour per day used or the total volume of water consumed per day. The system is a graduated system whereby the larger farms pay less per unit used. The per use charges are, for small farms and large farms, respectively, \$JM7.50 and \$JM.31 per cubic yard. Because the representative farm in this study is ten acres, the demand charge on the farm model was chosen to be \$JM7.50 for each cubic yard used. In addition, a service charge of \$JM24.23 per acre per month is applied to the farms using water from the

NIC. The water policy changes incorporated into the model will be discussed in the next chapter.

IPM profitability could potentially be affected by the change in water rates because some of the IPM systems require irrigation as a component. If the price of water rose as a result of the elimination of the subsidy, then the profitability of IPM might fall.

Credit Subsidy: The Agricultural Credit Bank (ACB) oversees the distribution of loans. When a farmer requires financial assistance, he will visit the local People's Cooperative Bank (PCB), rural lending institutions established in 1905, and apply for a loan. The PCB reviews the application and, if approved, will then send the application to the ACB for final confirmation. The ACB will then loan the money to the PCB who will in turn lend the money to the farmer.

Loans to farmers are categorized between small farmers and large farmers. Small farmers hold less than 25 acres of land or borrow less than \$JM100,000 (Williams, 1998). All of the farmers interviewed could be categorized as small farmers. Small farmers paid a nominal interest rate equal to the Jamaican Treasury Bill yield adjusted quarterly up until 1997 when the nominal interest rate was fixed to the lowest passbook rate. The nominal interest rate to farmers as of May 1, 1998 was 13% while the lending rate for non-agricultural borrowers was a weighted average rate of 35.51% in February 1998.

The effects of the credit subsidy on IPM profitability were incorporated into the model by adjusting the real interest rate charged to farmers. Farmers might shift their production methods towards or away from IPM adoption as a result of lower or higher costs of financial capital.

V b. Policies Not Incorporated into the Empirical Framework

Pesticide Import Restrictions and Tax: All pesticides used in Jamaica are imported into the country and are under the direct control of the Pesticide Control Authority (PCA). The PCA was established by the Pesticides Acts of 1975 with specific functions in regards to pesticides including: registering pesticides, distribution of import licenses, authorizing potential pesticide sellers and issuing licenses to pesticide control operators. The PCA is responsible for the importation, distribution and sale of pesticides within Jamaica.

In order to financially support the PCA, a tax on pesticides was issued in the Pesticides Act of 1975. In 1998, the tax was .5% of the value of the imported pesticides and the funds collected are used only for the PCA budget. In addition, the PCA prohibits and enforces a list of restricted pesticides including: DDT, flourocetamide, mercury compounds and any other substances not registered for importation.

Neither the pesticide tax nor the pesticide ban was included within the model. The effect of the pesticide bans could not be evaluated because of the lack of data on changes in crop yield with eliminating pesticides. The pesticide tax was not included in the model because the effect of the tax on the returns to IPM was assumed insignificant.

Inflation Rate: The Bank of Jamaica is responsible for controlling the inflation rate. The goal of the Bank is to lower the inflation rate to 3% to 5% as a way to ensure a stable interest rate. The goal is also influenced by the US inflation rate. An inflation rate closer to the US inflation rate will help to ensure more stable nominal and real exchange rates.

The inflation rate was not incorporated directly into the model. Changes in the real interest rate and the real exchange rate reflect changes in the inflation rate because both are a function of the inflation rate as described earlier. Analysis of the real interest rate and the real exchange rate will be addressed.

Income Tax Relief: In 1982, in accordance with a government policy to increase agricultural production, Income Tax Act 21 was passed. The act was designed to give income tax relief for people in prescribed agricultural activity. These prescribed activities included: growing of food crops, seed growing, growing trees for timber, fishing and fish farming, and horticulture. Income Tax Act 21 grants persons of the prescribed occupations a waiver on the federal income tax. In 1998, the income tax was 25% of personal income. The income tax relief was not added into the model because the relief is not tied to the use of IPM.

Minimum Wage: In 1996, the minimum wage was \$JM800 per week and continues to hold steady. In the summer of 1997 there was discussion among government officials with regards to raising the minimum wage to \$JM1000 per week. Since 1996, prices have risen while the minimum wage amount has not. The decrease in the purchasing power of the Jamaican dollar is causing concern among some government officials.

Farmers pay their hired help \$JM400 to \$JM600 per day depending on the task completed. Farmers in Clarendon paying the minimum wage to hired help would experience a shortage of supply because most laborers can earn more than the minimum wage. The minimum wage was excluded from the model because farmers are already paying more than the minimum wage. Raising the minimum wage would narrow the gap between the minimum wage and the wage paid by farmers. However,

the farm wage would continue to be greater than the minimum wage and was assumed not to be affected by the change in the minimum wage.

Research Allocation: For the fiscal year 1998-1999 the total Ministry of Agriculture budget was \$JM725 million. Of the total budget, roughly 7.9% was allocated to the category of Research and Development. Research and Development is then broken down into six subcategories: administration, livestock research, crop research, plant protection, research station management, and post entry plant quarantine. Crop Research and Development received \$JM8.79 million, about 15.3% of the total funding for all research. IPM system development by the Jamaican government would fall into the Crop Research and Development category. Most of the IPM research, however, is being accomplished by the Caribbean Agriculture Research and Development Institute (CARDI). Implications of the quantity of funding and the source will be discussed following the model analysis. Research allocation was not included in the model because there was no means to show a link between changes in research funding and farming production practices.

Extension Allocation: For the fiscal year 1998-1999, \$JM207 million of the Ministry of Agriculture's budget was allocated as grants to the Rural Agriculture Development Authority (RADA). The funding to RADA was about 28.6% of the total budget for the Ministry of Agriculture. RADA is responsible for all of the extension to agriculture on the island, including all of the IPM extension. CARDI has limited extension responsibilities and relies on RADA for educating farmers on the new techniques developed. As more money is granted to RADA, more capital, such as vehicles, can be purchased and more personnel can be used to educate and assist farmers in the IPM systems being developed. As with the research allocation, extension allocation was not included in the model. Changes in funding levels have an

indirect effect on farm production methods and therefore could not be simulated simply by changing parameters within the empirical framework. The impacts of extension funding will be discussed after the model analysis is completed.

Land Taxes: "A relief of 50% of the tax is granted in cases where the land is used exclusively or principally for agriculture purposes" (Revenue Board, Guide No. 2). When the land tax system was implemented in the 1974, land in agricultural use was granted relief from the tax. In 1998, the relief granted was 50% of the potential value of the land where a minimum of \$JM50 per year per acre must be paid. Land taxes were not included in the empirical model because the tax is not tied to how or which crops are grown.

VI. Summary

Since the days of colonialism, agriculture has played a large part in Jamaica's economy. The agricultural sector, and the non-traditional exports category in particular, is presently facing problems with exporting their products and environmental degradation. USAID, CARDI and the Jamaican government are working together to develop IPM systems and educate farmers on the use of those systems. The political atmosphere and economic policies are potentially influencing the success in convincing farmers to adopt IPM. A wide variety of policy instruments were examined for this project. The following chapter will describe the model used for evaluating the effects of the policies on the production methods of farmers and the adoption of IPM by farmers.