ADOPTION OF INTEGRATED PEST MANAGEMENT TECHNOLOGY BY FARMERS IN THE JORDAN VALLEY

By
Yanal Hayel Al-Khassawneh

Supervisor
Dr. Ahmad Shukri Al-Rimawi

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Faculty of Graduate Studies
University of Jordan

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This thesis was successfully defended and approved on August 3, 2000.

Examination Committee	Signature
Dr. Ahmad Al-Rimawi , Chairman Assoc. Prof. of Agricultural Economics and Extension	A. Rimawi
Dr. Mohammad Samir El-Habbab, Member Prof. of Agricultural Marketing	
Dr. Akram Baqain, Member Assist. Prof. of Agricultural Extension	A. Rimawi
Dr. Laith Al-Rousan, Member Assist. Prof. of Rural Development and Extension	

Dedication

To

My Parents who gave me a sound philosophy of life by which to live and who taught me the value of education.

I would also like to dedicate my thesis to my husband, sister, brothers and friends.

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Abbreviations

ATC	**Average Total Cost**
DDT	**Dichlorodiphenyl Trichloro-ethane**
df(s)	**Degree of Freedom (s)**
Du	**Dunum (0.1 hectar)**
ESCWA	**Economic And Social Commission For Western Asia**
FAO	**Food and Agricultural Organization of the United Nations**
GH(s)	**Green House (s)**
GM(s)	**Gross Margin (s)**
GTZ	**German Technical Cooperation Agency**
JD	**Jordanian Dinar**
JES	**Jordan Environment Society**
JV	**Jordan Valley**
ICARDA	**International Center for Agricultural Research in the Dry Areas**
IPM	**Integrated Pest Management**
MOA	**Ministry of Agriculture**
MOI	**Ministry of Information**
MOP	**Ministry of Planning**
MC	**Marginal Cost**

NCARTT	**National Center for Agricultural Research and Technology Transfer**
OLS	**Ordinary Least Squares**
TVC	**Total Variable Cost**
TC	**Total Costs**
Ton	**1000 Kg**

Appendices

ABSTRACT

Adoption of Integrated Pest Management Technology by Farmers in the Jordan Valley

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Integrated Pest Management (IPM) technology is a tool of achieving sustainable agriculture. The factors influencing the adoption of IPM technology have not been a subject of analytical research in Jordan in the past. The main objectives of this study are: (a) to identify some factors influencing the probability of adopting IPM techniques by farmers in the Jordan Valley, focussing on some of the personal, farm resources and institutional factors and (b) to compare the costs of producing two major protected vegetable crops (tomato and cucumber) with Non-IPM and IPM technology. The study based basically on primary data using a semi-closed questionnaire. The study sample consisted of 110 growers of protected vegetable crops, Non-IPM adopters and IPM adopters. The Logit and Probit models besides chi-square test of independence were used to achieve the first objective of the study. The enterprise budgets and

the cost functions were calculated to compare the costs of producing tomato and cucumber crops with Non-IPM and IPM technology.

The major findings of the study indicated that, farmer's level of education, gender " female farmer ", the profession as an agricultural engineer, size of holding, residing outside the Jordan Valley, off-farm employment, participation in extension activities and access to agricultural credit have a significant positive relationship regarding the adoption of IPM. While, the farmers' age and land tenure status appeared to be insignificant factors. However, the years of experience have a significant negative effect upon adoption of IPM technology. The results of the enterprise budgets and cost functions showed that IPM technology is a saving technology and it generates higher gross margins and revenues.

It is concluded that IPM technology couples the better addressing of farm profitability, with practical stable pest and disease control in addition to its favorable important impacts on human health and environment. Thus it is an important implication to promote the IPM technology to farmers.

Part One
Frame of the study

Chapter One

1. Introduction

1. Introduction

1.1 General

The agricultural sector is considered as an important sector of the Jordan economy. It is a source of food production and raw materials for other sectors including the industrial sector (MOP, 1994). In 1998, its contribution was 4.4 % to the gross domestic product (GDP) and 3.7 % to the gross national product (GNP) (MOA, 1998).

Jordan always tries to improve the productivity of the agricultural sector and to put it on a sustainable footing for the future. It benefits from the climatic advantage in the Jordan Valley, which is one of the most active and largest agricultural areas. The Jordan Valley is a Rift Valley of 100 kilometers long and five to ten kilometers wide, running in a north-south direction between lake Tiberias and the Dead Sea, ranging between 200 to 400 meters below sea level, respectively. The annual rainfall varies between 100 mm near the Dead Sea to 350 mm in the north, and the temperatures ranges between 15°C to 30°C during the winter and might reach up more than 47°C during the summer season (MOI, 1981). Thus, its location below sea level results in a subtropical climate with relatively warm winters enables farmers to grow fruits and vegetables during the winter and spring seasons. In the Jordan Valley, two seasons of crop production exist, the autumn season, during which crops are grown between September and December, and the spring season during which crops are planted between February and July (MOA, 1998). Generally farms with the high percentage of tree crops are owner operated, whereas sharecropping and renting are more dominant for farms with vegetable crops production (Dietz *et al.*, 1993).

In Jordan, the use of modern technology was, and remains, the main objective of most agricultural policies, taking into consideration the limited arable land and water resources (MOA, 1998). The Integrated Pest Management (IPM) technology is one among other technologies that realize the promise of sustainable agriculture. In September 1998, the Jordanian Ministry of Agriculture announced that IPM policy would be implemented for most crops in Jordan, and lately the draft of the national IPM policy has been formulated.

1.2 Problem Statement

It is well known that people look forward to live in a clean environment free from pollution problems. That needs all the efforts of all sectors and mainly the agricultural sector. Unfortunately, most of the current conventional agricultural practices involve relatively heavy, improper use and overdosing of pesticides, chemical fertilizers and soil fumigants.

Improper mixing of pesticides is one of the serious and worrying agricultural problems in Jordan, which may cause reduction and loss in the effectiveness of the pesticides used. Most of the time these practices turn secondary pests into primary pests, and kill a large portion of useful and beneficial microorganisms. This in turn can cause an imbalance in the environment, resulting in forcing the farmer into a circle of increased usage of agricultural chemicals (Schuenemann *et al.*, 1992). Misuse of agricultural chemicals is not only polluting the environment and affecting the health of consumers, but it is also a waste of the limited existing natural and financial resources.

Many studies and reports showed the problems of the heavy spraying of pesticides, and the degree of pesticides contamination of the Jordanian environment, soil, water and agricultural crops. One of those studies carried out by Naser (1994) to analyze 411 samples of human milk and 299 samples of blood plasma, which were obtained and selected randomly from five different geographical regions (representing about

85% of the Jordanian population). The results showed that the samples were contaminated with many hazardous pesticides. The concentration of DDT (Dichlorodiphenyl Trichloro-ethane) residues and its derivatives was high in the samples compared with the acceptable levels, taking into consideration that DDT has been banned for agricultural use in Jordan since 1985, and a positive significant relation was found in rural women whose husbands were farmers. Samhan (1995) took a sample of locally produced fruits and vegetables to identify the presence of harmful pesticide residues. He found that the percent of contaminated samples reached 60% of the whole sample size, in which pesticide residues of dithiocarbamate pesticides were higher than the acceptable level, and 7% of the total sample contained residues of the chlorinated hydrocarbon pesticide group, which has been banned since 1985.

On the marketing side, although the local market is growing fast, it is still relatively small and cannot absorb all surplus production. This leads to the need for Jordan to increase its export outlets into the external markets. However, these markets are more quality demanding (ESCWA, 1997). Therefore, Jordan will have to introduce substantial improvements in product quality, in terms of better standards of production in addition to post-harvest handling and packaging.

Generally, the declared aim is not to stop completely the use of agricultural pesticides, as it is necessary to control some agricultural problems, but looking forward to encouraging the adoption of sustainable agricultural systems, which are ecologically, and economically sound plant protection systems.

In Jordan, many studies related to technical subjects on IPM technology were accomplished. But determining the factors influence the adoption probability of IPM techniques and the profitability of IPM technology under consideration of the production costs and cost functions, were not applied in analytical researches in the past. This study will answer some questions related to the application of the IPM techniques.

1.3 Objectives

The main objectives of the study are:

(1) To identify some factors influencing the probability of adopting IPM techniques by the growers of protected vegetable crops in the Jordan Valley (JV).

(2) To compare the costs of producing two major protected vegetable crops (tomato and cucumber) between Non-IPM and IPM technology.

1.4 Hypotheses

The main hypotheses of the study are the following:

(1) The age of the farmer is supposed to influence the probability of adopting IPM technology negatively. While, level of education, the agricultural engineer farmer, years of experience, female farmer, size of holding, participation in extension activities, landowner farmer, residing outside the Jordan valley, off-farm employment and having access to agricultural credit are expected to affect positively the adoption probability of IPM technology.

(2) Producing tomato and cucumber crops with IPM technology is expected to be more profitable than conventional agricultural practices.

1.5 Organization of the Study

The study is divided into three main parts branched into seven chapters:

(A) Part One includes four chapters as follows: Chapter One presents an introduction, problem statement, objectives, hypotheses and the organization of the study. Chapter Two explores information about the IPM techniques, and the IPM project in Jordan with regard to the initiation, objectives, activities, target groups, funding, duration and executing agencies. Chapter Three covers the literature review of the major issues of the study. The Fourth Chapter explains the methodology of the study, the sources and the approach to data analysis.

(B) In Part Two, Chapter Five and Chapter Six, present the main findings of the survey, the data analyses and the tests of the hypotheses of the study.

(C) Part Three synthesizes the salient study findings; draws conclusions, develops recommendations and suggests future fields for research.

Chapter Two

2. Integrated Pest Management Technology

2. Integrated Pest Management Technology

2.1 Integrated Pest Management in Brief

2.1.1 Definition of IPM

The FAO (1983) elaborated the following definition of IPM: " Integrated Pest Management means a pest management system that in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods to maintain the pest populations at levels below those causing economically unacceptable damage or loss ".

Also, IPM is defined as; " a sustainable approach to managing pests by combining biological, mechanical, chemical, cultural tools to minimize economic, health and environmental risks, by using economically, ecologically appropriate and sustainable control methods " (Edwards *et al.*, 1990).

2.1.2 Principles of IPM

Integrated pest management as Daxl *et al.* (1994) has pointed out, adheres to the following principles:

- It is a holistic, interdisciplinary approach, which considers the ecological and socioeconomic conditions of a site as one unit, and strives to maintain the productivity of the agroecosystem on a sustainable basis.
- It focuses on controlling the losses caused by pests, utilizing natural limiting factors and the selective use of cropping and cultivation techniques.
- Measures to control pest infestation taking into account all the anticipated ecological, toxicological and economic impacts; preference is given to non-chemical methods over the application of chemical pesticides.

2.1.3 Basic Components and Instruments of IPM

The Global Crop Protection Federation (1994) indicated that IPM requires three areas of competence:

2.1.3.1 Prevention (Indirect Measures):

Many aspects of farm practices and crop management limit or prevent the initial build-up of pest infestation such as:

1) To grow the crops in appropriate locations where they fit to climate, soil and to provide the crop with optimal growing conditions from the beginning.

2) Crop rotation to reduce the build-up of certain pests and weed problems.

3) Cropping pattern to avoid planting of alternative host crops along side each other, to avoid weed, disease or pest pressure.

4) Plant breeding; choice of crop variety has always been a cornerstone of crop protection, especially the growing of disease and pest resistant varieties.

5) Mechanical and physical crop protection methods can be important in preventing or minimizing weed, disease and pest infestation. Removal and destruction of crop residue reduce the survival of some pests to the next season.

6) Fertilization; excessive use of nitrogen must be avoided. Too much lush and vegetative growth encourages many diseases, pests and weeds.

7) Habitat management; protection of natural habitats within the farm environment is recognized as a means of conserving many of the natural enemies of pests.

8) Trap crops; sometimes a pest can be attracted away from a valuable sensitive crop by another crop, which suffers less damage if attacked, and then controlled by limited spraying.

9) Harvesting and storage; carry-over of weed seeds and pathogens can be reduced by appropriate harvesting, seed cleaning and storage methods.

2.1.3.2. Observation (Decision Tools)

To determine "When" and "What" action to take through:

1) Crop monitoring; management of any crop needs routine inspections to assess how well plants are growing, and what actions need to be taken on cultivation, fertilizer use, weed, pest and disease control, as well as when to harvest.

2) Decision support systems; farmers need assistance in interpreting pest-monitoring data. Simple "expert systems" can be designed and made available to farmers in a range of ways, including simple charts, special booklets. Development and provision of up-to-date information such as radio and television are keys factors for enabling farmers to implement IPM.

3) Area-wide management; IPM often requires collaborative decisions within a national or more localized area to provide effective control of

pests. Some of these decisions need to be taken centrally by the government through quarantines regulation and legislation, training of advisory services and establishment of management strategies against highly mobile pests and diseases on major crops.

2.1.3.3 Intervention (Direct Measures)

The aim of the direct measures is to reduce the effects of economically damaging pest populations to an acceptable level. Biological and mechanical control measures may be applied individually or in combination, taking into consideration costs, benefits, timing, available labor force, machines and control agents, as well as ecological and environmental effects. Some of the principles of IPM intervention measures available for farmers include:

1) Pheromones; besides selective trapping techniques to monitor the movement of pests or changes in populations during the season, pheromones are also used in "lure and kill to attract the pest and reduce the need for overall crop spraying" and "mating disruption where a massive release of the pheromones confuses males and prevents mating".

2) Biological control; is the introduction of a predator or parasite for the control of a particular pest species.

3) Chemical control; the main requirement is to choose the suitable least harmful chemical and right timing of treatment within the day and season. As mentioned above, there are combinations of control measures. A farmer who adopts IPM needs to be aware of all these control measures and the right time to apply each one of them. The most common approach in implementing the IPM techniques is optimizing the use of pesticides through the use of scouting and control threshold. So, a clear distinction has to be made between the control threshold (action point) and the economic injury threshold. Daxl *et al.* (1994), defined control threshold the as the level of infestation at which a control measure must be implemented in order to prevent the pest population from exceeding the economic injury threshold. Edwards *et al.* (1990), defined the economic injury threshold as the lowest pest population density that will cause economic damage. In other words, it is the pest density at which the net revenue derived from spraying a pesticide equals the net revenue resulting from not applying a pesticide. A trained IPM farmer scouts in regular intervals during the growing season. The density of the pest is estimated using standardized sampling procedures, these data is compared to the control threshold to determine whether pesticide applications are

economically justified. Another result may be that it is enough to apply pesticide only to the points of infestation (hot spot treatment).

2.2 Integrated Pest Management Project in Jordan

2.2.1 Background

The IPM project "Promotion of Sustainable Plant Protection System" has started in 1995. It is a joint project based on an agreement between the governments of Jordan and the Federal Republic of Germany. The project had been requested by the Government of Jordan, at a time, when the plant protection available and the excessive use of pesticide proved to be insufficient to control certain agricultural pests at the farm level and did not satisfactorily prevent economic losses.

2.2.2 The Goal of the Project

The general goal of the IPM project is to introduce to the farmers an environmentally safe, economically feasible plant protection methods and providing consumers with high quality of fruits and vegetables. It aims to provide good and sufficient protection for the crop with the necessary minimum of pesticides from planting to harvesting, allow reliable, healthy and high quality produce, public awareness of IPM advantages and supports sustainable agriculture for the benefit of humans and the surroundings environment (GTZ-IPM, 2000).

2.2.3 The Concept of the Project

The project pursues an implementation concept consisting of several sets of dual strategies involving producers and consumers of fresh fruits and vegetables such as:

1) Develop economically advantageous pest management methods suitable for large and small-scale farmers.
1) Stimulate demand for fresh fruits and vegetables grown under environmentally friendly IPM technology, among consumers of all social classes.
2) Promote the availability of agricultural inputs needed for the IPM technology.
3) Disseminate to farmers, farm laborers and rural women the know-how required for IPM, through public and private extension services.
4) Create the consumer awareness through mass media, seminars and other extension methods. The project disseminates and introduces the IPM technology through field days, extension campaigns, meetings,

seminars, forums, radio programs and messages ...etc. These activities were held and are still planned to teach the IPM technology to all interested farmers in the various regions of Jordan (GTZ-IPM, 2000).

5) Promote marketing of IPM produce. IPM-quality produce is the fruits and vegetables that are produced with environmentally safe IPM techniques. If a pesticide is needed in the production process, the least toxic one is sprayed, avoiding harmful pesticide residues at harvest time. Farmers in Jordan can participate in the IPM-certification system, which is supervised by Jordan Environment Society (JES) in cooperation and participation with MOA, NCARTT, and GTZ-IPM Project. Currently a specialized group of agricultural engineers (Private agricultural company) monitor the correct implementation of IPM techniques (supervision) and the IPM certification of crops in the IPM farms, also assist IPM farmers if they encounter problems while applying IPM techniques. Those engineers are trained and have the know-how by the GTZ-IPM project on the principles and procedures of IPM techniques. They work under the supervision of JES, MOA, NCARTT and GTZ-IPM project. Their work is monitored by JES to make sure of the correct implementation.

Farmers, who want to join the IPM certified production system, have to sign a declaration specifying their commitment and what is expected of them especially in avoiding the use of harmful and toxic pesticides. New farmers and their farm laborers receive training on IPM techniques. They have to report all pesticide they used and make sure that the required waiting period before harvesting is observed. Those farmers also have to permit the inspection of their farms by the IPM engineers under the supervision of JES. From time to time IPM produce is sampled and analyzed to test for pesticide residues in the laboratory of the MOA.

Certified IPM produce is sold to the fruits and vegetables retail dealers by a marketing company that was established late 1997, in cooperation with the Municipality of Greater Amman. This company is located in Amman Wholesale Market for Fruits and Vegetables. Some other quantities of IPM certified produce is sold directly by the farmers themselves to the retailers. Those farmers are capable and having the facilities of acceptable packaging, doing that under the supervision of JES and the IPM project through the IPM specialists. The actual quantities of IPM produce in the market depend on the consumer demand for such produce. Some large farmers have contracts to export their IPM quality produce outside Jordan.

Table 2-1 shows the quantities of IPM certified produce sold during 1999 by the IPM marketing company in Amman wholesale market for fruits and vegetables. The IPM marketing company reported that its sale of IPM quality certified produce had been between 2.5 to 3 tons daily. Since the beginning of year 2000 it has increased to more than 3.5 tons daily. The prices shown are the wholesale price during the year 1999, including the costs for supervision and pesticides analyses as part of the farm gate price of the IPM produce.

Table 2-1
Total Quantities of IPM-Certified Produce Sold by the IPM Marketing Company and the Wholesale Prices of the IPM Produce during Year 1999

Crop	Quantity (Ton)	Lower Price (Fils)	Upper Price (Fils)
Tomato	108 (12%)	150	300
Cucumber	90 (10%)	200	350
Others	701.5 (78%)	170	2800
Total	899.5		

Source: IPM Marketing Company in Amman Whole Sale Central Market for Fruits and Vegetables.

The following Table 2-2 presents the fee of marketing some of the IPM certified produce that have been identified by the current IPM project in NCARTT. Certification includes many different fruits and vegetables, as their availability depend on their harvest time. The prices of the certified IPM produce are higher because certifying IPM quality produce needs frequent pesticide residues analyses, supervision and monitoring, special packaging expenses for plastic bags and stickers as certified IPM produce is sold in sealed packages identified by a sticker with the JES logo on it, besides the fee for JES, labor wages for packaging and grading. In addition to the transportation costs, the wholesale market fee and the dealers' commission are similar to that of the conventional fruits and vegetables.

Table 2-2
Total Fee of Marketing some IPM-Certified Produce (JD / Ton)

Crop	Supervision (JD/Ton)	Pesticide Residues (JD/Ton)	Packaging (JD/Ton)	Labor Wages (JD/Ton)	Fee for JES (JD/Ton)	Total Fee (JD/ Ton)
Cucumber	5.9	5.9	7.5	11.2	1	31.5
Tomato	5.9	5.9	8.2	12	1	33
Pepper	9	9.4	16.4	11.2	1	47
Eggplants	9	6	12	11	1	39
Brocclli	9.7	7.8	17	11	1	46
Potatoes	6.9	6	11.6	11	1	36.5
Stone fruits	10.37	5.18	5.5	8.69	0.76	30.5
Squash	10	5.9	10	10.9	0.2	37
Peas	17	11.8	19	10.7	1	59.5
Okra	17	11.8	19	10.7	1	59.5
Onion	15	10.2	13.8	11	1	51
Beans	13.2	9.4	13.5	9.9	1	47
Cabbage	15	10.2	13.8	11	1	51

Source: Integrated Pest Management Project (GTZ / IPM project / NCARTT).

2.2.4 Target Groups

The IPM project can be considered as a network between researchers, extensionists, economists and farmers. It is promoting the activities and information related to IPM technology among growers of fruits and vegetables, plus all concerned agents in both public and private Jordanian institutions.

In 1995, five vegetable growers in the JV started to cooperate with the project in the implementation of IPM techniques. The project began in areas, which contained a large number of holdings with a high potential of production and intensive pesticide use. The farmers received IPM information and updates on IPM research activities through the project staff at the National Center for Agricultural Research and Technology Transfer (NCARTT) and through the plant protection staff of MOA. In 1998, there were more than 50 vegetable growers, who were wholly or partially applying the IPM techniques in their farms. In addition hundreds of citrus, fruits and olive farmers learned, trained and were enabled to implement IPM technology in their orchards (GTZ-IPM, 1999).

2.2.5 Duration, Funding and Executing Agencies

The project is planned over seven years, divided into two phases. The first phase has already completed by the end of December 1997. It is followed by the second phase during the period January 1998 till December 2001. The German funding is a grant from the Government of the Federal Republic of Germany.

The executing agencies are NCARTT on the Jordanian side and the German Agency for Technical Cooperation (GTZ). Several public and non-government organizations have played a role in promoting the IPM technology.

Chapter Three

3. Literature Review

3.1 General

3.2 Extension and Agricultural Extension

3.3 Adoption of New Technology

3.4 Factors Influencing the Adoption of New Technology

3.5 Profitability of Producing Tomato and Cucumber Crops with Non-IPM and IPM Technology

3. Literature Review

3.1 General

This chapter discusses the concepts and research literature related to adoption of new technology, and the economic analysis of producing crops with IPM technology. It aims to sketch the process by which modern agricultural technology spreads between farmers and is ultimately adopted by some, most or all farmers who can use it.

Technology is the product of research, it is defined as the translation of scientific laws into machines, tools, mechanical devices, instruments, innovations, procedures and techniques to accomplish tangible ends, attain specific needs, or manipulate the environment for practical purposes (Theodorson *et al.*, 1969). Ideally, the flow of technology to farmers from research through extension should include a feedback to determine research needs from farmers to researcher (Watts, 1984). That flow of information about new technology to the farmers through the extension agents should be achieved in a simple and easy way, especially when that technology is proved to be technically and economically feasible (Al-Rimawi *et al.,* 1995). Higher productivity would require improved technology. Education and training of farmers and improvements in the delivery of research, extension and other producer services will further facilitate the adoption of improved technology and increase productivity. Thus, it is important to make such services more focused to farmers (ESCWA, 1997).

3.2 Extension and Agricultural Extension

" Extension " is an on-going process of getting useful information to people to acquire the necessary knowledge, skills and attitudes to utilize effectively this information or technology. Generally, the goal of the extension process is to enable people to use these skills, knowledge and information to improve their quality of life (Swanson, 1984). Feder *et al.* (1984), explained the extension as a source of information to many farmers, either directly through farmers' contact with extension agents and with other extension communication media (radio, leaflets..etc) or indirectly, as farmers who have benefited from direct extension exposure transmit information to other farmers.

Although extension is one of the components supporting development, it is also supported and affected by the quality of agricultural research and the degree to which policy and prices support the use of technological adoption. In an aggregate sense, extension can be illustrated as the link between research and farmers (Watts, 1984).

Maunder (1973) defined the "Agricultural Extension " as a service or system which assists farm people, through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, improving their level of living, and raising the social and educational standards of rural life. The main objectives of the agricultural extension are; (1) providing firm knowledge on which action can be based, (2) persuading the farmer to make a decision to try the new technology, (3) providing the information necessary for actual implementation, (4) providing the information needed by the farmer to assess the results of that decision, and hopefully to confirm the decision (Fliegel, 1984).

3.3 Adoption of New Technology

3.3.1 Adoption Process

One of the most important means of accelerating national development in economy is the adaptation and evaluation of new agricultural technology that can be adopted by farmers; this adoption can result in higher incomes for farmers, greater economic efficiency, and growth in the national economy (Johnson *et al.*1984). Adoption of technology has received frequent attention over the years (Jayson *et al.*, 1990). Sofranko (1984) reported that, agricultural technology is viewed as representing much more than only mechanization. It includes introduction of new farm inputs, such as a new fertilizer, or new plant varieties that are immune to fungus and diseases, and introduction of new techniques or practices, such as new planting and cultivation techniques. He added that the simplest classification of obstacles to agricultural development has been on the basis of, whether they lie within the farmer or within the farm environment. Obstacles residing within farmers themselves and their immediate cultures have been identified as traditional beliefs, illiteracy, lack of motivation for achievement, insufficient resources to take advantage of opportunities, low-level skills and limited aspirations. Because of those traditional beliefs, values and cultural practices, farmers are felt to be unconcerned with improvement, unwilling to take risks, or unable to take advantage of existing opportunities of using new technologies.

The obstacles in the farm environment have been defined as inadequate financial services and lack of necessary inputs. According to Van den Ban (1990) the adoption process with regard to innovation means that: changes take place within an individual, with regard to an innovation from the moment that, he first becomes aware of the innovation to the final decision to use it or not.

The adoption had been defined by Feder *et al.* (1985) as the degree of use of a new technology in the long run equilibrium, when farmers have full information about the new technology and its potential.

Lionberger (1968) defined the adoption as the full-scale integration of the practice into the on-going operation, through which people appear to go through a series of distinguishable stages (adoption stages):

(1) Awareness; the first knowledge about a new idea, product or practice.

(2) Interest; the active seeking of extensive and detailed information about the idea, to determine its possible usefulness and applicability.

(3) Evaluation; weighing and sifting the acquired information and evidence in the light of existing conditions, into which the practice would have to fit (weigh up the advantages and disadvantages of using it).

(4) Trial; the tentative trying out of the practice or idea, accompanied by acquisition of information on how to do it (test the innovation on a small scale).

(5) Adoption (apply the innovation on a large scale in preference to old method).

Rogers (1995) presented the model of the innovation-decision process consisted of five stages:

(1) Knowledge occurs when an individual is exposed to an innovation's existence and gains some understanding of how it functions.

(2) Persuasion occurs when an individual forms a favorable attitude toward the innovation.

(3) Decision occurs when an individual engages in activities that lead to a choice to adopt or reject the innovation.

(4) Implementation occurs when an individual puts an innovation into use.

(5) Confirmation occurs when an individual seeks reinforcement of an innovation-decision already made, or reverses a previous decision to adopt or reject the innovation if exposed to conflicting messages about the innovation.

3.3.2 Adopter Categories

Adopter categories are the classification of the members of a social system, on the basis of innovativeness, the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system (Rogers *et al.*, 1971). Rogers (1983) categorized the adopters into five adopter categories; (1) Innovators (Venturesome); who are very eager to try new ideas, this interest leads them out of the local circle of peer networks, and into more cosmopolite social relationships. Usually, they have substantial financial resources to absorb the possible loss owing to an unprofitable innovation, and the ability to understand and apply complex technical knowledge. He or she desires the hazardous, the rash, the daring, and the risky. (2) Early adopters (Respectable); who are a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early adopters are localities. This adopter category, more than any other, has the greatest degree of opinion leadership in most social systems. They are considered by many as the individuals to check with before using a new idea. (3) Early majority (Deliberate); they adopt new ideas just before the average member of a social system, they have a unique position between the very early and the relatively late to adopt, makes them an important link in the diffusion process. They provide interconnectedness in the system's networks. They may deliberate for some time before completely adopting a new idea. Their innovation-decision period is relatively longer than that of the innovators and the early adopters. (4) Late majority (Skeptical); they adopt new ideas just after the average member of a social system. Their relatively scarce resources mean that almost all of the uncertainty about a new idea must be removed before the late majority feels that it is safe to adopt. (5) Laggards (Conventional, Traditional); they are the last in a social system to adopt an innovation and accept any new idea very late. Their decisions are often made in terms of, what has been done in previous generations. When laggards finally adopt an innovation, it may already have been superseded by another more recent idea that is already being used by the innovators. Their traditional orientation slows the innovation-decision process to crawl, with adoption lagging far behind awareness-knowledge of a new idea. The laggard's precarious economic position forces these individuals to be extremely cautious in adopting innovations.

Farmers will adopt in a sequential manner rather than as a package, so farmers over time and in a stepwise manner will adopt the complete package of technology (Byerlee *et al.*1986). On the other side, it may be difficult to convince the farmers who isolate themselves from the benefits of a new technology (Al-Karablieh, 1995).

3.4 Factors Influencing the Adoption of New Technology

Factors related to adoption of new technologies include both the personal characteristics and those of the context in which farmers act. Al-Rimawi *et al.* (1995), indicated that the adoption of new technology is influenced by political and social factors such as institutional development, tenure systems, extension services, credit and exporting policies, taxes and prices. Al-Karablieh (1995) reported that information about factors influence the adoption of new technology needs to be made available to planners to facilitate the adoption of new technology. In Jordan such qualitative data is virtually non-existent. Therefore, there is a great demand for detailed socio-economic and socio-cultural studies of rural communities that would give a deeper insight into the working activities of such communities.

Hereinafter, reviewing the results of several previous studies and researches on a number of factors affecting the adoption of new technology. The factors which were taken into consideration in this study were: age, educational level, years of experience, profession, place of residence, gender, tenure status, size of holding, farm sources of finance and the access to credit services, off-farm employment and participation in the extension activities.

3.4.1 Personal and Social Factors

3.4.1.1 Age

Elderly farmers seem to be somewhat less inclined to adopt new farm practices than younger ones. The highest adoption was by middle age group (Lionberger, 1968). Jayson *et al.* (1990), found in evaluating survey data concerning rice stinkbug management by the rice producers in Texas that the adoption rate of insect sweep net decreases as age of farmer increases. Also, adoption behavior of fertilizer use technology, showed a negative significant relationship with the age of the farmers in Syria (ICARDA, 1994). In the rainfed areas in Jordan, Saleh (1993) indicated a significant negative effect of the lentil and chickpea farmer's age on the adoption process of new technology. Also, Al-Qudah (1996) found that the age of the farmer shows a significant negative effect on the adoption decision, indicating that younger farmers are more progressive and oriented towards the adoption of new innovation. While, Ra'ouf (1993) found that farmer's age had no significant relation with farmer's adoption of television agricultural programs recommendations regarding olive trees. On the other hand, Shadaydeh (1993) found a significant positive effect of age on the adoption of new agricultural idea by the vegetables growers in the Jordan Valley.

3.4.1.2 Educational Level

Schooling is valued as a mean of increasing knowledge. The assumption is that schooling facilitates learning, which in turn is presumed to create a favorable attitude toward the use of improved farm practices. The relationship between years of schooling and farm practice adoption rates is likely to be indirect, except in cases where individuals learn specifically about the new practices in school. Here, as with other variables associated with the adoption of farm practices, clear-cut relationships are hard to establish, because years of schooling is related to other factors likely to condition adoption rates, as, for example, income and age of the farm operator (Lionberger, 1968). Watt (1984) reported that the levels of literacy and education affect extension and adoption technology in direct ways. Illiterate farmers or those with very little education require more simple information that is easily understood. Simple audio-visual, radio and personal contact are mandatory techniques, as is demonstration. Roling (1982) indicated that the high access farmers are somewhat better educated, that will be a base to farmers to adopt and implement a new technology. Michael *et al.* (1984), showed that investments in farmer's formal schooling and continuing education enhance the efficiency of the adoption decision. Therefore, farmers with more education will adopt earlier than the other farmers (Rogers, 1983) and (Feder *et al.*, 1984). Padhee (1995) and Young (1996) found that farmer education level influence positively the adoption of IPM technology. Ra'ouf (1993), Shadaydeh (1993) and Saleh (1993) indicated that education has a positive significant effect on the adoption decision. Also, ICARDA (1994) and Al-Qudah (1996) found that increasing a farmer's educational level is expected always to increase the adoption of new technology.

3.4.1.3 Years of Experience

Improved knowledge and experience regarding new technologies through the accumulation of information over time, is hypothesized to be one of the main dynamic elements of the innovation adoption process, and so inducing most farmers to adopt the new technology (Feder *et al.,* 1984). Michael *et al.* (1984) and Feder *et al.* (1984) investigated the effect of experience on adoption. They found that farmers with more experience were more likely to adopt new technology earlier than other farmers. ICARDA (1994) indicated that farmers who had more experience in farming, adopted fertilizer technology faster than farmers with less experience, and Ra'ouf (1993) found that years of experience have a positive significant relation to the adoption of a new technology.

3.4.1.4 Place of Residence

In one of the studied zones in Syria, it was found that there was no relationship between adoption of new technology, and the place of residence (outside or inside the village). But in the other two studied zones, a positive and significant relation was found between the place of residence (outside the village) and the adoption of new technology (ICARDA, 1994).

3.4.1.5 Gender

The term " gender " describes the socially determined attributes of men and women, including male and female roles. It has proven to be an essential variable for analyzing the roles, responsibilities, constraints, opportunities, incentives, costs and benefits in agriculture. The improvement of women's access to agricultural research and extension services must begin with an analysis of men's and women's participation in the agricultural production process along with their role in agriculture and their role in the household (Jiggins, *et al.* 1997).

Watts (1984) indicated that women as farm managers and as contributors to agricultural production have been identified as a target group of extension. Even though the role of women in agricultural production varies significantly between countries and world regions. Typically, in farm families in the United States and Western Europe, women participate as co-managers of farms along with their husbands. They perform numerous activities, such as record keeping, which are essential and significant for successful farm operation and decision-making. Generally, in developing countries, women constitute to a larger proportion of the agricultural labor force (e.g. as farmers and farm workers) than in the industrialized countries. In some Middle Eastern countries, men seek work in the oil fields of the Gulf States and thus, women family members are responsible for farming. Further in many societies women are the primary decision-makers on the farm level and producers of food crops.

Near East Foundation (1993) reported that, women's roles in agriculture are determined by a correlation between social and economic variables. These variables are interrelated, affecting and being affected by the complete set of socio-economic and environmental factors, prevailing in rural Jordanian society. The greater woman's knowledge, the greater is her role in the farm decision-making and in adopting new agricultural techniques. Women who have greater mobility will tend to have more knowledge. The sources of their knowledge include direct experience and observation, local personal contacts, mass media and agricultural extension services.

3.4.1.6 Off-Farm Employment

ICARDA (1994) and Shadaydeh (1993) found that off-farm employment has a positive significant effect on the adoption level.

In contrary Fernandez *et al.* (1994) indicated that off-farm activity has negatively affected the adoption of IPM techniques by vegetable growers in Florida.

3.4.2 Farm Resource Factors

3.4.2.1 Tenure Status

Lionberger (1968) indicated that, farm owners have more complete control over farming operations than tenants. Owners can make decisions to adopt new practices, but tenants must often obtain the concurrence of the owner before trial or use. This is particularly true where some financial backing by the owner is required. Consequently, adoption rates are usually higher for farm owners than for those who rent their farms. However, differences between owners and tenants are likely to vary regionally due to differences in tenancy arrangements, and the freedom of tenants to make decisions. Also, farmers who may desire to make changes in farming are not always in a position to do so, because of final decisions may rest in the hand of the farm owner. Compton (1984) indicated that the land tenure is usually a determinant factor in efforts to promote improved agricultural practices and adopting new technology. Often tenant farmers cannot be expected to plan in long terms. The nature of landowner-tenant relationships will also affect tenant farmers' willingness and ability to try out new recommendations. Shadaydeh (1993) and Saleh (1993) indicated that there was a significant positive relation, between the tenancy and the adoption of new agricultural techniques. ICARDA (1994) concluded that when commercial producers sharecrop the land of smaller farmers, it is an arrangement that does not provide an incentive for fertilizer adoption on barley crop in the dry rain fed areas.

Lee *et al.* (1983), found that landowners have negative effect on adoption rate of minimum tillage on cultivated cropland across the United States. Also, Al-Karablieh (1995) indicated that a farmer who is a tenant or sharing the holding is more able to adopt technology than the landowner.

3.4.2.2 Size of Holding

Lionberger (1968) pointed out that size of holding is related positively to the adoption of new farm practices. Some technological innovations require large-scale operations, and substantial economic resources for their use. The use of improved farm practices produces economic benefits permitting the expansion of farming operations, which in turn makes it economically possible to use more improved farm practices. Roling (1982) and Rogers (1983) found that there is a positive relation between the farmers who have large size holdings and the adoption of new technology. Feder *et al.* (1984), indicated that large-scale farmers will adopt the new techniques earlier than other farmers, and Lee *et al.* (1983) found that farmers with small holdings, have lower minimum tillage adoption rates on cultivated cropland than do others with large holdings. Byerlee *et al.* (1986), explained that small-scale farmers lagged behind large-scale farmers in adoption. Compton (1984) indicated that it is usually easier to reach and interact effectively with larger, wealthier, and often highly motivated farmers than it is with small landholders, who have limited resources and low-income. Fernandez *et al.* (1994), found that vegetable producers, who adopt IPM, are more likely to operate large irrigated farms in Florida than non-adopters.

Saleh (1993) and Al-Qudah (1996) reported that, farm size has a positively significant relation between the size of the holding and the adoption level.

While Useem *et al.* (1992), found that small holders were as likely as large holders to master IPM techniques on rice crop in Indonesia. AL-Karablieh (1995) pointed out that farm size is found not to be significantly related to the use of new varieties, or early planting, whereas it is positively related to the adoption of machinery, herbicides and fertilizer application. On the other side, ICARDA (1994) found that the relationship between fertilizer adoption and farm size was weak and insignificant.

3.4.3 Institutional Factors

3.4.3.1 Farm Sources of Finance and Access to Credit Services

Many studies of the adoption and diffusion of new technologies investigate the effect of credit on adoption behavior. It is known that the serious limitation in rural development is the lack of available capital on which to develop a base of economic activity (Watts, 1984). Also, Fliegel (1984) indicated that external constraints on adoption, such as a lack of credit would be a limiting factor to adopt a new technology. Farmers with high access to credit services and inputs are frequently in a better position to adopt and try new forms of technology (Roling, 1982; Rogers, 1983).

Increasing the access to credit is expected to increase the probability of making an economically and correct adoption decision on the part of the farmer, that means it may enhance the efficiency of adoption. The farm operators, who have invested in new technology activities will be better informed about the existence and general performance of different technologies, and will make more efficient adoption decision (Michael *et al.,* 1984). Technological packages consisting of a number of components such as variety, fertilizer, planting method and weed control, may also provide a convincing effect to farmers by emphasizing the large yield difference, between traditional and improved practices. However, because of capital scarcity and risk considerations, farmers are rarely in a position to adopt complete packages. As an alternative, technological packages can usually be desegregated into subsets or clusters of one or two components, which allow critical interactions to be exploited and which enable adoption to follow a stepwise pattern (Mann, 1977). Farmers who desire to make changes in farming are not always in a position to do so, due to capital restrictions, or because of the final decisions may rest with moneylender. Also, high-income farm nearly always is associated with high-farm practice adoption levels. Alertness to prevailing farming conditions leads to higher incomes, this in turn makes more capital available for the adoption of new practices (Lionberger, 1968). Al-Rimawi (1991) found that credit is critical where the need for working capital is high, for financing the purchase of modern technology inputs. Also, the more educated farmers are most likely to use formal credit. Al-Karablieh (1995) indicated that, the farmers face the problem of shifting from an old technology to a new one. Such a shift, from less efficient old techniques to more efficient new ones is expected to take place as soon as the new technologies become available. Hence, the farmer faces the lack of capital, and uncertainty of the expected output.

These factors could explain why all farmers couldn't immediately adopt the new technological innovations. Al-Khayyat (1997) pointed out that obstacles facing the adoption of new techniques are mainly the shortage in working capital and unavailability of credit, marketing problems, unavailability of the required agricultural inputs. However, ICARDA (1994) reported that the effect of credit availability on adopting fertilizer technology in Syria was insignificant.

3.4.3.2 Participation in Extension Activities

A farmer actively participates in extension activities, when he expects it to provide information for a better economic return. The farmer gains information by listening to discussions among other farmers, or observing incidentally the practices followed by neighbors (Feder *et.al.*, 1984). Agricultural research and extension programs in developing countries, rather than following the conventional package approach, should be designed to take into account the fact that, farmers adopt improved technological components in a stepwise manner (Byerlee *et al.*, 1986). Roling (1982) indicated that, farmers who have access to information networks and extension activities are more frequently in a better position to try and adopt the new forms of technology. Feder *et al.*

(1984) and Rogers (1983) indicated that farmers with better access to information and participation in the extension activities will adopt technology earlier than other farmers, but over time most farmers will adopt.

Jayson *et al.* (1990), found that extension activities were significantly associated with increases in the probability of adopting sweep nets, which will improve the profitability of producing rice. Mcnamara *et al.* (1991), pointed out that the participation in extension activities and the extension materials had the greatest association with IPM adoption decision by peanut producers in Georgia, USA.

Van den Ban (1990) indicated that a large number of studies clearly show that, people who have adopted many innovations have frequent contact with change agents. That is because this contact results in the adoption of innovations, or it might be because people interested in innovation seek contact with change agents, or because the agents seek contact with these people, probably each factor plays some role. Shadaydeh (1993), Saleh (1993) and Al-Khayyat (1997) found that the participation in the extension activities was positively related to the adoption level. ICARDA (1994) found that there was no significant effect on adoption behavior, which could be assigned to the inadequate quality of the extension services.

3.5 Profitability of Producing Tomato and Cucumber Crops with Non-IPM and IPM Technology

It is known that the new technology will only be adopted, if it meets the farmer expectations within farm a production system. The innovations that are usually adopted most rapidly are the ones with the following characteristics as mentioned by Rogers (1983):

(1) Relative advantage is an important factor when it enables the farmer to achieve his goals better or at lower costs.

(2) Compatibility with the farmer's socio-cultural values, beliefs, experiences and needs.

(3) Complexity, if innovations require complex knowledge or skills. They often fail because they are not implemented correctly.

(4) Trialability (can be tried first on a small scale) a farmer will be more inclined to adopt an innovation, which he has tried first on a small scale on his own farm, and which proved to work better than an innovation he had to adopt on a large scale (low risk).

(5) Observability (can easily be observed); farmers learn much from observing and discussing their colleagues' experience. Observations are often a reason to start discussions.

Watts (1984) indicated that, the response of the farmer to new technological innovations is directly related to his or her perception of financial advantages resulting from such recommendations. Demonstrating increases productivity and convinces farmers, that such increases can mean greater income. Thus, profitability was the major determinants of the sequence of adoption of new technology (Compton, 1984). Daxl *et al.* (1994) explained that experiences in developing countries have shown that, agricultural innovations meet with the desired level of acceptance once they lead to a rise in the gross margin (GM), which can be achieved with the introduction of IPM techniques. This is primarily because of the normally relatively low cost of chemical plant protection measures. The IPM concepts are evaluated by calculating the costs and benefits of the introduction of such a concept. As a farmer accumulates knowledge and experience with the new technology, he can reasonably be expected to produce more output with lower costs for inputs (Feder *et. al.*, 1984). Useem *et al.* (1992) indicated that implementing IPM techniques on rice crop in Indonesia showed significant saving in pesticides expenses and no loss in the yield. In India, IPM technology on maize crop gave significantly higher gross margin and net returns, than traditional treatments (Angiras *et al.* 1991). Trumble *et al.* (1994), found that IPM technologies on tomato crop in USA, resulted in better yields and net profits as compared with the chemical and control treatments.

Hamdan *et al.* (1996), indicated that IPM concept is decreasing the use of pesticides, which means a reduction in the production costs, the protection of the environment (land, water, air) and the effects on consumers health. In addition, it may result in a significant reduction in social costs (health issues). Producers will adopt technologies, which increase their farm income, or at least that keeps it at the same level. The main aim of any producer is to maximize his profit, so the return he gets should cover at least his costs and provide him with the minimum expected profit which should be higher than producing under conventional conditions. Grenzebach (1997) mentioned that a comparison farm data of those cooperating the IPM project in Egypt and others who do not have this contact mostly achieves higher GM. In the production of protected tomato and cucumber crops, the subgroup with contact to the IPM project on average obtains higher yields than the subgroup without contact, in spite of using less fertilizer and pesticides. Generally, that shows a lower level of variable costs, and the average GM exceeds that of the other subgroup significantly.

In Jordan, Al-Attal (1998) found that using bumblebees for pollination (one of the IPM techniques) gave 40%, 60%, and 105% more yields per plant than the use of plant growth regulator, vibration treatment and the control, respectively. Bumblebees pollination shows clearly that the fruit look better in shape with no cavities inside, more seeds, harder, and uniform in color. These characteristics make fruits more preferable for exporting, and for the local market. While, fruits that were treated with plant growth regulator produced big sized, puffy fruits, have large cavities inside, are softer, and the color sometimes is not uniform.

Hamdan *et al.* (1996) studied the GM(s) of five pioneer farmers in the Jordan Valley, who were applying IPM technology besides the conventional agricultural practices. Additional five farmers who were producing only under conventional conditions were chosen to compare their production with the pioneer farmers. The study results of the different scenarios, which had been taken showed that GM(s) under IPM conditions were less than under Non-IPM conditions, except in some cases, where the price of products was higher with low frequency of pesticide residues analyses.

Chapter Four

4. The Study Methodology

4.1 Methods of Data Collecting

4.2 Units of Analyses

4.3 Sample Design and Procedure

4.4 The Questionnaire

4.5 Organization of Field Work

4.6 Data Analyses

4. The Study Methodology

4.1 Methods of Data Collecting

The data were collected through the following means:

(A) Primary data collection using a structured questionnaire and personal interviews with the sampled vegetables growers in the JV.

(B) Secondary sources were used in conjunction with the primary data, including statistics and reports from different sources of information, of the concerned ministries and public agencies. In addition, studies and publications by non-governmental organizations and various consultant agencies were utilized.

4.2 Units of Analyses

To determine the socio-economic factors influencing the adoption of IPM technology, the principal source of information came from the questioned farmers in the study area, " Non- IPM Adopters " and " IPM Adopters ".

In calculating the enterprise budgets and cost functions, all data were collected on one greenhouse basis, for that a 500 m^2 area was used as the basic unit for data collection and analyses.

4.3 Sample Design and Procedure

The questioned farmers of this study were divided into two main groups:

1) Non-IPM Adopters; who apply the conventional agricultural practices in their agricultural production process.
2) Adopters of IPM technology; the vegetable crop growers under GH(s), who applied at least one or more of the recommended IPM techniques, for at least one season before the season in which the data of the study were collected.

It was necessary to direct the attention to a critical action of selected farmers within the same target geographical areas. Thus, similar circumstances, and relatively homogeneous set of natural conditions and agricultural services such as the climate, topography, soil, access to inputs resources, credit and marketing opportunities were taken into consideration.

The study was conducted in blocks 21, 22 and 23 in the Jordan Valley, (*Alwahadneh, Albalawneh, Abu Obeidah, South and North Altwal, Alsawalha, Abu Sido, Deir alla, Alma'adi, Ghor damia, Alkarameh Villages*), where the activities of the IPM project are centered, and the holdings of IPM vegetable crop growers are located. The target was to interview a sample size consisted of 110 farm operators. Therefore, all the IPM adopters (55 vegetable crop growers) in the study area (JV) were included in the sample, the list of their names and addresses was provided by the IPM project's office in NCARTT. In addition an equal number of Non-IPM adopters (vegetable crop growers) were randomly selected as a control group.

To determine the list of the sampling units of the Non-IPM adopters, a list of unit numbers in each block of the study area was found at the Jordan Valley Authority. A simple random sample was drawn from every block of the study area. Then the units of Non-IPM adopters were selected at fixed intervals, starting from a randomly determined point. The method of selection started by assigning the total numbers of the holdings, which should be selected in each block, and then by using the table of random numbers, the sample holdings one by one had been identified until all the required numbers of holdings were selected randomly. A map of the sampled blocks was used and helped in locating the selected holdings.

To make the sample more representative, the size of the sample in each block was selected as a percentage depending on the proportion agricultural holdings in the study area.

Table 4-1 shows the distribution and percentages of the sampled holdings of the Non-IPM and IPM adopters. There were 11 and 9 holdings in block 21, 14 and 10 holdings in block 22 and 30 and 36 in block 23 were allocated to Non-IPM and IPM adopters, respectively.

Additional number of holdings were selected for every block as a reserve list to replace the cases, in which some farmers could not be found, refuse to cooperate, could be an IPM adopter, do not respond positively, the farm holding is not cultivated with the studied crops or not cultivated at all.

Table 4-1
Distribution and Percentages of the
Sampled Holdings of the Non-IPM and IPM adopters

The Study Area*				The Sample**		
Block Number	**Number of Holdings**	**Area (Du)**	**Area %**	**Non-IPM Adopters**	**IPM Adopters**	**Total Sampled Holdings**
21	270	10989	21	11	9	20
22	336	12612	25	14	10	24
23	698	27259	54	30	36	66
Total	1304	50860	100	55	55	110

Source: * Unpublished data provided by the Jordan Valley Authority, 1998.
** Estimated by the researcher.

4.4 The Questionnaire

The questionnaire was designed and organized to facilitate direct comparison between Non-IPM and IPM adopters. The first part of the questionnaire related to the obstacles and factors influencing the adoption of IPM techniques, while the second part focused on the production costs of tomato and cucumber crops, in the study area during season 1998/1999 (Appendix A is a blank questionnaire of the study).

A draft of the questionnaire was tested in the field (pre-testing) with the two compared groups. A number of modifications and rearrangements were found to be essential. An effort was made to make the questionnaire as focussed as possible to shorten the interview time with the farmer.

Therefore, the questionnaire was structured largely in a close-ended form, especially the part related to the factors affecting the adoption of IPM techniques.

4.5 Organization of Field Work

To promote the cooperation and increase the response rate of the sampled farmers, they were informed in a letter from the IPM project that the objectives of the study were purely academic.

During the fieldwork two assistants were asked for their help. An IPM advisor employed by the IPM project, and an assistant familiar with the study area helped to locate the sampled holdings. During the questioning process the list of sample was verified, 12 questionnaires were replaced from the reserve list due to incomplete data.

The interviews with the sampled farmers were carried out over the period June to September in 1999. The interviews were conducted in the farms, houses or agricultural input shops.

Daily, the collected information wad checked and the data entered into the computer for the descriptive, statistical, univariate and multivariate analyses.

4.6 Data Analyses

To run the analyses, the Excel 7.0 and the TSP 4.2 programs were used. Results are presented and discussed in Chapter Five and Chapter Six of this study.

4.6.1 Socio-economic Factors Analyses

The characteristics of farmers who adopted the IPM technology or one of its techniques were compared with those Non-IPM adopters by a descriptive analysis. In addition to a univariate analysis represented by Chi-square " Test of independence ", which can determine if there is a relationship between each factor of the farmer's characteristics and the adoption of IPM technology or not. It is unable to investigate the direction of the relationship (positive or negative). For this reason, multivariate analysis consisting of Logit model regression was carried out. Then, the Probit model regression was applied to compare its results with that of the Chi-square and the Logit regression. All these analyses were carried out at 1%, 5% and 10% levels of significance.

4.6.1.1 Dummy Dependent Variables

In this part, the models where the explained variable is a dummy variable will be briefly explained. This dummy variable can take on two or more values, but it is considered here the case where it takes on only two values, zero and one. It had been indicated by Maddala (1992) that since the dummy variable takes on two values, it is called a dichotomous variable (binary variable). There are several methods to analyze regression models where the dependent variable is a zero (0) or one (1) variable. The simplest procedure is to just use the usual least squares method. In this case the model is called the linear probability model. Where, the variable Y is an indicator variable that denotes the occurrence or non-occurrence of an event, having some explanatory variables determining that. We write the model in the usual regression framework as:

$$Y_i = B\,x_i + u_i$$

with $E(u_i) = 0$, the calculated value of Y_i from the regression equation will then give the estimated probability that the event will occur given the value of X . In practice these estimated probabilities can lie outside the admissible range (0,1) and the prediction errors can be very large.

Because of this problem (heteroskedasticity) the ordinary least squares (OLS) estimates of $\boldsymbol{B}$ from the above equation will not be efficient.

The other alternative is to say that there is an underlying or latent variable Y_i^* which we do not observe, so other models should be used and this is the idea behind the Logit and Probit models.

The Logit and Probit models differ in the specification of the distribution of the error term U in the following regression model:

$$Y_i^* = B_0 + \sum_{j=1}^{k} B_j X_{ij} + U_i$$

where; Y_i^* is not observed ;qualitative dependent variable, (here it is variable called a " Latent variable ". It can only be observed as dichotomous variable).

X's : are the factors supposed to influence Y_i^*

B_0 : is a constant.

U_i = is the error term.

If the cumulative distribution of U_i is logistic we have what is known as the Logit model, and if the errors U_i follow a normal distribution, we have the probit model (it should be appropriately be called the normit model, but the word probit was used in the biometric literatures).

Since the cumulative normal and the logistic distributions are very close to each other except at the tails, we are not likely to get very different results, unless the samples are large (so that we have enough observations at the tails). However, the estimates from the parameters B_j from the two methods are not directly comparable. Thus to make them comparable the Logit estimates (parameters) should be multiplied by 0.625. This transformation produces a closer approximation between the logistic distribution and the distribution function of the standard normal. If our interest is mainly in examining which variables are significant, we need not make any changes in the estimated coefficients for the Logit model. The significant variables could be determined by the values of t-ratios statistics, paying attention to the parameters, which have similar or opposite signs to those we would expect. Those signs indicate that if the explanatory variables are positively or negatively affect the probability of having the explained variables.

4.6.1.2 Prediction of Effects of Changes in the Explanatory Variables

Maddala (1992) indicated that after estimating the parameters B_j, the effects of changes in any of the explanatory variables on the probability observation of the explained variable could be known and given by any of the following equations depending upon the selected model for data analysis:

$$\frac{\partial P_i}{\partial X_{ij}} = \boldsymbol{B_j} \quad \text{for the linear probability model.}$$

$$\frac{\partial P_i}{\partial X_{ij}} = \boldsymbol{B_j}\, P_i\,(1- P_i) \quad \text{for the Logit model.}$$

$$\frac{\partial P_i}{\partial X_{ij}} = \boldsymbol{B_j}\,(\boldsymbol{Z_i}) \quad \text{for the Probit model.}$$

where ; $$\boldsymbol{Z_i} = \boldsymbol{B_0} + \sum_{i=1}^{k} \boldsymbol{B_i}\, \mathbf{X}_{ij}$$

4.6.1.3 Measuring Goodness of Fit

Because the use of the conventional R^2-type measure is not a representative measure for the goodness of fit in case of models with qualitative dependent variable, which has only two values (0 or 1). The proportion of high correct predictions measure was taken instead of the R^2 measure. It indicates how many from the studied cases were correctly predicted (Maddala, 1992)

In this study each main factor was represented by a number of variables as follows:

- Personal farmers' factors, such as age of the farmer, family members involved in farm decisions, gender, educational level, profession, years of experience, place of residence.
- Farm resources factors, such as size of holding, tenure status, off-farm employment.
- Institutional factors, such as farm sources of finance and accessing to credit services, participation in extension activities and access to agricultural inputs.

Factors which were taken into consideration in this study were; age, gender, educational level, profession, years of experience, place of residence, size of holding, tenure status, off-farm employment, farm sources of finance, accessing to credit services and participation in extension activities.

The following variables were taken in the Probit and Logit analyses as independent variables that could influence the probability of farmers' decision to adopt IPM technology:

AGE (Years) = The farmer's age.

GENDER (1,0) = A dummy variable has a value of (1) if the farmer is a female, and (0) = otherwise;

EDUCATN (Years) =	The farmer's years of education.
PROFE (1,0) =	A dummy variable has a value of (1) if the farmer is an agricultural engineer, and (0) = otherwise;
EXPERIEC (Years) =	The farmer's years of experience;
RESIDEN (1,0) =	A dummy variable has a value of (1) if the farmer resides outside the Jordan Valley, and (0) = otherwise;
FRMSIZE (GH) =	Size of the holding;
OFF-FARM (%) =	The percentage of off-farm employment of the farmer.
EXTSION (1,0) =	A dummy variable has a value of (1) if the farmer participated in the extension activities, (0) = otherwise;
OWNFARM (1,0) =	A dummy variable has a value of (1) if the farmer owns the farm, (0) = otherwise;
CAPLOAN (1,0) =	A dummy variable has a value of (1) if the source of finance is mixed (Equity + Loan), (0) = otherwise (Equity capital);

The following dependent variables (IPM techniques) were included in the analyses, and they were treated as a dichotomous (binary) variable, which takes on the value of (1) if IPM technology is used and (0) otherwise:

1) Applying least toxic and environmentally sound pesticides (IPM tech1).

2) Using bumblebees instead of hormones (IPM tech2).

3) Soil solarization instead of Methyl Bromide soil fumigant (IPM tech3).

4) Using muslin screens for tight screening (IPM tech4).

5) Growing disease and pest resistant varieties (IPM tech5).

6) Rational fertigation (IPM tech6).

6) Monitoring and scouting (IPM tech7).

7) IPM technology as one package; (all the above techniques were considered as one package; to adopt IPM technology or not).

8) Intensity of using IPM technology; (number of GH(s) under the IPM technology compared to the total number of GH(s) in each farm). This dependent variable was included in the Probit regression analysis only.

The findings of the Probit regression were used to determine and quantify the marginal effects (the contributions of the studied socio-economic factors on the probability of adopting IPM techniques).

4.6.2 Costs and Returns Analyses

The collected data were analyzed for statistical tests, which are:

- Usage averages (Means) of agricultural inputs for the two compared groups (n=55 farmers for each group).
- Coefficient of variation to statically test for significant difference among farmers in each group in term of the agricultural inputs usage.
- Two-tailed Z-test at 5% significance level to investigate for significant difference between the means of using the agricultural inputs for the two groups.
- Enterprise budgets for the two studied crops were calculated.

Then, the OLS regression analysis (econometric analysis) was used to estimate the cost functions for tomato and cucumber crops with Non-IPM and IPM technology. These two crops were selected due to the fact that, these are the most consumed products by the local population, exporting crops, repetition of growing products annually and the relatively high number of GH(s) producing these vegetable crops. MOA (1998) reported that, in the Jordan Valley and during the agricultural season of 1998, there were 4937 GH(s) grown with tomato and 9305 GH(s) grown with cucumber crop that represents about 24% and 46% of the total GH(s) in the whole Jordan Valley, respectively.

4.6.2.1 Crop Enterprise Budget

Depending on the farmers' estimates, the enterprise budgets and profitability of growing tomato and cucumber crops, with Non-IPM and IPM technology were calculated. A number of indicators such as gross revenues, gross margin and net profit had been calculated. Gross revenues depend on the estimated average yield, and the weighted farm gate prices during the period December 1998 to June 1999. Weighted farm gate price for the ordinary produce was calculated depending on the prices and quantities provided by Department of Statistics and the Agricultural Marketing Organization. While, the weighted farm gate prices of IPM produce were estimated, from quantities and prices that were taken from the concerned IPM marketing company in Amman wholesale Market for fruits and vegetables. The deduction for the cost of transportation and the fee of the wholesale market on sold fruits and vegetables were taken into consideration. Two different scenarios were used to calculate each enterprise budget for the selected IPM crops. The first was calculated in a way that the IPM produce was sold for the IPM market prices, and the second at the price of the ordinary produce in the wholesale market

The enterprise budget is divided into three parts, total returns, fixed costs and variable costs.

(A) Total Returns

The total returns minus variable costs indicate what is called the gross margin or the return above variable costs. To calculate the net profit (net return to management), costs of fixed assets were deducted from the calculated GM.

(B) Fixed Costs

Total fixed costs (TFC) are resources or input costs with fixed quantities do not vary during the production period (independent of output). They include mainly building depreciation, machinery and equipment depreciation caused by the passing of time, rents, interest on capital investment and opportunity cost of family labor (Doll, 1984).

The straight-line method was used to calculate the annual depreciation of the fixed items that last for several seasons. All depreciations were included in the enterprise budget sheets, such as depreciation of drip irrigation systems, water pool and pumps, buildings, muslin screen for IPM greenhouses, main and lateral irrigation pipes, frames and plastic sheets of the GH. The average land rent had been included in the calculations, considering the opportunity cost for the owned holdings, as well as the family labor available in the farm. Interest on fixed costs was calculated at a rate of 8%. This rate represents the average opportunity cost based on the interest rate of commercial banks on money deposits.

(C) Variable Costs

Total variable costs are defined as resources or inputs with varying quantities at the start of or during the production period (Doll, 1984).
The variable costs included in the enterprise budget sheets were the averages of the data collected. The variable costs of land preparation and spraying of pesticides were calculated as hired services, which are normally done by a contractor at the prevailing market price. Other variable costs were also included such as seeds or seedlings, water, threads, black mulch, bioregulator (hormone), chemical and organic fertilizers, in addition to transport costs to the farms, pesticides and soil

fumigant. Farmers usually use pesticides and fertilizers from a large selection of products, with different prices and application rates. Therefore expenses for plant protection treatments and chemical fertilizers were summarized as an average cost for each GH. Data on the required time and cost of hired seasonal labor was collected for each major operation of the production process. The interest on the variable costs was calculated at 8% (annually), this depicts the interest rate on the formal credit provided by the Agricultural Credit Corporation during the season 1998-1999. The costs of pesticide residues analysis and supervision for certified IPM products were added.

The cost for biological control (release of natural enemies) was excluded from the enterprise budgets because the available information is insufficient for the analysis, it is rarely applied by the IPM adopters.

4.6.2.2. Total Cost Function

Costs are the expenses incurred in organizing and carrying out the production process. They include outlays of funds for inputs and services used in production. In the short run, total costs include fixed and variable costs. In the long run, all costs are considered variable costs because all inputs are variable (Doll, 1984).

Fitting the ordinary least squares regression (OLS) method, the total cost functions for the long run period had been derived for Non-IPM and IPM technology for the production of tomato and cucumber crops. The resulted are presented and discussed in Chapter Six of this study.

The following equation model as stated by Doll *et al.* (1984) was used to represent the total cost function in the long run term:

$$\mathbf{TC = aY^3 + bY^2 + cY}$$

Where; Y = Production, and the following restrictions must be held, ($a > 0$, $b < 0$, $c > 0$), a,b and c = Parameters to be estimated.

To get the TC equations, the data, which was collected for each group, had been analyzed particularly for each group, or all data for the two groups were considered as one sample (Pooled data consisted of N = 110). In that case dummy variable was required because there were qualitative explanatory variables such as IPM and Non-IPM, which were introduced into the regression analysis by assigning the value of (1) for the IPM and (0) otherwise for the Non-IPM production process. The dummy variable was used to capture the changes (shifts) in coefficients of variables that might occur due to the application of the IPM technology in the production process. Thus, regression analyses were run for the following different scenarios; effect of IPM technology on the coefficient of the first variable only, on the coefficient of the second variable only, and on both coefficients of the first and second variables.

Then, the appropriate equations were selected and used to calculate the minimum average total cost per ton and optimal size of output for each crop, at which the average total costs reach its minimum, where the slope equals zero. At that level of output the average total cost equals the marginal cost. Average total cost ATC was computed by dividing the functions of total costs TC at the level of output (Y). The marginal cost MC was calculated by finding the first derivative of the total cost function. Usually, the average total costs and marginal cost curves decrease, reach the minimum and then increase again.

Part Two
Results of the study

Chapter Five

5. Adoption of IPM Technology in the Jordan Valley

5.1 Results of the Descriptive Statistics and Univariate Analysis

5.2 Results of the Multivariate Analyses

5. Adoption of IPM Technology in the Jordan Valley

The purpose of this chapter is to investigate some factors affecting the probability of adopting IPM technology, among protected vegetables crops growers, in the JV. It focuses to hypothesize some major factors as key issues for adoption behavior of farmers, particularly the farmers' personal characteristics, farm resources, institutional and communication factors. The main obstacles to adopt the new technology may lie within the farmers themselves, they may be attributed to the general socio-economic environment that discourage change on the part of the farmers, or it can be affected by the agricultural policy in the country. While these factors will affect the diffusion and adoption of a new technology, we should consider the access of farmers to these factors. Taking into consideration that, whenever a farmer is asked to change some traditional habits or incorporating new information, it is more likely that resistance will occur. Because there is for sure the fear of the unknown outcome and the reluctance of many farmers to know, learn and adopt new techniques.

In this chapter, the information collected from farmers was compared and analyzed. Findings of descriptive statistics, univariate and multivariate analyses for the variables obtained from the survey are presented. Also, some obstacles to the adoption of some IPM techniques from the researcher's point of view are highlighted.

5.1 Results of the Descriptive Statistics and Univariate Analysis

5.1.1 IPM Techniques Applied by IPM Adopters

As mentioned before, the IPM technology includes many agricultural techniques. Table 5-1 shows some IPM techniques and the application percentages by the IPM adopters. It shows that, soil solarization was among the most widely practiced IPM techniques, because applying that technique is so simple, easy, cheap and farmers in the Jordan Valley can use as an alternative to Methyl Bromide. Soil solarization is considered a sustainable and environmentally friendly alternative without risk of yield loss.

On the other hand, the use of biological pest management on vegetable crops was among the least practiced technique. The highest degree of reservations against changes was expressed in regard to it, and very few of the IPM vegetable growers were using that technique. Most of the farmers consider it a complex and impractical practice, especially when it is applied individually, as they believe it needs the cooperation among the farmers' community in discouraging harmful pesticide spraying. In addition, it is a costly technique as long as it depends on importing the natural enemies, which even might not be available on time. Imported beneficials were also reported to have difficulties to adapt to the local climate, also might not be available on time. That could explain why most of IPM vegetable growers are not convinced of such a technique. Currently in Jordan, two specialized private companies are working to establish commercially on mass rearing. Local production might help in reducing the cost of biological pest management on one side, and increasing the efficiency and availability of natural enemies on the other side. In Jordan, biological pest management for green houses was presented to the farmers very early, when the idea of IPM technology itself was still very new to the farmers. Such technique might be better to be considered one of the upper steps in the ladder and not the first one. Van den Ban (1990) indicated that, it is difficult to know when to release an innovation for use by the farmers. It may fail or spread sluggishly if released too soon. That might be another reason for rejecting the use of biological pest management. But it is worth to be noted that biological pest management is applied successfully in citrus groves in the Jordan Valley.

Most of the IPM adopters in the study area can be categorized into the innovators, and the early adopters categories, because they have most of the characteristics mentioned by Rogers (1983) who indicated that innovators are people who are very eager to try new ideas. Usually, they have substantial financial resources to absorb the possible loss owing to unprofitable innovation and the ability to understand and apply complex technical knowledge. They enjoy the hazardous, the rash, the daring and the risky. Early adopters have the greatest degree of opinion leadership in most social systems, and are considered by many as the individuals to ask before using a new idea.

The survey indicated that two thirds of the Non-IPM adopters lack the know-how of the IPM technology. While the rest are afraid to change their agricultural production process. The relatively scarce resources and their traditional habits slow the adoption decision process until they feel that it is safe and there is no risk to adopt.

Table 5-1
Percentages of IPM Techniques Application by the IPM Adopters

IPM Techniques	Percentages of IPM Techniques Application
Applying Least Toxic Pesticides	83 %
Using Bumblebees	88 %
Biological Pest Management	5 %
Soil Solarization	94 %
Muslin Screen	90 %
Disease and Pest Resistant Varieties	85 %
Rational Fertigation	86 %
Scouting and Monitoring	85 %
All IPM Techniques excluding Biological Pest Management Technique	82 %

Source: Calculated from the Collected Field Study Data during the Season 1998/1999 / Jordan Valley

Table 5-2 shows that Non-IPM adopters (55 farmers) in the sample owned 1342 GH(s) in total while the IPM adopters (55 farmers) owned 2626 GH(s). It can be estimated the average farm size of the IPM adopters was 47 GH(s), compared to only 24 GH(s) of the other group. It was found that IPM adopters applied IPM technology on 78% of their GH(s).

Table 5-2
Number of GH(s) in the Study Sample that belonging to the Non-IPM Adopters and IPM Adopters

	Tomato	Cucumber	Other Crops	Total
Total No. of (GHs) that belonging to Non-IPM Adopters	318	897	127	1342
Total No. of (GHs) that belonging to IPM Adopters	815	1298	513	2626

Source: Calculated from the Collected Field Study Data during the Season 1998/1999 / Jordan Valley

The results of the survey showed the major reasons of applying IPM techniques by the IPM adopters as shown in Table 5-3.

Table 5-3
Reasons of Applying IPM Techniques by the IPM Adopters

Reason of Applying IPM Techniques	Percentage
Environment protection	39%
Producing healthy fruits and vegetables crops	51%
Lower production costs	94%
Higher yield	88%
Higher produce price	91%

Source: Calculated from the Collected Field Study Data

Noting that in spite of the IPM adopters' interesting in applying IPM technology in their farms, the marketing of their IPM produce was and still a major problem.

5.1.2 Personal and Social Factors

5.1.2.1 Age

Many studies indicated that older farmers seem to be less inclined to adopt new technology than younger ones, and that age of farmer had a negative significant effect on the adoption decision (Jayson *et al.*, 1990). The farmers' age categories in the study sample are stated in Table 5-4. It shows that the highest percentage, about 49% of the IPM adopters are aged below 35 years comparing with only 15% of the Non-IPM adopters, and 29% of IPM adopters are aged more than 46 years against 64% of the Non-IPM adopters. Generally, younger farmers are more innovative, progressive and more likely to adopt new techniques than old farmers, who seem to be less interested in implementing or trying new ideas, practices or techniques. Sometimes, elder farmers might have other non-agricultural sources of income from their employed family members, or pension that might discourage change to any new technique. Or they may have other needs, which could be family related or health and social matters more than maximizing their income and profit.

The chi-square test for independence between the age of the farmer and the adoption of IPM technology showed that the null hypothesis is rejected ($P < 0.05$). Therefore, the hypothesis that age of farmer is related to the adoption of IPM technology is supported by the results.

Table 5-4
Distribution of the Study Sample According to the Age Categories

Age Categories (years)	Non-IPM Adopters (%)	IPM Adopters (%)
15 – 25	2 (3.6%)	2 (3.6%)
26 – 35	6 (10.9%)	25 (45.5%)
36 – 45	12 (21.8%)	12 (21.8%)
46 – 55	20 (36.4%)	12 (21.8%)
56 – 65	15 (27.3%)	4 (7.3%)
Total	**55 (100%)**	**55 (100%)**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 20.42 with 4 *dfs*.
The figures in parentheses are percentages.

5.1.2.2 Educational Level

Lionberger (1968) indicated that schooling has been valued as a mean of increasing knowledge. But, as with other variables associated with the adoption of farm practices, clear-cut relationships are hard to establish, because years of schooling is related to other factors likely to condition adoption rates. Rogers (1983) stated that innovators are tending to be relatively bettered educated.

The educational level of the farmers in the study sample is presented in Table 5-5. It shows that around 64% of the IPM adopters were found to be university graduates, comparing with only 11% of the Non-IPM adopters. About 40% of the non-adopters were less than elementary level of education with only 9% of the IPM adopters. It can be noticed that the IPM adopters are better educated, which can create favorable atmosphere and good base for enhancing the acceptance of new techniques.

The chi-square test for independence indicated that the level of education and the adoption of IPM technology were related and statistically significant ($P < 0.05$). Therefore, the alternative hypothesis that education is enhanced to the adoption of IPM technology is accepted.

Table 5-5
Distribution of the Study Sample According to the Educational Level

Educational Level	Non-IPM Adopters (%)	IPM Adopters (%)
Illiterate	8 (14.5%)	5 (9.1%)
Primary	14 (25.5%)	0 (0%)
Elementary	9 (16.4%)	3 (5.4%)
Secondary	9 (16.4%)	7 (12.7%)
Agricultural Secondary	2 (3.6%)	1 (1.8%)
Community	7 (12.7%)	4 (7.3%)
Bachelor Science or higher	3 (5.5%)	5 (9.1%)
Agr. Bachelor Science or higher	3 (5.4%)	30 (54.6%)
Total	**55 (100%)**	**55 (100%)**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 42.42 with 6 *dfs.*
The figures in parentheses are percentages.

5.1.2.3 Years of Experience

Farmers with more experience were more likely to adopt new technology earlier than less experienced (Michael *et al.* (1984) and Feder *et al.* (1984)). Table 5-6 shows the years of experience of the farmers in the study sample. The Non-IPM adopters were found to have more years of experience in agriculture practices than IPM adopters. Roughly, 58% of the Non-IPM adopters had more than 21 years of experience compared to only 20% of the IPM adopters. Besides that, it had been noticed that Non-IPM adopters are more conservative. The well-established farming habits make it less likely for experienced holders to adopt new techniques in their farm production process. Considering that the years of experience are highly associated with the age of the holders.

The results of chi-square test for independence indicated that the farmer's years of experience and adoption of IPM technology were related ($P < 0.05$).

Table 5-6
Distribution of the Study Sample According to the Years of Experience

Experience Categories (years)	Non-IPM Adopters (%)	IPM Adopters (%)
1 – 10	6 (10.9%)	26 47.3%
11 – 20	17 (30.9%)	18 32.7%
21 – 30	21 (38.2%)	9 16.4%
> 31	11 (20%)	2 3.6%
Total	**55 (100%)**	**55 100%**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 23.22 with 3 *dfs*.
The figures in parentheses are percentages.

5.1.2.4 Place of Residence

Table 5-7 presents the distribution of the farmers in the study sample according to their place of residence. About 87% of the Non-IPM adopters reside in the Jordan Valley, compared with only 38% of the IPM adopters. Two thirds of the IPM adopters live in Amman or in other cities of Jordan. Those farmers most probably have better access to information sources, more exposure to urban culture. They are expected to remain well informed about new developments on farming practices, also the need of the market and how to market their produce at favorable prices than the Non-IPM adopters.

The result of the chi-square test for independence showed that adoption of IPM technology and the place of residence of the farmer were related ($P < 0.05$).

Table 5-7
Distribution of the Study Sample According to the Place of Residence

Place of Residence	Non-IPM Adopters (%)	IPM Adopters (%)
Jordan Valley	48 (87.3%)	21 (38.2%)
Other	7 (12.7%)	34 (61.8%)
Total	**55 (100%)**	**55 (100%)**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 28.68 with 1 *df.*
The figures in parentheses are percentages.

5.1.2.5 Gender

It is widely recognized that the rural women in the Jordan Valley play an important role in agricultural production and farm practices such as planting, weeding, and harvesting. They are involved in major decision making issues, which should be considered in developing and adopting new practices and technologies. Table 5-8 indicates the distribution of the study sample according to the gender. There was no big difference between the two compared groups.

The chi-square test for independence presented no relation between gender and the adoption of IPM technology ($P > 0.1$).

Table 5-8
Distribution of the Study Sample According to the Gender

Gender	Non-IPM Adopters (%)	IPM Adopters (%)
Male	48 (87%)	50 (91%)
Female	7 (13%)	5 (9%)
Total	55 (100%)	55 (100%)

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 0.37 with 1 *df.*
The figures in parentheses are percentages.

5.1.2.6 Off-Farm Employment

In theory, off-farm employment, might lead to higher income, this in turn could make more capital available for adopting new practices and techniques. Also, it might help greatly in exposure to mass media or personal communication, so new information and knowledge could be gained. Table 5-9 shows the distribution of the study sample according to the off-farm employment of the sample farmers. The percentages indicate that about 38% of the IPM adopters and only 5% of the Non-IPM adopters have off-farm employment.

The chi-square test for independence between the off-farm employment of the farmer and the adoption of IPM technology presented that this hypothesis (null) is rejected ($P < 0.01$). So the hypothesis that the off-farm employment of the farmer is related to the adoption of IPM technology is evident.

Table 5-9
Distribution of the Study Sample According to the Off-Farm Employment

Off-Farm Employment percentage	Non-IPM Adopters (%)	IPM Adopters (%)
0%	52 (94.6%)	34 (61.9%)
25%	2 (3.6%)	6 (10.9%)
50%	1 (1.8%)	7 (12.7%)
> 75%	0 (0%)	8 (14.5%)
Total	55 (100%)	55 (100%)

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 17.27 with 1 *df*
The figures in parentheses are percentages.

5.1.3 Farm Resource Factors

5.1.3.1 Tenure Status

The figures in Table 5-10 indicate that renting land is the most important type of land tenure for both Non-IPM adopters and IPM adopters groups. It might be that land tenure status most probably does not appear to be associated with the adoption of IPM techniques.

The chi-square test for independence found that tenure status and the adoption of IPM technology were not related ($P > 0.1$).

Table 5-10
Distribution of the Study Sample According to the Tenure Status

Tenure status	Non-IPM Adopters (%)	IPM Adopters (%)
Owned	11 (20.0%)	9 (16.4%)
Rented	40 (72.7%)	44 (80.0%)
Shared	4 (7.3%)	2 (3.6%)
Total	**55 (100%)**	**55 (100%)**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 0.24 with 1 *df.*
The figures in parentheses are percentages.

5.1.3.2 Size of Holding

Farmers who have large size of holding adopt the new techniques earlier than other farmers do (Roling, 1982). Feder *et al.* (1984), reported that large-scale farmers would adopt the new techniques earlier than other farmers, and Lee *et al.* (1983) found that small-scale farmers lagged behind large-scale farmers in adopting new techniques. In Table 5-11, the distribution of the study sample according to the size of holding is presented. The farm-size differs between the two groups of the study sample. The IPM adopters tend to have large size of holdings. About 65% of the IPM-adopters' holdings were between 1 to 40 GH(s), compared to 87% of Non-IPM adopters with holdings in this size range of the same category. Also, 15% had more than 100 GH(s), in comparison with only 2% of the Non-IPM adopters.

The results of chi-square test for independence rejected the null hypothesis. So, the adoption decision is related to the size of the holding (P < 0.05).

Table 5-11
Distribution of the Study Sample According to the Size of Holding

Size of Holding (GH)	Non-IPM Adopters (%)	IPM Adopters (%)
1 – 20	32 (58.2%)	16 (29.1%)
21 – 40	16 (29.1%)	20 (36.4%)
41 – 60	5 (9.1%)	6 (10.9%)
61 – 80	0 (0%)	5 (9.1%)
81 – 100	1 (1.8%)	0 (0%)
More than 100	1 (1.8%)	8 (14.5%)
Total	**55 (100%)**	**55 (100%)**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 13.64 with 4 *dfs*.
The figures in parentheses are percentages.

5.1.4 Institutional Factors

5.1.4.1 Farm Sources of Finance and Access to Credit Services

Farmers with high access to credit services and inputs are frequently in a better position to adopt, and try new forms of technology (Fliegel, 1984). Farmers in Jordan are provided with credit directly by financial institutions such as banks or by moneylenders, and mostly from formal government-subsidized credit services (Agricultural Credit Corporation), which charges much lower interest rates than any other credit services sources. Credit could be an important way to improve farmer adoption to new technologies. The farmer's ability to purchase inputs related to the new technology is particularly very important. Table 5-12 presents the distribution of the study sample according to the farm sources of finance. The survey data indicated that many farmers were using their equity capital, and only few were borrowers. The percentage of taking loans was higher (almost double) by the IPM adopters group.

The chi-square test for independence showed that the sources of finance and the adoption of IPM techniques were not related (P > 0.1).

Table 5-12
Distribution of the Study Sample According to the Farm Sources of Finance

Farm Sources of Finance	Non-IPM Adopters (%)	IPM Adopters (%)
Equity Capital	51 (92.7%)	47 (85.5%)
Mixed Capital (Equity + Loan)	4 (7.3%)	8 (14.5%)
Total	**55 (100%)**	**55 (100%)**

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: Chi-square X^2 calculated value was = 1.49 with 1 *df.*
The figures in parentheses are percentages.

5.1.4.2 Participation in Extension Activities

Farmers with high access to information networks and extension activities are more frequently in a better position to try and adopt the new technologies (Roling, 1982). The benefit of using extension methods and participation in extension activities is much more frequent for IPM adopters than for Non-IPM adopters, which is clearly reflected in the percentages stated in Table 5-13. These methods help in raising awareness and stimulating the interest in new ideas, practices and technology. It might be explained that IPM adopters actively solicit information and technical advice.

Table 5-13
Distribution of the Study Sample According to Farmers' Use of Extension Methods and their Participation in the Extension Activities

Extension Methods/ Activities	Non-IPM Adopters (%)	IPM Adopters (%)
Seminars	13 (23.6%)	38 (69.1%)
Radio Programs	7 (12.7%)	34 (61.8%)
Television Programs	3 (5.4%)	30 (54.5%)
Brochures and Leaflets	14 (25.4%)	49 (89.1%)
Agricultural Exhibitions	4 (7.3%)	28 (50.9%)
Newspapers and Magazines	6 (10.9%)	21 (38.2%)
Field Days by Agricultural Companies	5 (9.1%)	16 (29.1%)
Field Days by Governmental Institution	6 (10.9%)	22 (40.0%)
Field Days by Non Governmental Organization	2 (3.6%)	35 (63.6%)
Extension Activities by IPM Project/ NCARTT	18 (32.7%)	47 (85.4%)

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley

5.1.5 Summary Results of the Univariate Analysis

In summary, results of the chi-square test for independence are presented hereinafter in Table 5-14. The results supported the hypotheses that age, educational level, years of experience, place of residence, off-farm employment and size of holding influenced the adoption of IPM technology. While, gender, tenure status and farm sources of finance were not related to the adoption decision.

Table 5-14
Summary of Chi-square Test for Independence between some Socio-economic Factors and the Adoption of IPM Technology

Factor	CaCMMR/225)0-5/	Degree of Freedom	*P-Values*
Age of the farmer (*)	**20. 42**	**4**	**< 0.05**
Educational level (*)	**42. 42**	**6**	**< 0.05**
Years of experience (*)	**23. 22**	**3**	**< 0.05**
Place of residence (*)	**28. 68**	**1**	**< 0.05**
Gender	**0. 37**	**1**	**> 0.10**
Off-farm employment (*)	**17. 27**	**1**	**< 0.01**
Tenure status	**0. 24**	**1**	**> 0.01**
Size of holding (*)	**13. 64**	**4**	**< 0.05**
Farm source of finance	**1. 49**	**1**	**> 0.10**

MJ/CMMR/31

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Note: The Star (*) means that the nominated factor and the adoption of IPM technology are dependent.

5.2 Results of the Multivariate Analyses (Probit and Logit Models)

The detailed results of the multivariate analyses are displayed in Table 5-15 and Table 5-16.

5.2.1 The Main Findings of the Analyses:

1. The results showed that the age of the farmer does not play a significant role in the probability of adopting any of the IPM techniques. Rogers (1983), Van den Ban (1990) and Ra'ouf (1993) had similar results. Contrary to popular opinion, no relation was found between age and adoption of new technology. However, Jayson *et al.* (1990), Saleh (1993), ICARDA (1994) and Al-Qudah (1996) reported that the age of the farmer showed a significant negative effect on the adoption decision, indicating that elder farmers are somehow less progressive towards the change, and adoption of new technology. The contrast between our results and their results may be related to the difference in the characteristics of each innovation.

2. Educational level was found to have a significantly positive effect on the use of bumblebees, soil solarization and scouting and monitoring. Education is expected to encourage the farmers to look, analyze, decide, and act using and applying the available new innovation more objectively. The results implied in this study are similar to those results of Rolling (1982), Rogers (1983), Feder *et al.* (1984), Michael *et al.* (1984), Watt (1984), Ra'ouf (1993), Shadaydeh (1993), Saleh (1993), ICARDA (1994), Padhee (1995), Young (1996) and Al-Qudah (1996). They all indicated that farmer's educational level influences positively the adoption of new technology. Lionberger (1968) found that the adoption rate is likely to be direct and significant, specifically when the persons learned or heard about the new farm techniques in school. That appears clearly in the study findings by having about 54% of the IPM adopters group who are agricultural engineers, comparing to only 5% of the Non-IPM adopters group. That could explain why the profession of the farmers has a significant positive influence on the probability of the adoption decision of IPM technology, and that formal agricultural school education enhances the capability of the farmer to act positively toward adopting new agricultural techniques. Thus, the

importance of modern agricultural education is demonstrated especially when it comes to increasing yields and profit.

3. It was hypothesized that number of years of farming experience influences the probability of adoption positively. But contrary to what was expected, and to the results of Feder *et al.* (1984), Michael *et al.* (1984), Ra'ouf (1993) and ICARDA (1994). The study showed a significant negative relationship with the probability of adopting some IPM techniques such as spraying least toxic pesticides, using bumblebees, soil solarization, the use of muslin screens and growing diseases and pest resistant varieties. It might be explained that farmers with more years of experience are less inclined to adopt new farm agricultural techniques, because they are used to apply their practices for a long time. Sometimes they are not ready to learn, or to handle the risk of any change.

4. The findings support the hypothesis that the place of residence (outside Jordan Valley) showed a significant positive relationship with the probability of adopting of IPM techniques such as applying the least toxic pesticides, soil solarization, scouting and monitoring, growing

disease and pest resistant varieties and the rational fertigation. A possible explanation is that farmer who resides outside the village might have more chances to hear, see and listen to more new information and innovations. Also, he could have many facilities to reach a higher level of education, extra sources income that encourage him to upgrade his production process to improve his farm income.

5. The results show a significant positive relation between "female farmers" and the adoption probability of most of the IPM techniques. That could be explained by the following reasons:

- Many women are initiative and have high aspirations for themselves and for their children and all their family members when it comes to their health. Taking into consideration that the IPM technology is an environmentally friendly technology, protects human beings and the environment. To be initiative is one of the characteristics of people who are quick to adopt new innovations (Van den Ban, 1990).
- The IPM project as the major source of information about IPM technology is somehow a gender-sensitive project. When the project organizes extension activities, such as meetings, seminars, trials, field days, demonstrations. It takes into consideration, so as to encourage

farmers to attend and participate, that time and place have to be fully appropriate, convenient and accessible to most of farmers, including rural women. Sometimes, special activities are organized mainly for women, when they meet in one of their farms. That does not mean any concentration by the project on selected progressive farmers or on rural women, but it takes into consideration the field conditions, as well as the major socio-economic categories of farmers, which may help in developing the adoption of the IPM technology more effectively.

6. As expected, the off-farm employment had a significant positive effect on the probable adoption of many IPM techniques such as applying the least toxic pesticides, soil solarization, scouting and monitoring, growing disease and pest resistant varieties and the rational fertigation. This finding could be due to better financial situation of the farmers who have off-farm employment. An active social life with more contacts may lead to more exposure to information and communications about any new technology. This result is similar to the results of Shadaydeh (1993) and ICARDA (1994) who found that off-farm employment has a significant positive effect on the adoption

level. However, Fernandez *et al.* (1994) found that off-farm employment negatively affected the adoption level in a case of vegetable growers in Florida. The contrast between the result of this study and that of Fernandez *et al.* (1994) may be due to the different farming conditions. In Jordan farmers hire permanent or seasonal farm labor, which help them widely in technical agricultural issues, and sometimes manage the production process as farm managers. This situation helps the farmer to have more time for off-farm employment in contrast to farmers in Florida, where farm labor is very expensive. Thus, a part time farmer has less time to think about and implement innovative technologies.

7. No significant relation was found between the tenure status and adopting probability of IPM technology. The results showed that the tenure status is not an important constraining factor and it has no effect with respect to IPM technology adoption. That might be due to adopting one or more of the IPM techniques may be a decision for a short term, and something related to the current seasonal agricultural practices, which does not need long term investments, in addition to that IPM techniques could be considered a group of agricultural

farming management decisions, and the final decision would be taken by the person who cultivated the land, no matter if he is a tenant, sharecropper or landowner.

8. Size of holding has a significant positive relationship with the probability of adoption decision of IPM techniques. These findings, agree with the results of Lionberger (1968), Roling (1982), Rogers (1983), Lee *et al.* (1983), Feder *et al.* (1984), Compton (1984), Byerlee *et al.* (1986), Saleh (1993), Fernandez *et al.* (1994) and Al-Qudah (1996) who indicated that farm size has a significantly positively relationship with the adoption decision. It had been noticed that many of the small-scale farmers who responded to the survey are more concerned with minimizing risk, rather than adopting new technology, even though it may maximize their profit. Many large-scale farmers are wealthier farmers. They have the ability to absorb any possible risk in having loss due to the applying of the new innovation. They run their farms on an economic basis, and they are often highly interested in and value any information about innovations, as a major factor in their farming practice success. They depend on such information as an

important part in their decision-making, especially when they promise to provide economic benefits.

9. The results supported the hypothesis that there is a significant positive relation between the adoption of many IPM techniques and having agricultural loan and the capital. The results obtained by Lionberger (1968), Mann (1977), Roling (1982), Rogers (1983), Fliegel (1984), Michael *et al.* (1984), Al-Rimawi (1991), Al-Karablieh (1995) and Al-Khayyat (1997) supported the result obtained in this study. Sometimes, farmers are unable to implement and apply an innovation due to insufficient capital needed to purchase the required inputs. It is worth noting that, in general, the IPM technology is considered as a cost saving technology, which reduces the overall production costs. In applying some IPM techniques, the farmer can realize a direct benefit through reduction of cost at the beginning of the production process, e.g. applying soil solarization as an alternative to Methyl Bromide. Other IPM techniques require the purchase of relatively expensive inputs for which cash is required. Bumblebees hives, for example are needed during the crop flowering stage. The benefits of bumblebees are realized only at harvesting time, through higher yields and better

fruits quality. Another example is the muslin screen, which costs three times more than ordinary screen, although it lasts for three years. Through the muslin screen most insect pest are excluded from the greenhouse, which reduces the need for expensive pesticide applications. During the survey, it had been noticed that the credit service is usually available for landowner farmers, as it is considered acceptable collateral by the formal credit institutions. But, they are not interested and refused to get formal credit to avoid paying interest due to religious reasons. Farmers who are tenants do not quality for credit. Many farmers buy most of the agricultural inputs they need from retailers' shops, on a short-term loan. They have to pay at the end of the season, but with higher prices than paying in cash. Farmers who are relatively rich use a combination of their equity and agricultural loans. They buy the inputs they need in cash which gives them the opportunity to negotiate discounts.

10. A significant positive relationship was observed between the participation in the extension activities and the probable of adopting some IPM techniques such as applying least toxic pesticides, soil solarization, growing disease and pest resistant varieties, rational

fertigation and scouting and monitoring. This result supported by those of Roling (1982), Rogers (1983), Feder *et al.* (1984), Van den Ban (1990), Jayson *et al.* (1990), Mcnamara *et al.* (1991), Shadaydeh (1993), Saleh (1993) and Al-Khayyat (1997), who found a positive relationship between the adoption probability and the participation in extension activities. It might be worth to note that many IPM related activities were held and are still planned in order to teach current and new IPM techniques to farmers in many regions of Jordan. The smooth flow of information on IPM technology to the farmers might explain the good effect on the adoption of the IPM techniques. The characteristics of the information flow are similar to a large extent to the principles of agricultural extension as stated by Fliegel (1984), which include persuading the farmer to try the new technology, providing the information necessary for actual implementation and providing the information needed by the farmers to assess the results of the decision, and then to confirm that decision. In addition, the mass media need to support the process through 1) audio media method as radio programs, 2) visual methods including slides, transparencies and printed materials such as newspapers, newsletters, fact sheets, farm magazines, leaflets, folder, posters, bulletins and pamphlets, 3) audio-visual media including television programs, video documentary films. Most of these methods have been produced and used by the IPM project, in order to reach the farmers and inform them about the benefits of the recommended new IPM technology practices. It had been noticed that these methods are really needed by the farmers, and suit the local farming conditions. The exposure of farmers to information through the mass media is expected to have an influence on traditional beliefs, also improving the flow of information to farmers, assisting and encouraging them to adopt new techniques and so improving their leadership skills. Sometimes, farmers themselves could be a source of information, which helps in diffusion of innovations, as many small farmers look up to large and successful farmers who are a model for them.

In summary, in this chapter there are no contrasts among the results of the univariate and multivariate analyses, except in three factors, which are the age, gender and the farm sources of finance. That could be explained by that the univariate analysis based on analyzing categorized data and identifies if there is a particular relationship between two variables (the adoption and each of the socio-economic factors in particular), while the multivariate analyses based on analyzing the real numerical (uncategorized) data taking into consideration the effect of all the socio-economic factors of the farmer on the probability of the adoption decision that gives more accurate results. It is worth noting that the chi-square test of independence does not reflect or measure the direction of the relationship (positive or negative), while the multivariate analyses "Logit and Probit models" can measure the direction of the relationships between variables. In this study, both Logit and Probit models analyses showed similar results of the relationships directions between the probability of adopting the IPM techniques, and the socio-economic factors. Therefore, in such case, it might be better if the results of the multivariate analyses are considered as main results of this study.

5.2.2 The Marginal Effect of the Socio-economic Factors

The multivariate analysis was used to quantify the marginal effects of some socio-economic factors on the probability of adopting IPM techniques. Table 5-15 shows the equations of the Probit Model regression. Equation 1 indicates that the contributions of some factors to the probability of adopting IPM technology in the Jordan Valley are statistically significant. These factors are; (gender " female farmers ", education, profession " agricultural engineer farmer ", years of experience, residing outside the Jordan Valley, size of holding, off-farm employment, participation in the extension activities and having agricultural credit). It can be observed that female farmer lead to an increase in the probability of adoption decision by 1.52%. However, an increase of one year of education and one GH in the size of holding, increase the probability of IPM adoption by 0.10% and 0.12%, respectively. If the farmer is, an agricultural engineer that increases the probability of adoption by 0.86%, while an increase of one year of experience decreases the probability of IPM adoption by 0.04%. Other factors such as residing outside the Jordan Valley, off-farm employment, participating in extension activities and having agricultural credit, would lead to an increase in the probability of adoption decision by 1.39%, 0.94%, 1.93% and 1.28%, respectively. The effects of age and tenure status were found to be insignificant. Noting that equations from 2 to 8 in Table 5-15 represent the marginal effects of the socio-economic factors on the probability of adoption decision for each technique of the IPM technology. They can be explained in the same way depending on the signs and the parameters values of the significant factors for each equation.

Table 5 – 15

Results of Probit Model Regression for some Factors Influencing the Adoption of IPM Technology

Dependent Variables ⇒		IPM package	Least Toxic Pesticides	Bumblebees	Soil Solarization	Muslin Screening	Resistants Seedlings	Rational Fertigation	Monitoring & Scouting	IPM Intensity
Independent Variables ⇓	Expected Sign ⇓	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6	Equation 7	Equation 8	Equation 9
AGE (Years)	-	- 0.011 (- 0.348)	0.004 (0.141)	0.030 (0.972)	- 0.009 (- 0.294)	- 0.024 (- 0.602)	0.673 (0.216)	0.014 (0.449)	- 0.013 (- 0.394)	0.011 (0.264)
GENDER (1,0)	+	1.524 (2.205)[b]	1.382 (2.109)[b]	1.321 (1.974)[b]	0.011 (0.019)	0.681 (0.885)	0.933 (1.469)[c]	1.132 (1.537)[c]	1.782 (2.550)[a]	0.948 (0.958)
EDUCATN (Years)	+	0.104 (1.939)[b]	0.032 (0.656)	0.095 (1.792)[b]	0.081 (1.633)[c]	0.033 (0.527)	0.0004 (0.917)	0.027 (0.544)	0.105 (1.949)[b]	0.082 (1.311)[c]
PROFE (1,0)	+	0.865 (1.426)[c]	0.733 (1.215)	1.409 (2.596)[a]	0.848 (1.290)[c]	0.687 (0.680)	0.456 (0.724)	0.754 (1.395)[c]	0.596 (1.074)	7.611 (0.003)
EXPERIEC (Years)	+	- 0.043 (-1.970)[b]	-0.058 (-1.367)[c]	- 0.081 (-2.055)[b]	- 0.081 (-1.926)[b]	- 0.114 (-2.148)[b]	- 0.079 (-1.993)[b]	- 0.025 (- 0.599)	0.0004 (0.011)	- 0.166 (-2.440)[a]
RESIDEN (1,0)	+	1.397 (2.147)[b]	2.279 (3.101)[a]	0.347 (0.679)	2.139 (1.923)[b]	13.486 (0.863)	1.470 (2.193)[b]	1.326 (2.734)[a]	1.158 (2.100)[b]	4.566 (0.003)
FRMSIZE	+	0.128 (2.269)[b]	0.114 (2.130)[b]	0.142 (2.667)[a]	0.203 (2.659)[a]	0.098 (1.413)[c]	0.078 (1.518)[c]	- 0.015 (- 0.217)	0.058 (1.039)	0.322 (2.574)[a]
OFF-FARM (%)	+	0.942 (2.684)[a]	0.615 (1.750)[b]	0.104 (0.445)	1.376 (1.351)[c]	18.708 (0.008)	0.735 (1.536)[c]	0.493 (2.058)[b]	1.150 (3.288)[a]	-8.736 (0.004)
EXTSION (1,0)	+	1.936 (2.834)[a]	1.599 (2.044)[b]	0.533 (1.029)	1.382 (1.445)[c]	13.489 (0.008)	0.991 (1.489)[c]	0.883 (1.644)[c]	1.882 (2.947)[a]	4.417 (0.003)
OWNFARM (1,0)	+	0.110 (0.205)	-0.124 (- 0.224)	- 0.190 (- 0.374)	- 0.448 (- 0.865)	0.286 (0.380)	0.451 (0.887)	-1.031 (-1.008)	- 0.225 (- 0.422)	0.706 (1.002)
CAPLOAN (1,0)	+	1.288 (2.085)[b]	1.002 (1.593)[c]	0.937 (1.662)[c]	0.896 (1.229)	2.487 (2.192)[b]	1.539 (2.461)[a]	-0.021 (-0.034)	1.153 (1.858)[b]	9.143 (0.002)
Percent Correct Prediction		**0. 87**	**0. 81**	**0. 86**	**0. 91**	**0. 89**	**0. 83**	**0. 87**	**0. 83**	**0. 80**

Source: Compiled from Probit Model Solution. The Analysed Data were Collected during the Field Study / Season 98 99 / Jordan Valley.

Notes: (1) a, b and c indicate statistical significance at the 1% , 5% and 10% levels. (2) Figures in parentheses are representing t statistics values.

Table 5 – 16

Results of Logit Model Regression for some Factors Influencing the Adoption of IPM Technology

Dependent Variables ⇒		IPM package	Least Toxic Pesticides	Bumblebees	Soil Solarization	Muslin Screening	Resistants Seedlings	Rational Fertigation	Monitoring & Scouting
Independent Variables ⇓	Expected Sign ⇓	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6	Equation 7	Equation 8
AGE (Years)	-	- 0.027 (- 0.474)	0.003 (0.051)	0.056 (1.037)	- 0.039 (- 0.607)	- 0.039 - 0.568	0.010 (0.207)	0.020 (0.345)	- 0.024 (- 0.403)
GENDER (1,0)	+	2.549 (2.148)[b]	2.370 (2.117)[b]	2.250 (1.945)[b]	0.054 (0.051)	1.215 (0.933)	1.470 (1.347)[c]	1.941 (1.558)[c]	2.995 (2.487)[a]
EDUCATN (Years)	+	0.183 (1.891)[b]	0.044 (0.472)	0.158 (1.663)[b]	0.148 (1.606)[c]	0.034 (0.309)	0.013 (0.165)	0.034 (0.385)	0.191 (1.930)[b]
PROFE (1,0)	+	1.388 (1.293)[c]	1.290 (1.248)	2.371 (2.565)[a]	1.869 (1.361)[c]	1.306 (0.708)	0.976 (0.862)	1.401 (1.479)[c]	1.023 (1.095)
EXPERIEC (Years)	+	- 0.065 (- 1.924)[b]	-0.103 (-1.324)[c]	-0.142 (-2.039)[b]	- 0.129 (-1.681)[b]	- 0.215 (-2.156)[b]	- 0.146 (-2.065)[b]	- 0.040 (- 0.557)	0.007 (0.107)
RESIDEN (1,0)	+	2.680 (2.138)[b]	4.354 (2.861)[a]	0.623 (0.704)	4.067 (1.902)[b]	36.191 (0.010)	3.032 (2.207)[b]	2.357 (2.772)[a]	2.131 (2.110)[b]
FRMSIZE	+	0.207 (2.165)[b]	0.197 (2.176)[b]	0.242 (2.579)[a]	0.410 (2.521)[a]	0.164 (1.332)[c]	0.132 (1.536)[c]	- 0.023 (- 0.175)	0.100 (1.044)
OFF-FARM (%)	+	1.903 (2.481)[a]	1.285 (1.790)[b]	0.185 (0.468)	2.436 (1.340)[c]	52.07 (0.010)	1.256 (1.466)[c]	0.902 (2.087)[b]	+2.176 (3.052)[a]
EXTSION (1,0)	+	3.565 (2.704)[a]	2.845 (1.952)[b]	0.884 (0.974)	2.813 (1.493)[c]	35.950 (0.010)	1.988 (1.600)[c]	1.544 (1.600)[c]	3.500 (2.851)[a]
OWNFARM (1,0)	+	0.207 (0.223)	-0.150 (- 0.158)	- 0.333 (- 0.373)	- 0.831 (- 0.830)	0.557 (0.428)	0.815 (0.946)	- 1.731 (-0.442)	- 0.343 (- 0.372)
CAPLOAN (1,0)	+	2.349 (2.019)[b]	1.734 (1.591)[c]	1.527 (1.588)[c]	1.721 (1.219)	4.200 (2.215)[b]	2.629 (2.453)[a]	-0.033 (-0.030)	2.093 (1.887)[b]
Percent Correct Prediction		**0. 88**	**0. 82**	**0. 87**	**0. 92**	**0. 90**	**0. 82**	**0. 87**	**0. 85**

Source: Compiled from logit Model Solution. The Analysed Data were Collected during the Field Study / Season 98 - 99 / Jordan Valley.

Notes: (1) a, b and c indicate statistical significance at the 1 % , 5% and 10% levels. (2) Figures in parentheses are representing t - statistics values.
(3) The coefficients of the logit model should be multiplied by 0.625 in order to be comparable to the estimates obtained from the probit model.
(4) When the main interest is in examining which variables are significant, there is no need to make any changes in the estimated coefficients for the logit model.

Chapter Six

6. Economic Analyses of Producing Tomato and Cucumber with Non-IPM and IPM Technology

6.1 Usage of Agricultural Inputs

6.2 Producing Tomato and Cucumber Crops

6.2.1 Enterprise Budgets

6.2.2 Total Cost Functions

6. Economic Analyses of Producing Tomato and Cucumber with Non-IPM and IPM Technology

Profitability is a major determinant of the adoption of new technology (Compton, 1984). Thus, economic analysis can play an important role in the adoption and development. As Watts (1984) indicated the response of the farmer to technological innovation is directly related to his or her perception of deriving a financial advantage from applying such technology. This chapter will interpret information to help farmers in making decisions, by analyzing and evaluating the performance of the IPM technology on the basis of production costs. The principle economic factor is the profit opportunity available to the farmers, who strive to improve productivity by applying new technology.

6.1 Usage of Agricultural Inputs in the Study Area

In this part the use of the major agricultural inputs per one greenhouse is described. Table 6-1 and Table 6-2 show that IPM adopters have lower coefficients of variation and average usage of agricultural as compared to the Non-IPM group. Also, the Z-test results show a significant difference in the usage of the agricultural inputs between the two compared groups. These results could be due to the homogeneity among the IPM adopters, especially, their educational level since more than 50% are agricultural engineers. IPM adopters have relatively better scientific knowledge, and a high concern for optimal and rational use of agricultural inputs.

Table 6-1
The Average (Mean) Usage of Agricultural Inputs in the Study Sample for Tomato Crop Production with Non-IPM and IPM Technology /GH

Agricultural Input	Unit	Non-IPM Technology		IPM Technology		Z
		Mean	C.V*	Mean	C.V	Test**
Seedlings	Seedling	1656	13%	1445	11%	-5.57
Chemical fertilizer	JD	78	36%	63	15%	-4.8
Organic fertilizer	Ton	2	31%	3	14%	6.94
Soil fumigation (MeBr)	Can	46	45%	___	___	___
Soil solarization	JD	___	___	20	0.5%	___
Pesticides	JD	84	23%	47	16%	-14.8
Hormones	JD	14.50	6%	___	___	___
Bumblebees	JD	___	___	20	19.5%	___
Water	m^3	424	19%	336	6%	-12.4

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
*C.V= Coefficient of Variation. ** Calculated Z - Test at 5% level of significance.
Number of farmers =55 farmers for each group.

Table 6-2
Average (Mean) Usage of Agricultural Inputs in the Study Sample for Cucumber Crop Production with Non-IPM and IPM Technology /GH

Agricultural Input	Unit	Non-IPM Technology		IPM Technology		Z
		Mean	C.V*	Mean	C.V	Test**
Seeds	Seed	1569	13%	1407	7%	-5.26
Chemical fertilizer	JD	81	30%	69	17%	-4.34
Organic fertilizer	Ton	2.5	33%	3	14%	3.35
Soil fumigation (MeBr)	Can	48	69%	——	——	——
Soil solarization	JD	——	——	20	0.5%	——
Pesticides	JD	88	19%	62	16%	-10.3
Water	m^3	458	13%	350	9%	-14

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
*C.V= Coefficient of Variation. ** Calculated Z - Test at 5% level of significance.
Number of farmers =55 farmers for each group.

6.2 Producing Tomato and Cucumber with Non-IPM and IPM Technology

6.2.1 Crop Enterprise Budgets

(A) Table 6-3 presents a summarized comparison of the enterprise budgets results of tomato production with Non-IPM and IPM technology. It shows that IPM technology results in a higher GM(s). The yield was 8% more, with higher gross revenues, and lower total variable costs per GH. Selling the IPM produce at IPM farm gate price (IPM (A) Scenario) gave a GM up to JD 909/GH, and JD 149/GH in case of selling at the same farm gate price of the conventional tomato (IPM (B) Scenario), while it was only about JD 59/GH for the Non-IPM tomato. The IPM adopters' group has a reduction of fixed costs by about 10%. It is worth to be noted that applying IPM technology is not the reason for that reduction. This can be explained by that the larger holding size the smaller average fixed costs per GH. Finally, the results also showed that IPM tomato production achieved a positive net profit.

Table 6-3
Summary of the Enterprise Budgets Results of Producing Tomato Crop with Non-IPM and IPM Technology

Indicators	Non- IPM	IPM (A)	IPM (B)
Tomato Productivity (Kg/GH)	6915	7449	7449
Total Gross Revenue (JD/GH)	664	1475	715
Total Variable Costs (JD/GH)	605	566	566
Gross Margin (JD/GH)	59	909	149
Total Fixed Costs (JD/GH)	412	373	373
Net Profit (JD/GH)	(353)	536	(223)

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley

(B) Table 6-4 shows that the average yield of producing cucumber under IPM technology was about 1% less. Total variable and fixed costs were higher for the Non-IPM production process. The GM(s) were found to be positive in all cases, but higher with the application of IPM techniques. Selling the cucumber produce at IPM farm gate price gave a

GM equal to JD 935/GH (IPM (A) Scenario), and about JD 395/GH in case of selling at conventional price (IPM (B) Scenario). In both cases, the GM(s) were higher in comparison to the Non-IPM products, which was about JD 346/GH. Also, the IPM technology achieved a positive net profit for cucumber crop production. Taking into consideration that the prices of the vegetable crop during the season of this study were relatively low for both IPM and Non-IPM produce due to marketing problems in the local Jordanian market.

Table 6-4
Summary of the Enterprise Budgets Results of Producing Cucumber Crop with Non-IPM and IPM Technology

Indicators	Non- IPM	IPM (A)	IPM (B)
Cucumber Productivity (Kg/GH)	6917	6837	6837
Total Gross Revenue (JD/GH)	955	1483	943
Total Variable Costs (JD/GH)	608	548	548
Gross Margin (JD/GH)	346	935	395
Total Fixed Costs (JD/GH)	412	373	373
Net Profit (JD/GH)	(66)	563	23

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley

The Tables 6-5, 6-6, 6-7 and 6-8 present the detailed findings of the enterprise budgets. They show that the costs of the agricultural chemicals (pesticides and soil fumigants) within the total variable costs take a large share. That might give indications about the inclination of farmers to switch from the conventional pest management to IPM technology. Most IPM adopters stated that they now use less pesticide than they did 4 years ago. And, they noted that, they now obtain better pest control, especially when using IPM technology. IPM technology is a part of general improvements of crop management, which may lead also to lower costs of water, chemical fertilizer and other agricultural inputs. It was found that the average relative share of chemical fertilizer, pesticides and soil sterilization in the total variable costs for the crops is 23% for the IPM tomato and 40% for Non-IPM tomato, and 28% for IPM cucumber and 42% for Non-IPM cucumber. The IPM techniques save between 60% to 70% of agricultural chemicals expenses (pesticides and soil fumigants), and about 15% to 20% of the chemical fertilizer expenses. This leads to higher GM(s) and better profits. That agreed with the opinion of Daxl *et al.* (1994) explaining that new agricultural technology meets with the desired level of acceptance once it lead to a rise in the GM(s), which can be achieved with the introduction of IPM techniques. This is primarily because of the normally relatively low cost of chemical plant protection measures.

It can be concluded that the results of the enterprise budget analyses support the hypothesis that IPM technology is more profitable. These results were in line with those of Grenzebach (1997) who found that the IPM adopters in Egypt, obtained higher yields with lower costs and significantly higher GM(s) in producing tomato and cucumber crops. Also, Trumble *et al.* (1994) found that IPM techniques on tomato crop in the United States of America resulted in better yields and net profits in comparison with the chemical and control treatments. And Useem *et al.* (1992) indicated that implementing IPM techniques on rice in Indonesia resulted in savings of pesticide expenses with no loss in yield. Similar results obtained by Angiras *et al.* (1991) who reported that IPM technology on maize in India gave higher GM and net returns than traditional treatments. Higher yields in tomato crop under IPM technology agree with observations done by Al-Attal (1998), who found that the use of bumblebees, which is one of the IPM methods for pollination, resulted in more yield in the tomato crop.

Hamdan *et al.* (1996), found that the GM(s) of producing IPM tomato and cucumber in the Jordan Valley were negative and not feasible. The contrast between the results of this study with that of Hamdan *et al.* (1996), could be explained on the basis of change in the cost and expenses of many agricultural production inputs, mainly the cost of pesticide, fertilizer, bumblebees, and the pesticide residue analysis. In addition to that, the data was collected at the beginning of the project in 1996, from a sample consisted only of five vegetables growers, which is considered unrepresentative sample.

Table 6-5
Enterprise Budget of One Green House for Tomato Production with Non- IPM Technology

Average production and Farm gate price	Kg	6915	0.096	
1) Total gross revenue from producing tomato crop under non-IPM conditions	**JD**			**663.84**
2) Total Variable costs	**JD**			**604.75**
Seeds	Seed	1656	0.049	81.14
Nursery fee for seedling	Tray	8	1.25	10.00
Organic fertilizers	Ton	2	10.71	21.42
Chemical fertilizers (Lump Sum)	JD			78.00
Pesticides (Lump Sum)	JD			84.00
Soil Fumigation (MeBr)	Can	46	1.75	80.50
Water	m^3	424	0.011	4.66
Hormones				14.50
Black mulch	Kg	10	0.92	9.20
Threads	Roll	7	1.15	8.05
Screen	JD			15.16
Rented machinery				
Land preparation (ploughing)	Hour	1.5	3.50	5.25
Other (spraying)	Hour	5	2.00	10.00
Hired labor				
GH Preparation and Planting	Hour	110	0.50	55.00
Crop husbandry	Hour	99	0.50	49.50
Hand-pick harvesting	Hour	133	0.50	66.50
Sum of Variable Costs of Inputs	JD			**592.89**
Interest on operating capital (8%)	JD			11.86
3) Income above variable costs (gross margin) (1 - 2)	**JD**			**59.09**
4) Total Fixed costs	**JD**			**412.29**
Buildings depreciation	JD			3.16
Minor irrigation pipes depreciation	JD			3.00
Major irrigation pipes and pumps depreciation	JD			22.38
Water irrigation pool depreciation	JD			1.25
Green house frames depreciation	JD			105.00
Plastic sheets depreciation	JD			100.00
Land rent	JD			33.00
Family labor	Hour	43	0.50	21.50
Sum of Fixed cost	**JD**			**289.29**
Interest on fixed investment (8%)	JD			123.00
5) Total costs (2 + 4)	**JD**			**1017.04**
6) Net profit (Return to management) (1 - 5)	**JD**			**-353.20**
Source: Calculated from the Collected Field Study Data during the Season 98 - 99 / Jordan Valley				

Table 6-6
Enterprise Budget of One Green House for Tomato Production with IPM Technology

Item	Unit	Quantity	Price/Unit (JD)	Value (JD)	Value (JD)
Average production and farm gate price	Kg	7449	0.198	Selling at IPM price	Selling at non-IPM price
1) Total gross revenue from producing tomato crop with IPM technology	**JD**			**1474.90**	**715.10**
2) Total variable costs	**JD**			**565.61**	**565.61**
Seeds	Seed	1445	0.049	70.81	70.81
Nursery fee for seedlings	Tray	7	1.25	8.75	8.75
Organic fertilizers	Ton	3	7	21.00	21.00
Chemical fertilizers (lump sum)	JD			63.34	63.34
Pesticides (lump sum)	JD			47.00	47.00
Soil solarization	JD			20.00	20.00
Bumblebees	JD			20.00	20.00
Water	m^3	336	0.011	3.70	3.70
Black mulch	Kg	9	0.92	8.28	8.28
Threads	Roll	6	1.15	6.90	6.90
Rented machinery					
Land preparation (ploughing)	Hour	1.5	3.50	5.25	5.25
Other (spraying)	Hour	2	2.00	4.00	4.00
Hired labor					
GH preparation and planting	Hour	108	0.50	54.00	54.00
Crop husbandry	Hour	111	0.50	55.50	55.50
Hand pick harvesting	Hour	156	0.50	78.00	78.00
Supervision and inspection	JD			44.00	44.00
Pesticide residues analysis	JD			44.00	44.00
Sum of variable costs of inputs	JD			**554.52**	**554.52**
Interest on operating capital (8%)	JD			11.09	11.09
3) Income above variable costs (gross margin) (1 - 2)	**JD**			**909.29**	**149.49**
4) Total fixed costs	**JD**			**372.72**	**372.72**
Buildings depreciation	JD			0.30	0.30
Minor irrigation pipes depreciation	JD			1.89	1.89
Major irrigation pipes and pumps depreciation	JD			6.00	6.00
Water irrigation pool depreciation	JD			0.43	0.43
Green house frames depreciation	JD			100.00	100.00
Plastic sheets depreciation	JD			96.00	96.00
Muslin screen depreciation	JD			16.10	16.10
Land rent	JD			33.00	33.00
Family labor	Hour	8	0.50	4.00	4.00
Sum of fixed cost	**JD**			**257.72**	**257.72**
Interest on fixed investment (8%)	JD			115.00	115.00
5) Total costs (2 + 4)	**JD**			**938.33**	**938.33**
6) Net profit (return to management) (1 - 5)	**JD**			**536.57**	**-223.23**
Source: Calculated from the Collected Field Study Data during the Season 98 - 99 / Jordan Valley					

Table 6-7
Enterprise Budget of One Green House for Cucumber Production with Non- IPM Technology

Item	Unit	Quantity	Price/Unit (JD)	Value (JD)
Average production and farm gate price	**Kg**	**6917**	**0.138**	
1) Total gross revenue from producing cucumber crop under IPM conditions	**JD**			**954.55**
2) Total variable costs	**JD**			**608.23**
Seeds	Seed	1569	0.065	101.99
Organic fertilizers	Ton	2.5	10.71	26.78
Chemical fertilizers (lump sum)	JD			81.00
Pesticides (lump sum)	JD			88.00
Soil fumigation (MeBr)	Can	48	1.75	84.00
Water	m^3	458	0.011	5.04
Black mulch	Kg	10	0.92	9.20
Threads	Roll	6	1.15	6.90
Screen	JD			15.16
Rented machinery				
Land preparation (ploughing)	Hour	1.5	3.50	5.25
Other (spraying)	Hour	7	2.00	14.00
Hired labor				
GH preparation and seeding	Hour	100	0.50	50.00
Crop husbandry	Hour	105	0.50	52.50
Hand-pick harvesting	Hour	113	0.50	56.50
Sum of variable costs of inputs	JD			**596.31**
Interest on operating capital (8%)	JD			11.93
3) Income above variable costs (gross margin) (1 - 2)	**JD**			**346.31**
4) Total fixed costs	**JD**			**412.29**
Buildings depreciation	JD			3.16
Minor irrigation pipes depreciation	JD			3.00
Major irrigation pipes and pumps depreciation	JD			22.38
Water irrigation pool depreciation	JD			1.25
Green house frames depreciation	JD			105.00
Plastic sheets depreciation	JD			100.00
Land rent	JD			33.00
Family labor	Hour	43	0.50	21.50
Sum of Fixed cost	**JD**			**289.29**
Interest on fixed investment (8%)	JD			123.00
5) Total costs (2 + 4)	**JD**			**1020.52**
6) Net profit (return to management) (1 - 5)	**JD**			**-65.98**

Source: Calculated from the Collected Field Study Data during the Season 98 - 99 / Jordan Valley

Table 6-8
Enterprise Budget of One Green House for Cucumber Production with IPM Technology

Item	Unit	Quantity	Price/Unit (JD)	Value (JD)	Value (JD)
Average production and farm gate price	Kg	6837	0.217	Selling at IPM price	Selling at non-IPM price
1) Total gross revenue from producing cucumber crop with IPM technology	**JD**			**1483.63**	**943.506**
2) Total variable costs	**JD**			**547.98**	**547.98**
Seeds	Seed	1407	0.065	91.46	91.46
Organic fertilizers	Ton	3	7	21.00	21.00
Chemical fertilizers (lump sum)	JD			69.00	69.00
Pesticides (lump sum)	JD			62.00	62.00
Soil solarization	JD			20.00	20.00
Water	m^3	350	0.011	3.85	3.85
Black mulch	Kg	9	0.92	8.28	8.28
Threads	Roll	6	1.15	6.90	6.90
Rented machinery					
Land preparation (ploughing)	Hour	1.5	3.50	5.25	5.25
Other (spraying)	Hour	2.5	2.00	5.00	5.00
Hired labor					
Preparation and seeding	Hour	96	0.50	48.00	48.00
Crop husbandry	Hour	112	0.50	56.00	56.00
Hand-pick harvesting	Hour	121	0.50	60.50	60.50
Supervision and inspection	JD			40.00	40.00
Pesticide residues analysis	JD			40.00	40.00
Sum of variable costs of inputs	JD			**537.24**	**537.24**
Interest on operating capital (8%)	JD			10.74	10.74
3) Income above variable costs (gross margin) (1 - 2)	**JD**			**935.65**	**395.52**
4) Total fixed costs	**JD**			**372.72**	**372.72**
Buildings depreciation	JD			0.30	0.30
Minor irrigation pipes depreciation	JD			1.89	1.89
Major irrigation pipes and pumps depreciation	JD			6.00	6.00
Water irrigation pool depreciation	JD			0.43	0.43
Green house frames depreciation	JD			100.00	100.00
Plastic sheets depreciation	JD			96.00	96.00
Muslin screen depreciation	JD			16.10	16.10
Land rent	JD			33.00	33.00
Family labor	Hour	8	0.50	4.00	4.00
Sum of fixed cost	**JD**			**257.72**	**257.72**
Interest on fixed investment (8%)	JD			115.00	115.00
5) Total costs (2 + 4)	**JD**			**920.70**	**920.70**
6) Net profit (return to management) (1 - 5)	**JD**			**562.93**	**22.80**

Source: Calculated from the Collected Field Study Data during the Season 98 - 99 / Jordan Valley

6.3.2 Total Cost Functions

Using the Ordinary Least Squares (OLS) method. The cubic functions were found to be the appropriate choice to estimate the total cost functions of producing tomato and cucumber crops in the long run, in the JV. Therefore, the constant term, which represents the fixed costs, was dropped from the equation.

(A) The estimated TC equations of producing tomato with Non -IPM and IPM technology:

The results showed that the most appropriate, and economically logic of the multiple regression analyses was the regression equation that showed the effect of IPM technology in shifting the parameters of the first and the second variables, as shown below.

Equation of multiple regression analysis				R^2	F-statistic
Variable	**Parameters**	**t-statistic**			
Y	$B_1 = 129.871$	23.75		**0.97**	**894. 64**
Y^2	$B_2 = -0.1855$	-3.93			
Y^3	$B_3 = 0.00041$	3.41			
Y	$B_{11} = -9.126$	-0.76	(IPM)		
Y^2	$B_{22} = -0.067$	-1.37	(IPM)		

From the previous equation the following two equations are derived:

1) TC with Non-IPM Technology

$$TC = B_1 Y + B_2 Y^2 + B_3 Y^3$$

$TC = 129.871\ Y - 0.1855\ Y^2 + 0.00041\ Y^3$ (23.75) * (- 3.93) * (3.41) *	0.97	894.64

$$ATC = 129.871 - 0.1855\ Y + 0.00041\ Y^2$$

$$MC = 129.871 - 0.371\ Y + 0.00123\ Y^2$$

2) TC with IPM Technology

$$TC = (B_1 + B_{11})\ Y + (B_2 + B_{22})\ Y^2 + B_3 Y^3$$

$TC = 120.745\ Y - 0.2525\ Y^2 + 0.00041\ Y^3$ (22.99) * (- 5.30) * (3.41) *	0.97	894.64

$$ATC = 120.745 - 0.2525\ Y + 0.00041\ Y^2$$

$$MC = 120.745 - 0.505\ Y + 0.00123\ Y^2$$

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Figures in parentheses are representing *t-statistic* values at 95% confidence of interval.
The star * means significant at 5% level of significance.
Y= Production (Ton).

The equations show that all coefficients have the right signs, so they are economically appropriate. The t-statistic values and the F-statistic are also significant. Using these equations, the ATC and MC of tomato production with Non-IPM and IPM technology had been derived. It was found that the average variable cost equals to JD 109 / ton for Non-IPM tomato and JD 82 / ton for IPM tomato. The optimal size of output, to meet the economic efficiency were 226 tons of tomato about 33 GH(s) for Non-IPM tomato production process, and 308 tons about 41 GH(s) with IPM technology. These findings point-out the effect of the technology (IPM) on the production process in increasing the production size and decreasing the costs per unit of production (ton).

Total cost, average total cost and marginal cost curves of tomato production with Non-IPM and IPM technology are graphed in Figures 6-1 and 6-2, which show how the IPM technology has affected the TC, ATC and MC curves by shifting them downward to the right. The curves are graphed with unit of cost on the vertical axis (JD) and units of output on the horizontal axis (ton).

Figure 6-1
Total Cost (TC) Curves of Tomato Production with Non-IPM and IPM Technology

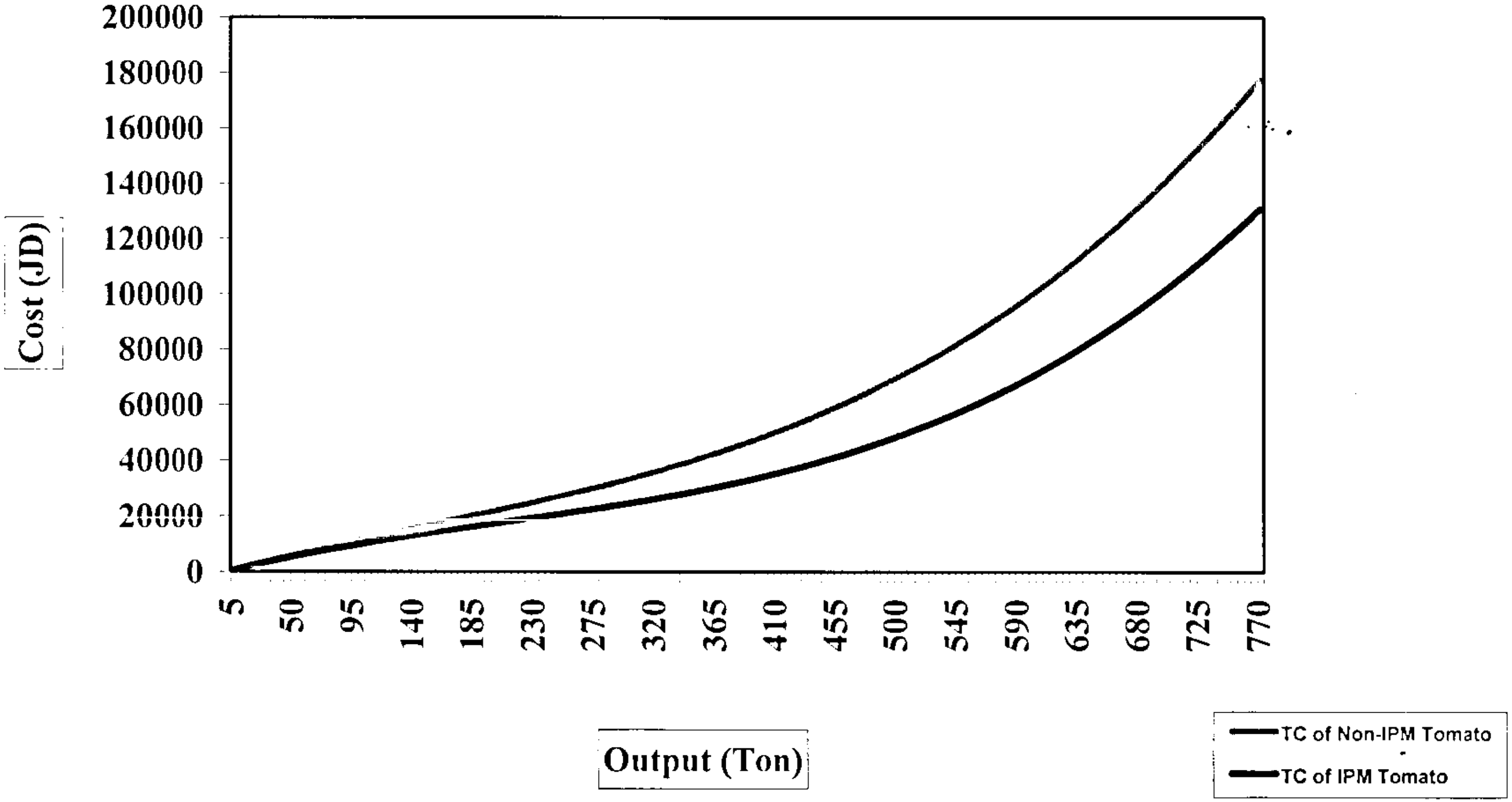
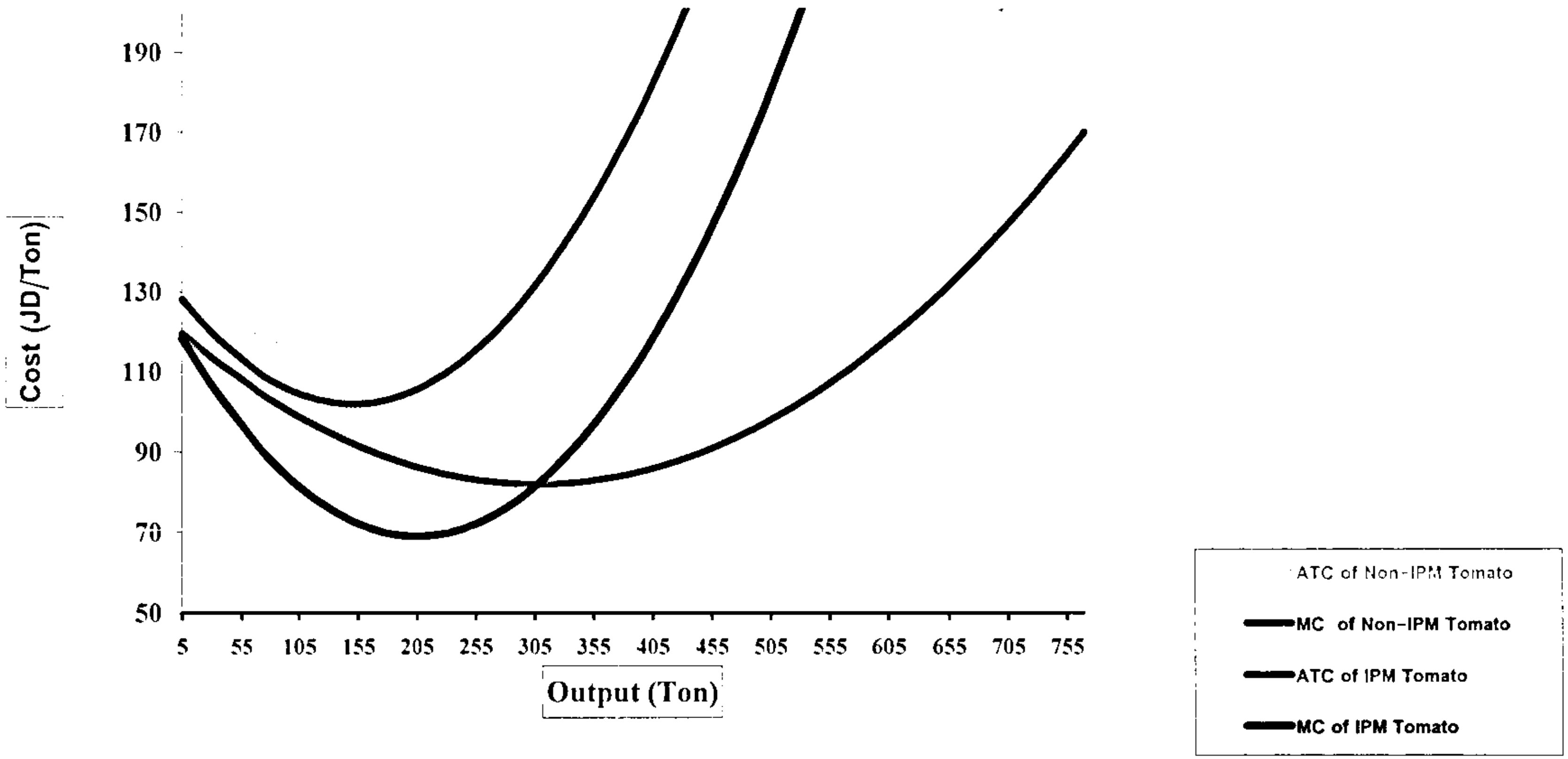


Figure 6-2
Average Total Cost (AVC) and Marginal Cost (MC) Curves of Tomato Production with Non - IPM and IPM Technology



(B) The estimated TC equations of producing cucumber with Non-IPM and IPM technology:

The data collected for cucumber crop for the two compared groups had been individually estimated for TC functions. The results of the regression analysis showed an economic logic and appropriate TC function only for producing Non-IPM cucumber, but not for the IPM cucumber. For that reason, a solution was adopted to estimate the TC function for IPM cucumber depending on repeating the run of OLS regression using the same data collected, but dropping the costs of supervision and pesticide residues analysis out of the total costs.

Equations of multiple regression analysis	R^2	F-statistic
1) TC with Non-IPM Technology		
$TC = 133.103\,Y - 0.1570\,Y^2 + 0.000202\,Y^3$ (12.51) * (- 2.18) * (2.07) *	0.89	414.84
$ATC = 133.103 - 0.1570\,Y + 0.000202\,Y^2$		
$MC = 133.103 - 0.314\,Y + 0.000606\,Y^2$		
2) TC with IPM Technology		
$TC = 94.785\,Y - 0.1771\,Y^2 + 0.000304\,Y^3$ (14.11) * (- 3.07) * (2.82) *	0.96	701.26

$$ATC = 94.785 - 0.1771\ Y + 0.000304\ Y^2$$

$$MC = 94.785 - 0.3542\ Y + 0.000912\ Y^2$$

Source: Calculated from the collected field study data during the season 1998/1999 / Jordan Valley
Figures in parentheses are representing *t - statistic* values at 95% confidence of interval.
The star * means significant at 5% level of significance.
Y= Production (Ton).

The equations show that all coefficients have the right signs and they are economically appropriate. The t-statistic values and the F-statistic (the test for the overall significance of the regression) are also significant.

From the above mentioned TC equations, it was found that the optimal size of output to meet the economic efficiency were 389 ton about 56 GH(s) for Non-IPM cucumber production process, and 290 ton about 42 GH(s) with IPM technology. That will meet the average variable cost per unit equals to JD 103 / ton for Non-IPM cucumber and JD 69 / ton for IPM cucumber. The total cost, average variable cost and marginal cost curves of cucumber production with Non-IPM and with IPM technology are graphed in Figures 6-3 and 6-4. They show how IPM technology reduces the variable production costs, causing a shift in the curves downward. But contrary to the situation with the tomato crop, and contrary to the economic opinion, the curves were shifted to the left instead of shifting to the right.

That can explained depending upon the opinion of many of the IPM adopters, who mentioned that applying IPM on cucumber crop is somehow difficult if compared with other vegetable crops especially tomato crop, because cucumber need more effort in monitoring and scouting as it is very sensitive to pest and diseases especially fungus diseases, which spread quickly and so it is difficult to be controlled if there is a serious infection. For that reason, farmer would face more problems in controlling and monitoring if he increases the size of production which might by time increase the costs due to the necessity of using more pesticides and plant protection control.

The results in this chapter support the hypothesis that producing tomato and cucumber crops with IPM technology is expected to be more profitable, and economically more feasible than conventional agricultural practices. That is achieved through reduction in the production costs and increase in revenues.

Figure 6-3
Total Cost (TC) Curves of Cucumber Production
with Non-IPM and IPM Technology

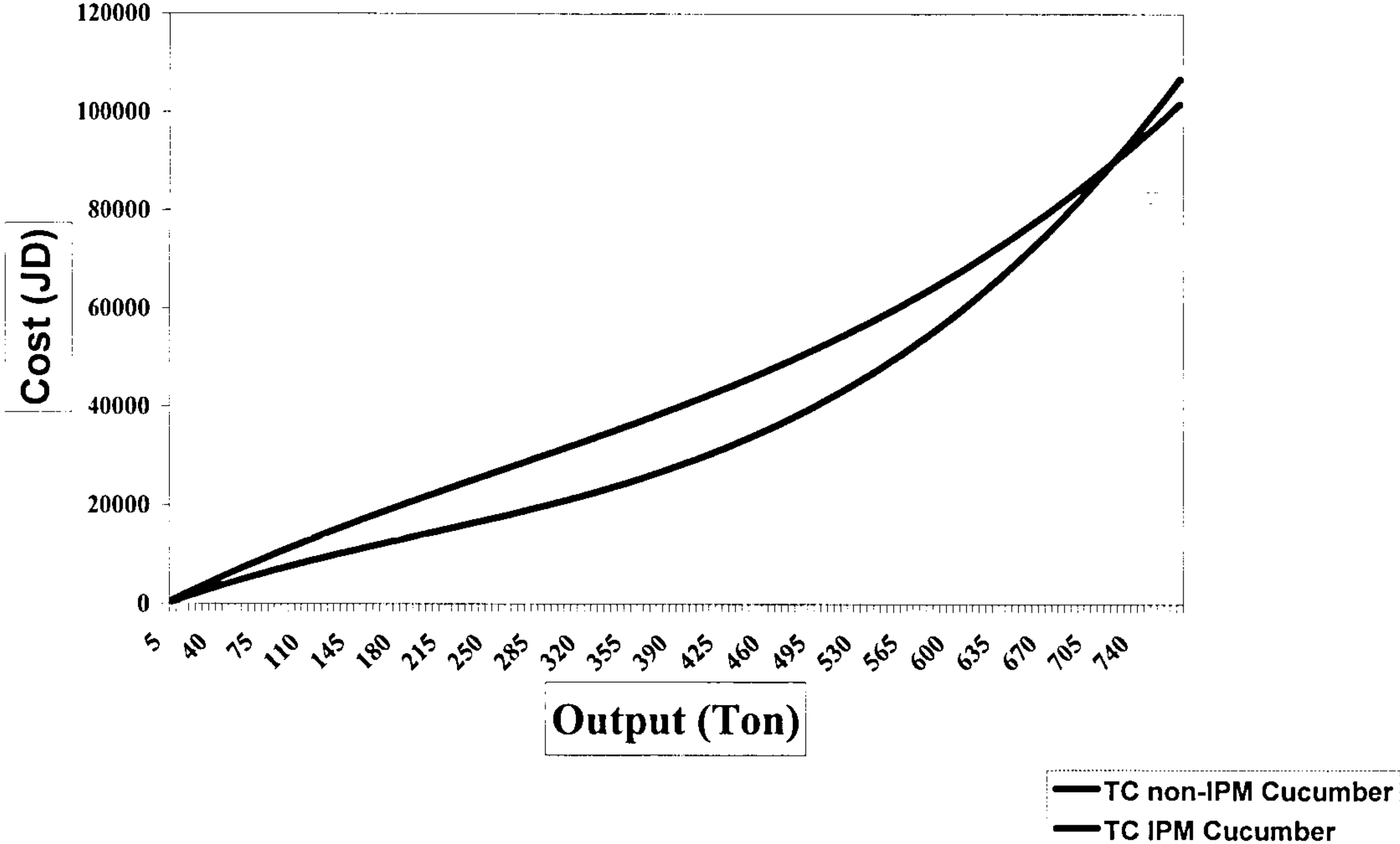
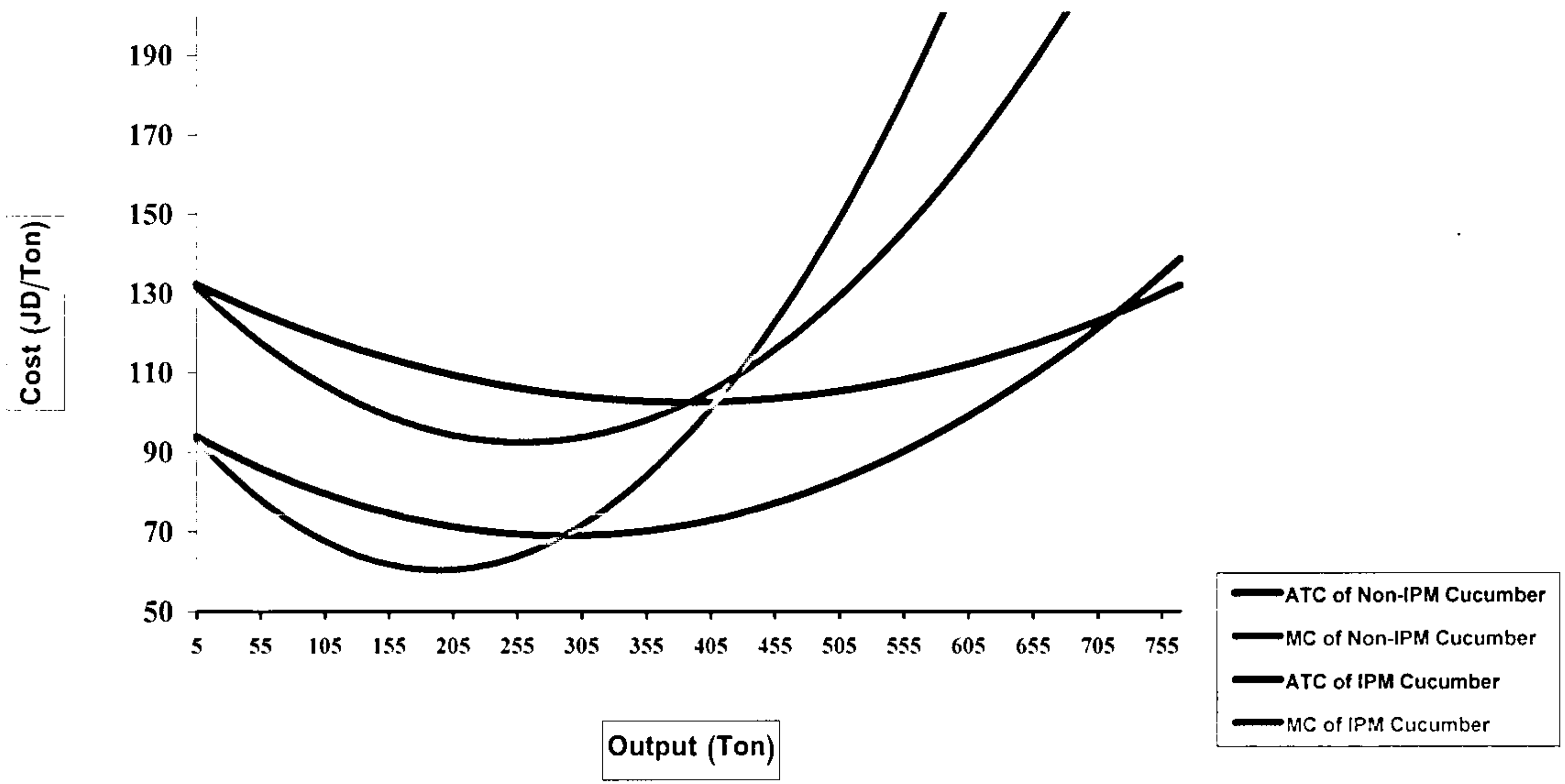


Figure 6-4
Average Total Cost (ATC) and Marginal Cost (MC) Curves of Cucumber Production with Non – IPM and IPM Technology



Chapter Seven

7. Conclusions and Recommendations

7. Conclusion and Recommendations

7.1 Summary and Conclusions

From the study results, the following can be summarized and concluded:

1. IPM technology can be highlighted as a major step towards sustainability in agriculture. It is aiming for a dual effect, to provide technical reasonable pest and disease control and the protection of human health and environment. It is an approach, which is not only ecologically conscious, it improves farmers economical situation as well. Social acceptance of the IPM system could be achieved in the long run. It is ecologically conscious, better economically, and might become more acceptable socially, especially with the increase in public emphasis on human and environmental safety. Thus, it is worth to bring IPM technology into the agricultural production mainstream.

2. IPM technology has the characteristic of high relative advantage that enables the farmer to achieve his goals and objectives better, or at lower expense than he could previously.

3. The findings of the study indicate the following percentages of applying IPM techniques: soil solarization 94%, muslin screen 90%, use of bumblebees 88%, rational fertigation 86%, resistant varieties seedlings 85%, scouting and monitoring 85%, use of least toxic pesticides 83% and biological pest management 5%.

4. The advantages of the IPM technology could not yet convince all the farmers in Jordan, but there has been an increase in the use of IPM technology. It has been noticed that the adoption of single IPM technique accelerates the adoption of other related techniques of the IPM technology package, especially, when the farmers' personal results indicated that IPM technology showed reduction in inputs costs and maximization in profits and yields.

5. Descriptive statistics of the study showed that the IPM adopters applied IPM techniques on 78% of their GH(s). IPM adopters were found to be more educated, operate large size farm holdings, have less years of farming experience, engage more off-farm employment, have more access to agricultural credit and participate more often in

extension activities. In addition to that, two thirds of them reside outside the Jordan Valley.

6. The findings of the multivariate analyses " Logit and Probit models" show that the attributes level of education, size of holding, profession as an agricultural engineer, residing outside the Jordan valley, more off-farm employment, participation in extension activities, access to agricultural credit and " female " farmer have a positive relationship regarding the adoption of IPM technology. While the farmers' age and land tenure status have a neutral effect with respect to the adoption of IPM. However, the years of farming experience has a negative effect upon the adoption of IPM. Knowing how these factors are related to and influence adoption of IPM technology may facilitate in implementing more appropriate development programs and may contribute to suitable agricultural policies to encourage the adoption decision by farmers.

7. The enterprise budgets and the cost functions analyses indicate a reduction in the total variable costs per GH. It is more profitable due to higher GM(s) and revenues without reduction in the quality of the

crops. Noting that the current applied IPM package suits tomato production more than cucumber crop.

7.2 Recommendations

1) It is recommended to apply IPM technology because it is a saving technology.

2) Further efforts should be made to enable farmers in Jordan to apply IPM technology. It is an advantageous substitute to the farmers' common chemical pest control strategy lowering costs and increasing farm profitability. As a welcome side effect, it has a favorable impact on the environment and the health of both the farmers and consumers.

3) To overcome the main obstacles preventing the widespread adoption of IPM technology, the following recommendations may encourage farmers to adopt IPM technology in Jordan:

* It is recommended to establish IPM network units among agricultural Directorate of the MOA. Specialists and extensionists who are trained and experienced on IPM subjects should be employed to run each unit.

* Complete formulating and activating the national IPM policy.

* The priorities of educating and training farmers on IPM techniques should be derived from a base-line survey of holder populations, and programs tailored to the local circumstances.

* Any training for the farmers should be started with the easiest IPM technique, so as to convince them to apply more techniques.

* It is essential to develop and implement effective extension programs to popularize the IPM technology. Farmers' understandings of IPM techniques have to be given the prime consideration.

4) Future issues and subjects that are recommended to be studied:

- Because Cucumber is a sensitive crop to pest and diseases, special IPM package for producing IPM cucumber crop should be recommended.
- The consumers' demand in Jordan for the IPM fruits and vegetables.
- Marketing of IPM produce, locally and abroad, considering exporting and importing policies.
- The economic value of health and environmental benefits of IPM technology.
- The IPM impact on Jordan's macroeconomic situation.
- The influence of some other factors on IPM technology diffusion, e.g.; farmers' rationality, standard of living, orientation towards farming, risks, mental flexibility and dogmatism.

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رقم الاستمارة :________________

التاريـــــــخ: ________________

اســم المزارع:____

عمــر المزارع:__________ سنة

عدد سنوات الخبرة الزراعية (للمزارع)

1) 1-10	2) 11-20	3) 21-30	4) أكثر من 30

مكان إقامة الـــمزارع:____

موقع المزرعــــــة : ____

مساحة المزرعــــــة :____

تاريخ إنشاء المزرعة:____

المهنة الحالية لمالك المزرعة:____

هل المزرعة 1) شركة تجارية 2) شركة أفراد بالاتفاق 3) مزرعة خاصة فردية

المستوى التعليمي للمزارع: (يرجى وضع دائرة حول الإجابة الصحيحة)

1)أمي
2) ابتدائي
3) إعدادي
4) ثانوي
5) كلية متوسطة
6) بكالوريوس (تخصص ____________________)
7) ماجستير (تخصص____________________)
8) دكتوراه (تخصص ____________________)

عدد أفراد أسرة المزارع من حيث:

1) عدد الأفراد الكلي للأسرة هو:________

2) عدد أفراد العائلة العاملين في المزرعة________

3) عدد أفراد العائلة العاملين في غير قطاع الزراعة ________

ما مدى التفرغ للعمل في المزرعة:

1) 20%	2) 40%	3) 60%	4) 80%	5) 100%

مصدر الدخل لمالك المزرعة، هل هو فقط من الزراعة؟ 1) نعم 2) لا

نسبة الدخل الزراعي بالنسبة لدخل المزارع الإجمالي هو ________________________

نوع الحيازة الزراعية (ملك أم إيجار أم مشاركة):________________________

إن راس المال المستثمر في مزرعتك:

1) قرض بالكامل 100%

2) تمويل ذاتي بالكامل 100%

3) قرض وتمويل ذاتي حيث أن القرض بنسبة ________% من إجمالي الاستثمار

ومصدر القرض هو________________________ أما قيمة القرض فهي________دينار

وبنسبة فائدة سنوية مقدارها__________% ولمدة ______________سنة

إن المسؤول عن اتخاذ القرار في الأمور الفنية التي تخص المزرعة هو:

1) المالك

2) مدير المزرعة

3) المالك ومدير المزرعة معا

4) المالك هو نفسه مدير المزرعة وهو متخذ القرار

إن المسؤول عن اتخاذ القرار في الأمور المالية التي تخص المزرعة هو:

1)المالك
2) مدير المزرعة
3) المالك ومدير المزرعة معا
4) المالك هو نفسه مدير المزرعة وهو متخذ القرار

هل سمعت عن مشروع المكافحة المتكاملة للآفات الزراعية: 1) نعم 2) لا

منذ متى؟________________________

ما هو تعريفك وتفسيرك للمكافحة المتكاملة:________________________

____

____

____

إن أسلوب الزراعة المتبع في مزرعتك هو:

1) المكافحة المتكاملة	تاريخ البدء بتطبيق المكافحة المتكاملة في مزرعتك__________	
2) الزراعة التقليدية		
3) كلا الأسلوبين السابقين بنسبة:	______% مكافحة متكاملة	______% زراعة تقليدية
من وجهة نظرك أيهما افضـــــل	________________	

العدد الكلي للبيوت البلاستيكية (Monospan) المزروعة:________________________

عدد البيوت البلاستيكية (Monospan) المزروعة بأسلوب المكافحة المتكاملة:__________

والمحاصيل المزروعة (مكافحة متكاملة) هي:________________________

____

____

عدد البيوت البلاستيكية (Monospan) المزروعة بالأسلوب التقليدي:________________

والمحاصيل المزروعة (زراعة تقليدية) هي:________________________

العدد الكلي للبيوت البلاستيكية (Multispan) المزروعة:______________________

عدد البيوت البلاستيكية (Multispan) المزروعة بأسلوب المكافحة المتكاملة:____________

والمحاصيل المزروعة (مكافحة متكاملة) هي:____________________________________

____

____

عدد البيوت البلاستيكية (Multispan) المزروعة بالأسلوب التقليدي:__________________

والمحاصيل المزروعة (زراعة تقليدية) هي:____________________________________

____

____

هل ترغب بالاستمرار في تطبيق أسلوب المكافحة المتكاملة على كامل مزرعتك؟__________

وفي حالة عدم الرغبة فما هي الأسباب؟_______________________________________

____

____

هل تعتقد بان تطبيق تكنولوجيا المكافحة المتكاملة في الأردن مرتبط بفترة مشروع المكافحة المتكاملة ؟____

لقد سمعت عن تكنولوجيا المكافحة المتكاملة من خلال: (يمكن الإجابة على هذا السؤال بأكثر من إجابة)

1) برامج إذاعية
2) برامج تلفزيونية
3) ندوات علمية إرشادية
4) مشاهدات وتجارب في المزارع الخاصة
5) كتيبات ونشرات علمية
6) شركات زراعية
7) مؤسسات غير حكومية (يرجى ذكر اسم المؤسسة____________________________________)
8) مؤسسات حكوميـــة (يرجى ذكر اسم المؤسسة____________________________________)
9) زيارة المرشدين الزراعيين والمهندسين العاملين في المشروع
10) الصحف اليومية
11) معارض زراعية
12) أيام حقل
13) أخرى(يرجى ذكرها)____

إن عدم مشاركتك في أي من نشاطات مشروع المكافحة المتكاملة الإرشادية والتعليمية العملية منها والنظرية كالندوات وأيام الحقل وغيرها بسبب:(يمكن الإجابة على هذا السؤال بأكثر من إجابة)

1) كثرة انشغالك بأمور أخرى غير الزراعة
2) عدم علمك بانعقاد النشاط
3) تحتاج إلى دعوة خاصة للمشاركة
4) عدم الاهتمام بفكرة المكافحة المتكاملة
5) بعد مكان انعقاد الندوة أو أي نشاط عنك
6) عدم قناعتك بكفاءة القائمين على تقديم المعلومات
7) اقتناعك بأن معلوماتك هي دائما صحيحة ولا ترغب في التغيير
8) صعوبة التطبيق لاعتقادك بان المكافحة المتكاملة تحتاج إلى الكثير من الأموال
8) أخرى (يرجى ذكرها)______________________________

هل ترى أنك بحاجة إلى المزيد من المعلومات فيما يتعلق بالمكافحة المتكاملة؟ 1) نعم 2) لا

إذا كانت الإجابة نعم فان النشاطات التي تلزم لذلك برأيك هي:

1)______________________________

2)______________________________

3)______________________________

وان كنت لست بحاجة إلى المزيد من المعلومات فهل يعود السبب إلى: (يمكن الإجابة على هذا السؤال بأكثر من إجابة)

1) عدم اقتناعك بفكرة تطبيق المكافحة المتكاملة
2) عدم توفر الوقت الكافي للمشاركة في النشاطات والمعلومات المتوفرة لدى مشروع المكافحة المتكاملة
3) عدم حاجتك إلى المزيد من المعلومات كونك أتقنت فهم وتطبيق المكافحة المتكاملة
4) أخرى (يرجى ذكرها)______________________________

إذا سمعت عن وجود أساليب زراعية جديدة فما الطريقة التي تحاول الحصول فيها على المعلومات؟

1) تستفسر عن مصدر المعلومة وتذهب للحصول عليها مهما كانت الصعوبة
2) تنتظر حتى يتم تقديمها لك من قبل المرشدين
3) تسأل جيرانك (المزارعين) عنها
4) لا تهتم بأية معلومات جديدة لأنك مقتنع بأن ما تقوم به هو الصحيح ولا تريد تغييره
5) من خلال الصحف والمجلات الزراعية وأية مصادر أخرى تبحث في مثل هذه الأساليب

إن نسبة قراءتك للصحف اليومية (بشكل عام)

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة قراءتك للمجلات العلمية الزراعية:(بشكل عام)

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اهتمامك للاستماع إلى الراديو وبالأخص البرامج الإرشادية الزراعية:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اهتمامك بمشاهدة التلفزيون وبالأخص البرامج الإرشادية الزراعية:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اقتناعك باستخدام أسلوب المكافحة المتكاملة:(بشكل عام)

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اقتناعك باستخدام النحل الطنان بدلا من الهرمونات النباتية:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اقتناعك باستخدام الحشرات النافعة بدلا من استخدام المبيدات:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اقتناعك بالتعقيم الشمسي بدلا من استخدام التعقيم بغاز الميثيل برومايد:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اهتمامك بمعرفة المواد الكيماوية التي يتكون منها المبيد:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

إن نسبة اهتمامك بمعرفة فترة الأمان للمبيد هي :

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

في حالة أنك اطلعت على تعهد توثيق منتجات المكافحة المتكاملة، فما هي نسبة اقتناعك بالبنود الواردة فيه:

1) (0 – 20%)	2) (21 – 40%)	3) (41 – 60%)	4) (61 – 80%)	5) (81 – 100%)

أية ملاحظات تود أن تقترح تعديلها على سياق التعهد وبنوده: ____________

____

____

الأسباب التي اتخذتها بعين الاعتبار لتبني أسلوب المكافحة المتكاملة:(يمكن الإجابة على هذا السؤال بأكثر من إجابة واحدة)

1) البعد البيئي (الحفاظ على البيئة، والتقليل من المشاكل البيئية والتلوثات التي تسببها المبيدات الزراعية)
2) لإنتاج منتج صحي خالي من متبقيات المبيدات الضارة (لحماية والحفاظ على المستهلك)
3) تقليل التكاليف لمدخلات الإنتاج وأهمها المبيدات الزراعية
4) زيادة الإنتاجية (للمحصول) وبالتالي ربح أكبر
5) لان منتجات المكافحة المتكاملة تباع بسعر أعلى
6) سهولة تطبيقها
7) أخرى (يرجى ذكرها)____________________

عند اتخاذك لأي قرار في مزرعتك يكون بناءا على :(يمكن الإجابة على هذا السؤال بأكثر من إجابة واحدة)::

1) نصائح المهندسين الزراعيين (المرشدين) العاملين في مشروع المكافحة المتكاملة ووزارة الزراعة
2) نصائح شركات مستلزمات الإنتاج والمبيدات الزراعية
3) الاقتداء بجيرانك من المزارعين
4) الخبرة الشخصيـــــة السابقة
5) أخرى (يرجى ذكرها)____________________

إن عناصر تكنولوجيا المكافحة المتكاملة التي تستخدمها هي:(يمكن الإجابة على هذا السؤال بأكثر من إجابة واحدة):

1) مبيدات زراعية رفيقة بالبيئة وبصحة الإنسان والحيوان
2) خلايا النحل الطنان
3) الحشرات النافعة
4) التعقيم الشمسي

إن عدم استخدامك للحشرات النافعة يرجع إلى : (يمكن الإجابة عن هذا السؤال بأكثر من إجابة واحدة)

1) عدم توفرها بشكل عام
2) عدم توفرها بالوقت المناسب
2) القناعة بعدم الجدوى من استخدامها
3) ارتفاع كلفتها
4) الصعوبة وعدم معرفة كيفية إطلاق الحشرات والتعامل معها
5) عدم المعرفة بأهمية استخدام هذه الحشرات النافعة
6)عدم توفر الكمية المطلوبة بالوقت المناسب
7)عدم توفرها بالنوعية المطلوبة
8) لم أسمع عن استخدام الحشرات النافعة من قبل
9) أخرى (يرجى ذكرها) ________________________________

إن عدم استخدامك للموسلين يرجع إلى : (يمكن الإجابة عن هذا السؤال بأكثر من إجابة واحدة)

1) عدم توفرها
2) القناعة بعدم الجدوى من استخدامها
3) ارتفاع كلفتها
4) عدم المعرفة بأهمية استخدامه
5) عدم توفر النوعية المرغوبة
6) لم أسمع عن استخدام الموسلين من قبل
7) أخرى (يرجى ذكرها) ________________________________

إن عدم استخدامك للتعقيم الشمسي بدلا من التعقيم بغاز الميثيل بروميد يرجع إلى : (يمكن الإجابة عن هذا السؤال بأكثر من إجابة واحدة)

1) عدم توفر المعلومات الكافية لتطبيق التعقيم الشمسي
2) القناعة بعدم الجدوى من استخدام التعقيم الشمسي بدلا من الغاز
3) لم أسمع عن التعقيم الشمسي من قبل
4) عدم المعرفة بأهمية استخدام التعقيم الشمسي
5) وجود المزرعة في منطقة الشفا
6) الخوف من عدم نجاح التعقيم الشمسي أما التعقيم بالغاز فهو مضمون النتائج
7) أخرى (يرجى ذكرها) ________________________________

إن استخدامك التعقيم الشمسي يعود للأسباب: (يمكن الإجابة عن هذا السؤال بأكثر من إجابة واحدة)

1) قلة تكلفة التعقيم الشمسي مقارنة مع التعقيم بالغاز
2) التعقيم الشمسي يعطي نتائج مرضية توازي التعقيم بالغاز
3) سهل التطبيق
4) يحافظ على البيئة والعاملين بالمزرعة من أخطار الغازات السامة
5) أخرى (يرجى ذكرها) ________________________________

لو اعتبرنا أن المكافحة المتكاملة تعطي محصول أقل ككمية أو كسعر، فهل تستمر في تطبيق المكافحة المتكاملة فقط لأنها تحافظ على البيئة أم لا؟ 1) نعم 2) لا

من وجهة نظرك هل يوجد مشكلة تلوث بسبب الاستخدام المكثف للمبيدات في الأردن؟

1) نعم 2) لا

يرجى ذكر عدد الرشات التي قمتم برشها خلال الموسم:

اسم المحصول	العدد الكلي للرشات خلال الموسم	عدد الرشات الوقائية خلال الموسم	زراعة تقليدي أم مكافحة متكاملة
بندورة			
خيار			
فراولة			
باذنجان			
فلفل			

لماذا تستخدم المبيدات الزراعية؟ ________________________________

____

____

برأيك ما هي أسباب عدم كفاءة المبيدات الزراعية المستخدمة في بعض الأحيان؟________

برأيك بماذا تضر المبيدات الزراعية؟ (يرجى ذكر 3 نقاط على الأقل)__________

إن كنت من المزارعين المطبقين لتكنولوجيا المكافحة المتكاملة فأي من المحاصيل تفضل زراعتها بأسلوب المكافحة المتكاملة ولماذا؟______________________________

أي من المحاصيل لا تفضل زراعتها بأسلوب المكافحة المتكاملة ولماذا؟____________

كيف تقوم بتسويق منتجات (IPM) من الخضار والفواكه؟ المنتجة في مزرعتك ________

وهل ستستمر في ذلك؟_______________________________

إن كنت لا تسوق من خلال شركة أمان، فما هي الأسباب؟__________________

وان كنت تسوق من خلال شركة أمان فما هي الأسباب؟

من وجهة نظرك ما هي معوقات تبني تكنولوجيا المكافحة المتكاملة للآفات الزراعية؟

هل هنالك أية اقتراحات أو توصيات بخصوص تطبيق المكافحة المتكاملة في الأردن؟ وماذا تقترح لبقاء وديمومة تطبيق المكافحة المتكاملة على الزراعات المختلفة في الأردن؟

بســـــم الله الرحمـــــــن الرحيـــــم

رقم الاستمارة:____________

التاريـــخ:____________

اسم المزارع:____

العنوان (الهاتـــــف)____

مساحة المزرعــــــــة____

اسم المنطقـــــــــة____

هل الأرض مستأجرة أم مملوكة____________________________________

قيمة الإيجار السنوية (بالدينار الأردني)/ وحدة أو دونم ____________________________

قيمة الأرض في حالة تم شرائها(السعر لكامل القطعة)_________________________

عدد البيوت البلاستيكية المزروعة بمحصول الخيار ______________ نوع البيوت البلاستيكية المزروعة بمحصول الخيار من حيث: Monospanوعددها____________ أم / و Multispan وعددها____________________

عدد البيوت البلاستيكية المزروعة بمحصول البندورة ______________ نوع البيوت البلاستيكية المزروعة بمحصول البندورة من حيث: Monospan وعددها____________ أم / و Multispan وعددها____________________

معدل مساحة البيت Monospan هو____________ ، معدل مساحة البيت Multispan هو____________

أ) بنود التكاليف المتغيرة:

عناصر الإنتاج المتغيرة	الكمية الكلية للبيت الواحد (لمحصول البندورة)	(لمحصول الخيار)	سعر الوحدة الواحدة فلس دينار لمحصول البندورة	سعر الوحدة الواحدة فلس دينار لمحصول الخيار
أشتال (شتلة) / بيت	______شتلة	______ شتلة	______فلس/شتلة	______فلس/شتلة
بذور / بيت الصنف______________	______	______	______دينار/(كغم)	______دينار/(كغم)
كلفة التشتيل صواني 84______________ صواني 209______________	 ______ صينية ______ صينية	 ______ صينية ______ صينية	 ______دينار/ صينية ______دينار/ صينية	 ______دينار/ صينية ______دينار/ صينية
خيطان التعليق / بيت	______ لفـة	______ لفـة	______ دينار/ لفـة	
خيطان تسليق / بيت	______ لفـة	______ لفـة	______ دينار/ لفـة	
مياه /م^3 / بيت	______ م3	______ م3	______ دينار/م3	
تكاليف ملش أسود (م) / بيت السماكة المستخدمة للبندورة ______ملم السماكة المستخدمة للخيار ______ملم	______م/ بيت	______م/ بيت	______ دينار/م	______ دينار/م
تكاليف سماد عضوي (طن) / بيت سمـــــاد مخمر زبـــــل دجاج زبـــــل غنم	 ______طن/بيت ______طن/بيت ______طن/بيت	 ______طن/بيت ______طن/بيت ______طن/بيت	 ______دينار/طن ______دينار/طن ______دينار/طن	 ______دينار/طن ______دينار/طن ______دينار/طن
تكاليف سماد كيماوي نوع السماد هو 1)______________ 2)______________ 3)______________	 ______طن/بيت ______طن/بيت ______طن/بيت	 ______طن/بيت ______طن/بيت ______طن/بيت	 ______دينار/طن ______دينار/طن ______دينار/طن	
كلفة التعقيـــم الشمسي / بيت ** كلفة تنعيم وحراثة الأرض______________دينار / بيت ** كلفة المياه للغمر______________دينار / بيت ** كلفة البلاستيك ______________دينار / بيت ** كلفة العمل ______________دينار / بيت ** اهتلاك أنابيب الري ______________دينار / بيت ** كلفة تشغيل الماتور ______________دينار / بيت				

كلفة التعقيم بالغاز (الميثيل بروما يد) / بيت

** كلفة تنعيم وحراثة الأرض ____________دينار / بيت

** كلفـــة الغاز ____________دينار / بيت

** كلفـــة البلاستيك ____________دينار / بيت

** كلفة العمل ____________دينار / بيت

تكاليف المبيدات/بيت/ لكامل الموسم		
كلفة مبيدات حشرية وعناكب________	______دينار/ بيت	______دينار/ بيت
كلفة مبيدات فطرية________	______دينار/ بيت	______دينار/ بيت
كلفة مبيدات أعشاب________	______دينار/ بيت	______دينار/ بيت
كلفة العمل للرش خلال الموسم________	______دينار/ بيت	______دينار/ بيت

الهرمونات النباتية / بيت ** كلفة الهرمونات ** كلفة العمل	________ ________		________ ________	
كلفة النحل الطنان / بيت				
التكاليف شراء حشرات النافعة (المكافحة الحيوية)				
رسوم اعتماد منتجات المكافحة المتكاملـــة وتغليفها وبيعها	______دينار/طن	______دينار/طن		

تكاليف الآلات المستأجرة / بيت

** حراثة____________دينار/بيت

** تنعيم____________ دينار/بيت

** أخرى1)____________ دينار/بيت

2)____________ دينار/بيت

3)____________ دينار/بيت

تكاليف الوقود والزيوت للآلات المملوكة / بيت

** ماتور الري____________دينار/بيت

** تراكتور____________ دينار/بيت

** ماتور رش____________ دينار/بيت

** سيارة____________ دينار/بيت

** أخرى1)____________ دينار/بيت

2)____________ دينار/بيت

3)____________دينار/بيت

إجمـــالي تكـــاليف الصيانـــة الســـنوية لـــلآلات المملوكـــة هي____________دينار/ سنة.

مجموع البيوت البلاستيكية المزروعة هي________بيت عدد البيوت البلاستيكية المزروعة بندورة هي________بيت عدد البيوت البلاستيكية المزروعة خيار هي________بيت				
تكاليف الكهرباء للآلات المملوكة هي ________دينار/________(سنة،شهر)				
تكاليف العبوات / بيت	____عبوة/بيت	____عبوة/بيت	____فلس/عبوة	____فلس/عبوة
التكاليف الكلية لنقل المحصول إلى السوق لكل بيت (في حالة عدم معرفة الكلفة للبيت يرجى ذكر فقط كلفة النقل الكلية للمزرعة) بدون عمولة السوق المركزي				
العمولة دينار/ طن عمولة السوق____ دينار/طن التحميل والتنزيل____ دينار / طن أخرى____ دينار/طن				
تكاليف إزالة النباتات ما بعد جني المحصول ____دينار/بيت				
تكاليف أخرى تستخدم في عملية الإنتاج (يرجى ذكرها) 1) 2) 3)				

القروض الزراعية:

مدة القرض	مصدر القرض	قيمة القرض (دينار)	تاريخ الحصول على القرض	سعر الفائدة السنوية (%)	فترة السماح

تكاليــــــف العمــــــل:

تكاليف العمالة / بيت بلاستيكي	دينار / بيت لمحصول البندورة	دينار / بيت لمحصول الخيار
تحضير الأرض للزراعة /يدوي / بيت		
تحضير الأرض للزراعة /آلي / بيت		
تكاليف عمل للتعقيــــم الشمســـي		
تكاليف العمل لاستخدام الميثيل بروموايد		
فرد السماد العضوي		
فرد السماد الكيماوي		
تغطيـــة البلاستيك		
مد أنابيب الري والتمديدات الأرضية		
فرد المـــلش		
عمالة للزراعـــــــــة		
تسليق ولف		
التطـــويش		
التعشيـــب		
رش المبيدات/ للبيت/للموسم		
رش الهرمونات		
جني المحصول (قطف وتدريج)		
ربط خيطان التسليق		
إزالة النباتات بعد جني المحصول		
تكاليف أخرى (يرجى ذكرها)__________		

العمل العائلي أن وجد:

الجنس	الدائمين					غير الدائمين				
	عدد أيام العمل	القيمة		طبيعة العمل		عدد أيام العمل	القيمة		طبيعة العمل	
		فلس	دينار				فلس	دينار		
ولد										
رجل										
امرأة										
المجموع										

ب) بنود التكاليف الثابتـــــــة:

عناصر الإنتاج الثابتة	الوحدة	العدد الكلي أو المساحة الكلية	التكاليف الكلية بالدينار الأردني لكامل المزرعة	التكاليف الكلية بالدينار الأردني لكل بيت بلاستيكي	العمر التشغيل (سنة)
إعداد وتجهيز الأرض	ــــــ				
سياج حول المزرعة	م				
الأبنية والمخازن في المزرعة	م2				
بركة المياه المستخدمة للري	م3				
نظام الري(السمادة، ...لخ)	ــــــ				
تكلفة أقواس البيوت البلاستيكية	1 بيت				
أنابيب الري	1 م				
ماتور رش مبيدات					
ماتور السقاية					
تراكتور					
محراث					
وسيلة نقل (بك أب أو سيارة)					
تكلفة أسلاك التعليق وملاقط التثبيت					
تكلفة الشرائح البلاستيكية					
تكلفة تركيب البيوت (الأقواس المعدنية)					
المـــــوسلين	م				
الشاش					
عمل دائم (مدير مزرعة)					
عمل دائم (عمال دائمين)					
أخرى يرجى ذكرها					

ج) الإنتاج والعائدات:

المحصول	الكمية(طن)/بيت	القيمة(دينار)/طن	ملاحظات
البندورة			
الخيـــار			

ملخص

تبني تكنولوجيا المكافحة المتكاملة للآفات الزراعية من قبل المزارعين في وادي الأردن

إعداد

ينال هايل حسين الخصاونة

المشرف

الدكتور أحمد شكري الريماوي

تعتبر تكنولوجيا المكافحة المتكاملة للآفات الزراعية إحدى أدوات تحقيق الزراعة المستدامة. من هنا جاءت أهمية هذه الدراسة التي تهدف إلى (1) تحديد بعض الخصائص الاجتماعية والاقتصادية التي تؤثر على تبني تقنيات المكافحة المتكاملة من قبل مزارعي الخضار (الزراعات المحمية) في الأغوار. (2) إجراء مقارنة بين تكاليف إنتاج محصولي البندورة والخيار بإتباع الطرق التقليدية وبأسلوب المكافحة المتكاملة. ولتحقيق هذه الأهداف تم إعداد استبانه وجمعت البيانات من مزارعي العينة والبالغ عددهم 110 مزارع. ثم تم إجراء تحليل إحصائي وقياسي للبيانات باستخدام طرق التحليل (Logit) و(Probit) بالإضافة إلى اختبار مربع كاي لمعرفة العوامل التي تؤثر على تبني تكنولوجيا المكافحة المتكاملة. كما تم حساب ميزانية النشاط لقياس الربحية، بالإضافة إلى دوال التكاليف.

أظهرت نتائج الدراسة أن هناك علاقة معنوية طردية بين تبني تكنولوجيا المكافحة المتكاملة وبين مستوى التعليم للمزارع، حجم الحيازة الزراعية، عمل المزارع خارج المزرعة، المشاركة في النشاطات الإرشادية، بالإضافة إلى أن الحصول على قرض زراعي، المرأة

المزارعة، المهنة " كمهندس زراعي، الإقامة " خارج منطقة وادي الأردن " ذات تأثير إيجـــابي معنوي على التبني . بينما كان لسنوات الخبرة علاقة معنوية عكسية. ولم تبين النتـــائج أيـــة علاقة معنوية بين عمر المزارع أو ملكية الحيازة وتبني هذه التكنولوجيا. أما نتـــائج ميزانيـــة النشاط الزراعي والانحدار الخطي المتعدد، فقد بينت أن هناك هامش ربحي وعائدات أكبر، تكاليف أقل في حالة استخدام تقنيات المكافحة المتكاملة.

إن أهم ما توصلت إليه الدراسة إلى أن تقنيات المكافحة المتكاملة علاوة على أنها تحـافظ على صحة الإنسان والبيئة، فإنها تمثل أداة جيدة لمكافحة الآفات الزراعية ذات جدوى اقتصاديـــة وذلك من خلال المساهمة في تخفيض التكاليف وزيادة العائدات.