COMPARATIVE COST-BENEFIT ANALYSIS OF USING INTEGRATED CROP MANAGEMENT TECHNOLOGY AND CONVENTIONAL METHOD IN VEGETABLE PRODUCTION IN THE LOWER MANYA KROBO DISTRICT OF GHANA

BY

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DECLARATION

I, EUGENIA ODURO, author of this thesis do hereby declare that apart from the references which have been properly quoted, the work presented in this thesis, "COMPARATIVE COST-BENEFIT ANALYSIS OF USING INTEGRATED CROP MANAGEMENT TECHNOLOGY AND CONVENTIONAL METHOD IN VEGETABLE PRODUCTION IN THE LOWER MANYA KROBO DISTRICT OF GHANA" was done fully by me under the supervision of Dr. John K. M. Kuwornu and Mr. D.P.K. Amegashie in the Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, Legon from August 2014 to June 2015. This work has never been presented in full or in part for any other degree in this University or elsewhere.

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DEDICATION

I dedicate this work to the Holy Spirit for His direction and to my parents Mr. Oduro Mensah and Mrs. Dorothy Ampofowah.

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I am most grateful to the Almighty God for His guidance and support to be able to complete the second degree successfully and seen me through the writing of my thesis.

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ABSTRACT

A new agronomic practice known as integrated crop management (ICM) technology is a combination of best farming practices to create a favorable environment thereby discouraging the use of the conventional method of farming. The main objective of this study is to compare the costs and benefits of using the integrated crop management technology and the conventional method. Primary data was solicited from 120 vegetable farmers using well-structured questionnaires. Descriptive statistics were used to describe the level of awareness and extent to which farmers understand the use of ICM technology. A cash flow projection was done on a 0.4Ha size of land for five years. Net Present Value (NPV) and Benefit-Cost Ratio (BCR) analyses were performed for farmers operating under the conventional method and the integrated crop management technology production situations. The Net Present Value analysis revealed that production of vegetables under both production technologies is viable. Moreover, the incremental Net Present Values (ΔNPV) for cabbage production, onion production and whole farm enterprise were all positive suggesting that the ICM technology is more financially viable than the conventional method of production. In this respect, the incremental NPV is GHS 2563.58 for cabbage enterprise and GHS 3949.43 for onion enterprise, and that of the whole farm enterprise (i.e. combined cabbage and onion production) is GHS 6,162.75. Further, the Benefit-Cost Ratio (BCR) analyses results revealed that vegetable production under the two methods are viable, confirming the results of the Net Present Value analyses. In this respect, the BCR for cabbage production is 1.58 for conventional method, 2.08 for the ICM technology; the BCR for onion production is 2.69 for the conventional method, 4.36 for the ICM technology. In addition, the BCR for whole farm enterprise is 2.42 for conventional method, 3.93 for the ICM technology. The results of the sensitivity analyses under the assumption of 5% reduction in yield and a 10% cost over-run indicated a positive NPVs for both methods of production in the case of cabbage production, onion production, and the whole farm enterprise. It is worthy to note that the NPV's resulting from the use of the ICM technology were still higher than those obtained under the conventional method of production. Moreover, the factors influencing farmers' practice/use of the ICM technology were estimated using the Logit regression model. The regression results of the factors influencing farmers' practice of ICM technology revealed that gender and awareness are significant factors influencing the farmers' practice/use of the ICM technology. Being aware of the technology and being a male farmer had a positive influence on farmers' practice of ICM technology.

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ICM	Integrated Crop Management
CM	Conventional Method
BCR	Benefit-Cost Ratio
NPV	Net Present Value
ΔNPV	Incremental Net Present Value
IOBC	International Organization of Biological Control
CBA	Cost-Benefit Analysis
GSS	Ghana Statistical Service

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Vegetables are important crops produced that contain vital nutrients for health maintenance and the prevention of diseases such as cancer, stroke and heart diseases (Chowdhury *et al*. 2011). Vegetables are easily perishable due to their fresh nature hence there is the need to constantly handle them with care when it comes to production and marketing. They can be further processed and treated carefully to avoid contamination.

According to Cofie *et al.* (2003) in most African countries, 50-90% of the vegetables produced are by farmers in the peri-urban and the urban cities. This assertion is consistent with what pertains in Ghana. The vegetables grown in Ghana include the following: cabbage, onion, okra, chilli pepper, hot pepper, tomato, eggplant and shallot. A considerable number of the actors involved in the production and marketing of vegetables are known to have both commercial and domestic gardening as well as transport facilities to transport the vegetables from the rural farms to the point of sale. Of importance here is the key role being played by middlemen in the transportation and marketing of vegetables in Ghana (Kuwornu *et al*., 2010). The ready market for the vegetable production serves as a means of revenue to these farmers as well as creating a source of employment for these farmers.

Obuobie *et al.* (2006) indicated that the production and the marketing of vegetables have provided a means of employment for lots of people especially living in urban and peri-urban areas. Thus, since the farmers know what their consumers want, they are able to produce and market their products with ease. Furthermore, Cofie *et al*. (2003) and Ravallion *et al.* (2007) also showed that most of the agricultural activities such as vegetable production undertaken in the urban and peri-urban areas create employment for the people especially the poor.

Vegetable production plays an important role in the standard of living of farmers and its' production and consumption is known to lessen the problem food insecurity. Cornish *et al.* (2001) and Danso *et al.* (2002) revealed that the livelihoods of 90% of smallholder farmers producing vegetables in the city of Accra have improved.

Though vegetable production has become one of the profitable enterprises for both small and large scale farmers, they are easily attacked by insect pests causing diseases to these crops. This incidence is very dominant during their production stage as well as storage. This also affects the quality of the produce in such a way that farmers receive low income due to poor quality. In order for the vegetable farmers to meet the demand at hand and to increase their revenue, they end up applying pesticides during production to control these pests from destroying their crops. One of the studies undertaken by Amoah *et al.* (2006) revealed that the demand for vegetable has increased and due to this farmers spray high quantity of chemicals to minimize diseases caused by pest in order to meet the increasing demand.

A study carried out in Ghana illustrated that most of the vegetables consumed had deposits of the pesticides which is very unhealthy to consumer (Obuobie *et al.*, 2006).

Applications of pesticides have become very common to most farmers because from their point of view it does not require much labor and most of them do not know the negative effect on the environment (Matthews, 2008). Due to these inappropriate practices by these farmers, most consumers have now become health conscious of the vegetables they consume. In recent years, issues have been raised concerning the amount of pesticides used by these vegetable farmers. It is also revealed that most consumers are much interested in taking vegetables free from chemicals because these vegetables are known to be tasty, safer and healthier to these consumers. Lambert (2001) revealed that there had been some kind of awareness on the consumption of these vegetables and its health benefits associated with it thereby increasing the consumption.

The conventional method of production of vegetables has to do with the use of agrochemicals including insecticides, herbicides and fungicides to the crops for reduce pest infestation. Though farmers have the intention of controlling the pest and diseases associated with the vegetables, they spray too much of the chemical to the crops which end up causing more harm than what is expected (Obuobie *et al.*, 2006). Most of these chemicals are made up of active ingredients that are harmful to the health of consumers'. Due to this, consumers are very careful of insecticide, herbicide and fungicide residues in the vegetables on the market.

Though vegetables can be produced by using the conventional method, another agronomic practice known as the Integrated Crop Management (ICM) technology can be practiced by these farmers, which will not only increase productivity but also sustain the environment (Kletnikoski *et al*., 2013; Parra- Lopez *et al*., 2007). The Integrated Crop Management technology if practiced by farmers will enable them produce quality products which would even increase their income.

Integrated Crop Management is a whole farm approach introduced to discourage the use of inorganic inputs such as pesticides. This technology involves, amongst others intercropping of the vegetables on the same piece of land, less tillage, crop rotation, application of manure, weeding and irrigation (Kletnikoski *et al*., 2013). For instance, intercropping two vegetables such as cabbage and onion helps in the management of diseases caused by the diamond moth that easily attacks the cabbage crop. This happens as a result of the strong unpleasant scent emanating from the onion hence preventing the insect pests from destroying the cabbage. This is a very good agronomic practice because instead of applying pesticides which will in turn leave residues on the vegetable crop, these crops are rather intercropped with other crops which prevents the insect pests from attacking the vegetable crop. Furthermore, intercropping some non-leguminous (cabbage) crops with leguminous crops (beans) helps sustain the soil fertility. In general, this agronomic practice combines various traditional methods with the aim of controlling pests as well providing a friendly environment thereby maintaining the fertility of the soil. This method preserves the environment from being polluted since chemicals are not applied to the vegetables during production.

A study conducted by Parra- Lopez *et al*. (2007) indicated that the next best agronomic practice that can be used instead of the traditional method of pesticide application is the

Integrated Crop Management technology. This new technology is receiving much attention in order to address the issue of deposits of pesticides in vegetables.

It is one of the best technologies used in the cultivation of crops, especially vegetables because it does not involve the use of other artificial means. Hence this method is most suitable and recommended to most farmers since some of these vegetables are eaten in their raw forms without cooking. Farmers must also be market oriented in their operations and farming practices.

1.2 Problem Statement

According to Dinham (2003), diseases caused by pests have destroyed most of the crops grown in Ghana and this has become one of the key challenges to farmers. As a result, farmers end up applying high quantity of synthetic chemicals in order to control these pests. Unfortunately, most often, these chemicals are not applied in their right quantities resulting in deposits of pesticides in the vegetables produced. Some farmers apply these chemicals at the production stage and others do apply just some few weeks before harvesting and this has resulted in pesticide residue in the vegetable crop. In this respect, consumers perceive vegetables on the markets as unsafe, unhealthy and harmful for human consumption (Obuobie *et al.,* 2006).

Numerous studies have been conducted on the application of pesticides using the conventional method of crop production in Ghana (e.g. Obuobie *et al.*, 2006; Ntow *et al.*, 2006). However, there are alternative recommended agronomic practices such Integrated

Crop Management (ICM) technology but farmers continue to use the conventional method of crop production because to a large extent, the farmers' awareness of the new technology is uncertain (farmers do not know much about the ICM technology). Further, most farmers find it difficult in practicing any new technology because they consider whether or not the new technology (ICM technology) will be beneficial to them.

Although, the traditional (conventional) method involves the use of pesticides and other chemicals, farmers are still using this method despite the fact that it involves more cost than the new technology (i.e. Integrated Crop Management) which is less costly and beneficial as indicated by previous studies (e.g. Kletnikoski *et al*., 2013). To the best of my knowledge studies on the costs and benefits of the above-mentioned systems of production are scanty or non-existence, more particularly on the vegetable industry in Ghana. This current research will provide a comparative cost-benefit analysis of vegetable production under the conventional method and the Integrated Crop Management technology.

In this respect, the following research questions are raised:

1. What is the level of awareness of the Integrated Crop Management (ICM) technology among vegetable farmers in the Lower Manya Krobo District of Ghana?

2. What is the extent to which vegetable farmers in the Lower Manya Krobo District of Ghana understand the importance of using Integrated Crop Management (ICM) technology?

3. How do the costs and benefits of using the ICM technology differ as compared with the conventional method (CM) among vegetable farmers in the Lower Manya Krobo District of Ghana?

4. What factors influence the practice of ICM technology among vegetable farmers in the Lower Manya Krobo District of Ghana?

1.3 Objective of the study

The main objective of the study is to perform a comparative costs and benefits analysis of integrated crop management (ICM) technology and conventional method among vegetable farmers in the Lower Manya Krobo District of Ghana.

The specific objectives are:

1. To determine the level of awareness of the ICM technology among vegetable farmers in the Lower Manya Krobo District of Ghana.
2. To measure the extent to which vegetable farmers in in the Lower Manya Krobo District of Ghana understand the importance of using ICM technology.

3. To conduct a comparative costs and benefits of using the ICM technology and conventional method among vegetable farmers in the Lower Manya Krobo District of Ghana.

4. To identify and analyze the factors influencing the practice of the ICM technology among vegetable farmers in the Lower Manya Krobo District of Ghana.

1.4 Relevance of the Study

The justifications of the study are the following. First, this study would inform and assist farmers through practical trainings in identifying a more suitable practice for vegetable production to enable them increase their productivity. Second, this study will help inform policy makers on the need for highlighting and dissemination of information on Integrated Crop Management in vegetable production. Third, this study will contribute to existing literature on the practice of Integrated Crop Management technology in developing countries.

1.5 Organization of Thesis

Following chapter one, chapter two presents review literature related to the study. Chapter three provides the methodology for the study, including methods of analyses, a brief description of the study area, and outlines the field data collection using structured questionnaires. Chapter four presents the empirical results and discussion. Chapter five presents the summary of the study, conclusion, recommendations, limitations and suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature related to the study. The first part reviews literature on the conventional method of crop production. The second section reviews literature on Integrated Crop Management (ICM) technology. The next section reviews studies on farmers' concerns on the use of inorganic chemicals, and then followed by a review of studies regarding consumers' concerns for the use of chemicals for vegetable production. Finally, this chapter reviews studies on cost-benefit analysis, including the benefit cost ratio (BCR) and the Net Present Value (NPV).

2.2 Conventional Method

The application of chemicals such as pesticides to vegetables and other crops is referred to as conventional method of crop production. These pesticides are used to control pest that easily attack vegetable crops. They are usually used and are made up of insecticide which is used to control insects, fungicide used to control fungus and herbicide to control weeds. These chemicals also cause negative effect therefore causing poisoning, infertility and even destroying the nervous system.

This practice has become one of the ways by which farmers control their vegetable crops from pests during production. Most of the vegetables in the markets that are sold are produced using the conventional method.

The conventional method (CM) has to do with the use of synthetic agricultural chemicals including pesticides, herbicides, fungicides and other soluble mineral fertilizers in crop production. Studies conducted by Hogson (2003) indicated that there had been some concerns regarding the application of pesticides on crops. Studies by Schreinemachers *et al*. (2011) also indicated that there had been high dependency on synthetic chemicals by farmers.

According to Hurtig *et al*. (2003), the World Health Organization has revealed that pesticides used in most developing countries have become a threat to both farmers and consumers. The environment is also affected because the excess chemicals are washed into most of our water bodies which becomes unsafe for use. McCauley *et al*. (2001) showed that most of the health of most people living close to areas where crop production takes place is threatened due to the intensive use of pesticides. This is consistent with Quandt *et al*. (2004) who also recorded that there has been an increase in the health risk of people whose houses are closer to the farms where these chemicals have been applied.

According to Miller (2004), the extensive use pesticide application has become more rampant in the developing countries as compared to the developed countries. Similar studies conducted by Bempah *et al*. (2012) showed that vegetable farmers still apply high rate of pesticides to their crops despite the cautions on pesticide residue in vegetables. According Fianko *et al*. (2011), majority of the vegetable farmers do not apply the right quantity of pesticides for their vegetable production. A study conducted by Williamson *et al*. (2008) indicated that there is farmers' inefficiency on the application of inappropriate combination of different chemicals to crops. The inappropriate mixing of these chemicals can be as a result of incorrect amount used and this also becomes harmful when the spraying is done at wrong time. Most farmers experience side effects when they mishandled the chemicals, leading to headaches, skin itches, dizziness, breathing problems, mental disorders and the worst case when their sight is affected leading to unclear vision (Ackerson and Awuah, 2010; Mensah *et al.*, 200).

This practice is also seen to be dangerous to farmers because most of them apply these chemicals without wearing any protective clothing. It is surprising to note that, some farmers even use the wrong chemical on their vegetable crops. Williamson (2003) revealed that some farmers use chemicals that were supposed to be used on a cotton crop for their vegetables crops.

Ntow *et al.* (2006) also indicated that some farmers apply a lot of pesticides to their vegetables by spraying in order for them to look fresher and appealing to consumers. The study indicated that some farmers even do a pre-harvest spraying and the time interval used for the spraying and harvesting is very short, hence, leading to pesticide residues in their harvested crops.

2.3 Integrated Crop Management Technology

Integrated crop management (ICM) technology is quite different from the conventional method because it involves the intensification of some practices such as intercropping, crop rotation and application of manure. According to Kletnikoski *et al*. (2013), the integrated crop management (ICM) technology is a new technology introduced to discourage the use of agrochemicals such as pesticides. A study conducted by Parra-Lopez et al. (2007) indicated that the next best agronomic practice that can be used instead of the conventional (traditional) method of pesticide application is the integrated crop management method. This new technology is receiving much attention in order to address the issue of the deposits of pesticides on vegetables. The ICM technology will enable farmers produce vegetables free from pesticide since consumers will be willing to purchase these vegetable on the market due to health reasons.

Integrated crop management technology has to do with the combinations of several practices such as crop rotation, intercropping, manure application, weeding and irrigation. These practices can be used by farmers to produce quality crops without contaminating the environment and also take into consideration the well-being of the consumer purchasing the product (International Organization of Biological Control, 2010).

Vegetable Farmers practicing crop rotation, intercropping, and manure application reduce the use of pesticides hence reducing the cost of purchasing these chemicals and increasing the income level of farmers (Theocharopoulos, 2009).

Some of the advantages these crops receive from each other include pest control and also sustaining the fertility of the soil. In other words this method is applied to more than one crop. The idea of the integrated crop management is a build-up on the integrated pest management whereby crops are used. For instance when onion and cabbage are intercropped, the onion serves as a biological control in preventing the diamond moth from destroying the cabbage crop. This practice is one of the biological means of protecting cops from insect attack.

Integrated crop management is one of the methods of farming which is environmentally friendly by minimizing toxic waste in the environment and also creates an avenue for a business that is viable. This type of management demands the producers taking good care of the production of the vegetables hence leading to high yields and safe products for human consumption.

Given the side effects of pesticide application, this agronomic practice (i.e. Integrated Crop Management technology) tends to reduce the use of artificial inputs such as pesticides and fertilizers with the aim of making the crops better and enhancing proper management. This type of management control is one of the natural ways of enhancing growth rather than applying chemicals. The integrated crop management technology involves no chemicals and artificial fertilizers applied to the soil. Hence, the vegetables produced using this technology is mostly free from pesticide residue.

This method of management focuses on making the soil fertile in order to enable the crops absorbs enough nutrients needed for growth. The practice also takes into account the economic and environmental aspect. For the economic aspect, the right varieties of seeds and other inputs are used with minimum cost whiles the environmental aspect has to do with crop rotation in order to improve the soil fertility.

This method of management reduces the number of insects attacking a particular crop. This also will help to decrease the chemical usage on the crops sustaining the environment. This method also involves the planting of crops that can resist the pest from destroying susceptible crops. For instance, cabbage can be planted together with onions because the cabbage crop is mostly attacked my most insects such as the diamond worm. The onion is intercropped with the cabbage due to its pungent scent which prevents the cabbage from being infested leading to an increase in yield.

The integrated crop management (ICM) technology involves all the farming systems put in place to ensure that the pests are controlled in order for farmers to increase their yield during the cropping season. A study conducted by Kletnikoski *et al*. (2013) indicated that the ICM technology put together most the best farming methods with other suitable modern technology, hence resulting in good economic production of crops with adequate environmental management.

2.4 Farmers' Concern on the use of Inorganic Chemical Application

In general, farmers have had many issues concerning the use of inorganic chemicals such insecticides and herbicides. Atreya *et al*. (2012) and Palikhe (2002) indicated that the main motive of the farmer using pesticides is to reduce the rate of pest infestation as well as weed in order to produce quality crops, but the frequent use of these chemicals tends to contaminate the crop and the health of the farmer involved in the spraying is also affected negatively.

Jaga and Dharmani (2003) indicated that farmers breathe in some of the chemicals in the course of spraying which is very detrimental to their health. Another study by Garcia (2003) also showed that farmers who are exposed to these chemicals for a long time tend to suffer from respiratory problem, memory disorders and cancer.

Macauley, *et al.* (2006) conducted an assessment on the effect of synthetic chemical application and revealed that most farmers in developing countries suffer from injuries and about 18,000 of them lose their lives due to the health hazards involved. This can be attributed to how vegetable farmers mishandle the chemicals when spraying since they do not have enough information on the use of these chemicals (Ngowi *et al.*, 2007).

Oo *et al.* (2012) indicated that very few of the farmers use protective tools such as gloves and nose mask and goggles when spraying in order to protect them and these results in health implications such as skin irritation, inhalation of dangerous chemicals and eye itches respectively (Konradsen *et al.*, 2003; Coronado *et al.*, 2004).

The use of insecticides and herbicides has become so common and other studies have shown that there has been an increase in the importation of these synthetic chemicals to most African countries (Pesticide and poverty, 2006). According to Obeng-Ofori *et al.* (2002), the inappropriate use of these chemicals has resulted in environmental pollution and this has also made most insects being not affected by these chemicals.

2.5 Consumer Concerns for the Vegetable Production

Vegetables are low in fats, which provide minerals and vitamins as well as fibre and these are essential to consumers. According to Van Duyn and Pivonka (2000) different research had revealed that the consumption of vegetables has positive health effects on consumers.

According to Rozin *et al.* (2004), consumers prefer food free from chemicals and Wier *et al.* (2003) revealed that consumers are always willing to purchase vegetables that are free from pesticides. This is so because they also take into consideration the health implication with regards to the consumption of these vegetables. This assertion is consistent with Gregory (2000) who revealed that consumers are also conscious of the overuse of pesticide by these farmers. Obuobie *et al*. (2006) also demonstrated that during the production of most vegetables, farmers use excessive pesticides in controlling pests from attacking their crops. As a result of this excessive application, some of the chemicals remain in the vegetable crop and this has brought about lots of issues related to the health of those who consume these vegetables. His study also found out that most of the vegetable farmers use waste water due to the unavailability of clean water for irrigating their vegetables. The water is used unhygienic to the extent of contaminating the vegetable crops which would later be sold in the market for consumers to purchase.

Further, Yeung and Morris (2001) demonstrated that whenever consumers decide to purchase anything with regards to vegetables, they would always prefer to buy safe vegetables in order to avoid any health risk in the future. Saba and Messina (2003) also indicated that consumers know of the use of pesticides, especially with vegetable production, hence are very mindful of the results in the future.

In a scenario when consumers are made aware of two products whereby one is produced using the Integrated Crop Management technology which is pesticides-free and the other produced using the conventional method that involves the application of pesticides, consumers will select the produce that is pesticide-free using the Integrated Crop Management technology (Chambers *et al*., 2007; Rozin *et al*., 2004). This shows that consumers are very concerned about what they purchase to consume due to health reasons.

These concerns have to do with the agronomic practices associated with the production of these produce and their quality. Due to this there has been an awareness of the health benefits of vegetable consumption and there is increasing demand for vegetables produced using Integrated Crop Management technology rather than those produced using the conventional method. Studies undertaken by Torjusen *et al.* (2001) showed that much attention have also been given to consumers in order to deliver what they are demanding as well as keeping a safe environment.

According to Coulibaly *et al*. (2002) the consumer's health is at risk due to the high application of synthetic chemicals while the consumers are not aware of the negative effects of the residues on these vegetables.

2.6 Cost-Benefit Analysis

Cost benefit analysis (CBA) shows the worth of an investment by doing a comparison on the costs involved with the benefits. It is used for financial analysis of projects in order to estimate the financial viability of the project. The financial ratios used for cost benefit analysis according to Gittinger (1982) include the net present value (NPV) and benefit cost ratio (BCR). According Gittinger (1982), the Benefit Cost Ratio is defined as the value today of all benefits divided by the value today of all costs. The Net Present Value (NPV) as defined by Gittinger (1982) as the difference between the value today of all present and future benefits and the value today of all present and future costs. Studies conducted by Mmopelwa *et al.* (2006) used the cost-benefit analysis defined by (Gittinger, 1982) which showed a higher financial viability of venturing into commercial fishing. Kuwornu *et al*. (2013) also used the cost-benefit analysis in measuring the financial viability of certified organic pineapple production and marketing in the Eastern and Central Regions of Ghana. The study showed an NPV of GH¢ 3,553.77 showing that the certified organic pineapple production is financially viable in the Central Region than the Eastern Region of Ghana.

CHAPTER THREE

METHODOLOGY

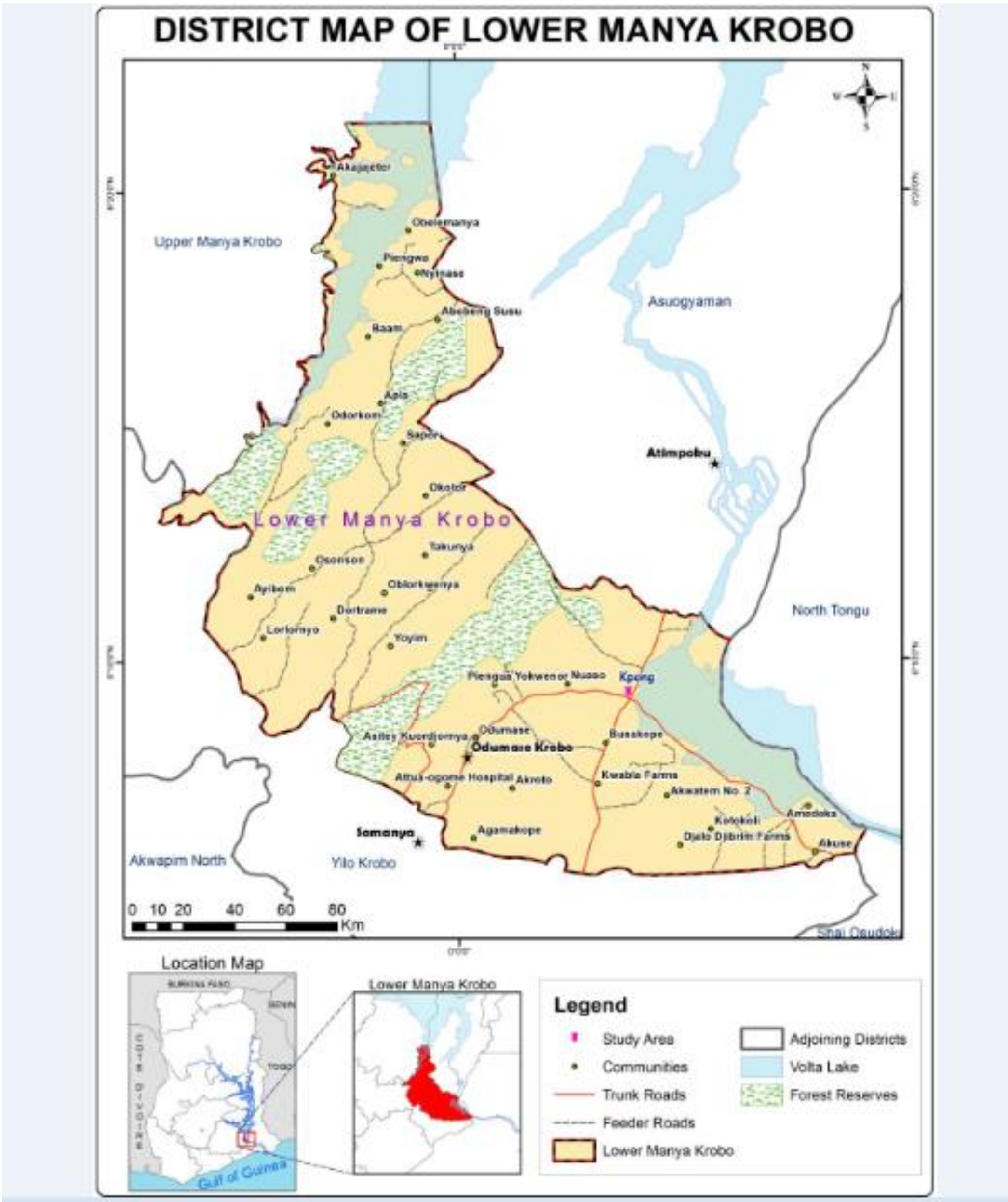
3.1 Introduction

This chapter provides a brief description of the study area in section 3.2. Section 3.3 also gives a brief explanation on how the data collection was done. This included information on types and sources of data, sampling technique, sample size, and the survey instrument used for the data collection. Section 3.4 describes the conceptual framework used for the study whereas section 3.5 gives a brief explanation of the theoretical framework used. This chapter also explains the method of analysis used to achieve the objectives of the study in section 3.6.

3.2 Study Area

Lower Manya Krobo District is located in the Eastern Region of Ghana which is among the seventeen districts in the region. It has an area of 1,476 squared km which is about 81% of the total land area within the Region. Odumase township is the capital of the district according to GSS (2010), the Lower Manya Krobo District has a population of 89,246. Kpong is known to be one of the towns located in the Lower Manya Krobo District and that was where the project regarding Integrated Crop Management (ICM) is being undertaken, for which awareness of the ICM technology is created among vegetable farmers in the area. Other major towns found in the district include Agormanya and Nuaso. Other districts to the north, south ,east and west include the Upper Manya Krobo, Dangme West, Asuogyman and Yilo Krobo districts respectively. The main occupation in the district is farming and some of the crops cultivated include vegetables, cassava, yam and maize. Other occupations also include teaching, trading and carpentry work.

Figure 3.1: Map of Lower Manya Krobo District



Source: *Survey Department2009*

3.3 Data Collection

This section describes how data was collected for the study.

3.3.1 Types and Source of Data

Primary data was used for the study. The data collected included the background information of the respondents which involved age, educational qualification of respondents, gender and household size of respondents. Other relevant information also included the farming experience in terms of years, their average annual income from their vegetable production, production of other crops, the quantity of vegetable harvested within the cropping season and the prices at which the vegetables are sold.

3.3.2 Sample Size and Sampling Technique

A multi-stage sampling technique was used for the study. Firstly Kpong was purposively selected since a project on the introduction of ICM technology is being implemented in the area. Secondly, a combination of simple random sampling (through the lottery method) and purposive sampling were employed to select 120 vegetable farmers using the conventional and ICM methods of Production. In this respect, eighty nine (89) farmers practicing the conventional method of vegetable production were randomly sampled from among 150 farmers. Among the eighty nine (89) vegetable farmers using conventional method of vegetable production that were sampled through simple random sampling, forty (40) were cabbage farmers, and forty nine (49) were onion farmers. Thirdly, all the thirty one (31) vegetable farmers practicing ICM technology were purposively selected and interviewed. In this case, the thirty one (31) vegetable farmers sampled consist of seventeen (17) cabbage farmers and fourteen (14) onion farmers.

3.3.3 Survey Instrument

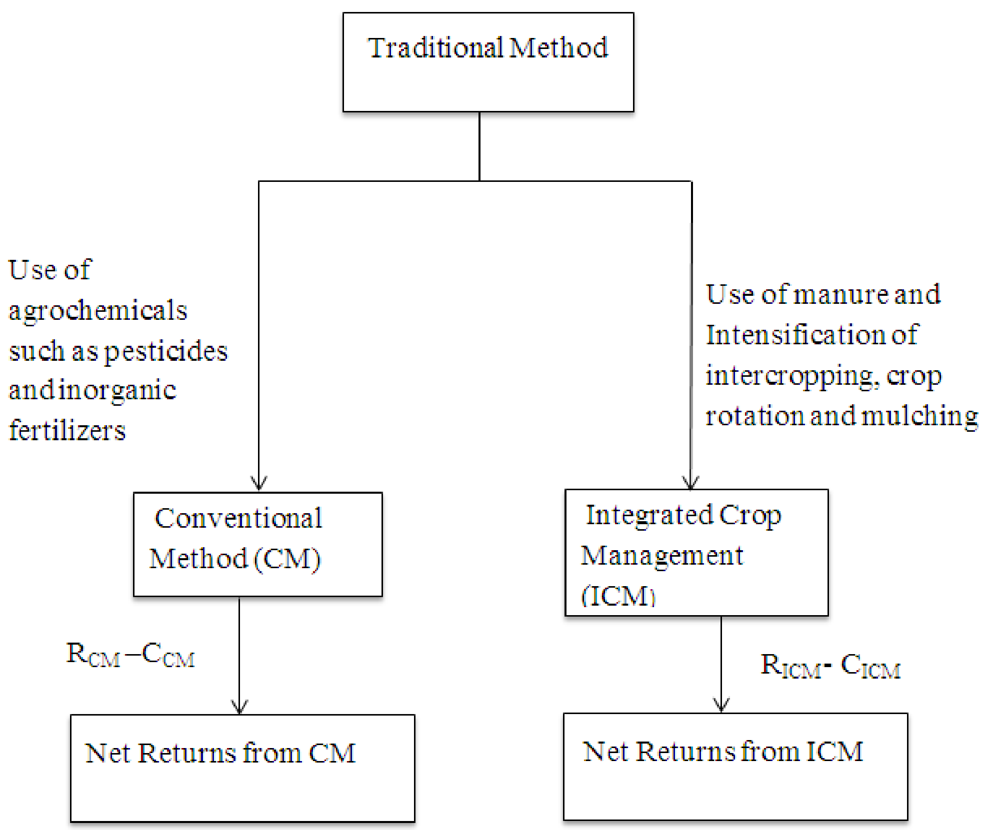
A well-structured questionnaire was administered to vegetable farmers, which included both cabbage and onion farmers.

3.4 Conceptual Framework

The primary objective of an enterprise (including vegetable farming) is to maximize profit. Most of the vegetable farmers aim at increasing the returns they obtain from their produce by attempting to produce quality vegetable. In their attempt to produce quality vegetables, they end up by spraying with insecticides as a means of reducing insect infestation. Alternatively, a farmer can also practice the Integrated Crop Management technology which can increase their returns. The Integrated Crop Management technology discourages the use of chemicals and rather uses other methods in reducing insect infestation and also reduces costs since farmers would not need to buy insecticides for spraying.

Figure 3.2 shows the conceptual framework of the traditional method farmers' cultivate their vegetables. A farmer applying agrochemicals such as pesticides and inorganic fertilizer to his vegetables is said to be practicing the conventional method (CM) and the returns he gets is as a result of selling the produce harvested (yield) at particular price which is equivalent to the market price. The net returns (R_{CM} –C_{CM}) are the difference between the overall costs of the vegetable production from the returns obtained as a result of selling the produce. On the other hand if a farmer makes the decision to reduce the use of agrochemicals such as pesticides and inorganic fertilizers but rather intercrop more of his vegetable with other crops to serve as a means of preventing pest infestation, and apply more manure to enhance vegetable growth as well as practicing crop rotation, then he is noted for practicing integrated crop management (ICM). The returns he gets is as a result of selling the yield of the produce at specific price which is equivalent to the market price. The net returns ($R_{ICM} - C_{ICM}$) are the difference between the overall costs of the vegetable production from the returns obtained as a result of selling the produce. Hence, farmers' net returns from vegetable production will depend on the type of agronomic practice employed, either by the conventional method or the integrated crop management technology.

Figure 3.2: Conceptual Framework



Source: *Author's Conception*

3.5 Theoretical framework

The theory was based on the financial analysis, which involves the Cost-Benefit Analysis technique that uses the discounted measures of project worth such as the Benefit Cost Ratio (BCR) and the Net present Value (NPV). Financial analysis was used because it takes into consideration both output and the cost of inputs. The costs of inputs include the seeds, fertilizer and other equipment needed for production. The output only included the yield of vegetables produced at the crop season. According to Gittinger (1982), the Benefit Cost Ratio is defined as the value today of all benefits divided by the value today of all costs. The equation is given as:

$$BCR = \frac{\sum_{t=0}^{t=T} B_t}{\sum_{t=0}^{t=T} C_t}$$

The decision rule states that if the Benefit Cost Ratio (BCR) is greater than 1then the projected is said to be financially viable hence it can be accepted.

The Net Present Value (NPV) as defined by Gittinger (1982) as the difference between the value today of all present and future benefits and the value today of all present and future costs. The equation is stated below:

$$NPV = \sum_{t=0}^{t=T} (B_t - C_t) . \frac{1}{(1+r)^t}$$

The decision rule states that if NPV is greater than zero, then the project is said to be financially viable hence it can be accepted. These measures of project worth were used for the analysis because they test whether the project being undertaken is financially viable.

3.6 Method of Analysis

This section shows the methods used to achieve each specific objective.

3.6.1 Determining the Level of Awareness of ICM Technology

Descriptive statistics (i.e. percentages) were used to present the level of awareness of the integrated crop management (ICM) technology among the vegetable farmers.

3.6.2 Measuring the Extent to which farmers understand the use of ICM Technology

Descriptive statistics (i.e. percentages) were used to measure the extent to which farmers understand the use of the ICM technology. In this case, a Likert scale of 1, 2 3, denoting no understanding, slight understanding, and complete understanding, respectively, was developed and used to solicit information regarding vegetable farmers' understanding of the various aspects of the ICM technology from the vegetable farmers. The values obtained from the farmers on the various aspects of the ICM were used to compute percentages of their level of understanding the ICM technology.

3.6.3 Comparing the Costs and Benefits of using the ICM Technology with the Conventional Method

Comparing the costs and benefits of the integrated crop management to the conventional method for the third objective, the "with" and the "without" project format was adopted using the NPV and BCR as indicators of project worth. The steps included:

1. Assumptions
2. A cash flow projection was estimated for both the conventional method and the integrated crop management technology.
3. The discounted measures of project worth for both methods were used in calculating for their BCRs and NPVs.

4. A sensitivity analysis was estimated for both methods to check whether the NPVs will still be positive if there is a percentage reduction in yield and a percentage cost over-run.

Next, before doing cash flow projections for both methods there is the need to estimate their costs and returns. The cost of vegetable production using the conventional method included the cost of materials such as the seeds, fertilizers, pesticides, herbicides and sacks for bagging the produce. Cost of labour are the costs of nursery management, herbicide application, fertilizer application, watering, harvesting as well as administrative and marketing costs.

The cost of vegetable production using the integrated crop management technology included the cost of materials such as the seeds, fertilizers and sacks for bagging the produce. Costs of labour are costs of nursery management, fertilizer application, weeding, watering, harvesting as well as administrative and marketing costs.

The cost of the capital items used for both methods included watering cans, wellington boots, hoes, cutlasses, wheel barrows, tape measure, PVC pipes, pumping machine and knapsack sprayer were estimated. The residual value (RV) of the capital items were estimated as explained by Gittinger (1982) as:

$$RV = \frac{O(U-N)}{\mathrm{U}} \tag{3.1}$$

Where: O denotes Original Cost, U denotes Useful life of capital item and N denotes the Number of years the capital item was used.

Other cost of services also included the cost of ploughing. The returns were estimated by taking into consideration the yields of vegetable (cabbage and onion) in bags which were measured in Kilogram (Kg) harvested from 0.4 hectares (1 acre) plot of land under cultivation.

1. Assumptions

The assumptions underlying the study were used to analyze the third objective by means of using the cost-benefit analysis technique. First of all a 5% contingency was assumed for the capital items because these capital items such as knapsack sprayer and cutlass are not massively affected when there are changes in prices as compared to seeds and fertilizer. For instance, taking a capital item such as knapsack sprayer will take either three or four years to reach its useful life. Secondly a 10% contingency was estimated for other variable inputs such as seeds and fertilizers because vegetable farmers will keep buying these inputs for every cropping season and given the likelihood those prices will increase in the future. Hence a contingency of 10% of the operating cost was included in order to cater for unforeseen extra cost to be incurred in the process of the vegetable production.

For repairs and maintenance in year one assumed 1% of the total cost item and increased by 1% each year over the life of the investment. Repairs and maintenance was also assumed to be 1% for any capital item being replaced in a particular year.

The Capital items reaching their useful life are assumed to have zero salvage value (Okoh *et al*., 2010).

2. Cash flow Projection of cabbage and onion using both methods

The cash flow projection was estimated for five years because by the end of the fifth year, it is assumed that the life span of the capital items used for the vegetable production would have ended. The five years would also help the vegetable farmer to recover the initial capital used for the project and also obtain benefit as a result of selling the produce.

The costs of materials and the labour costs under both methods of vegetable production were captured under operating cost where a 10% contingency was estimated to cater for any extra costs since they are variable costs and have high tendencies of increasing due to changes in prices. The total cash outflows included the total operating costs and the capital costs. The net cash flows for the two methods were estimated as a result of the difference between the cash outflow (costs) and the cash inflows (returns).

3. Discounted measures of project worth for both methods

The costs and benefits of cabbage and onion using the conventional and the integrated crop management were discounted at 28% which is the lending rate of the Agricultural Development Bank (ADB) since it known to be one of the banks that support farming activities. This was used for the discounted cash flows in order to calculate for the benefit cost ratio (BCR) and the net present value (NPV). These measures of project worth were used in order to compare the financial viability of the vegetable production under the integrated crop management technology with the conventional method.

Benefit-Cost Ratio (BCR)

According Gittinger (1982), the Benefit Cost Ratio is defined as the value today of all benefits divided by the value today of all costs.

The equation is given defined as:

$$\text{BCR} = \frac{\sum_{t=0}^{t=T} B_t}{\sum_{t=0}^{t=T} C_t} \quad (3.2)$$

Where: B_t denotes Benefit or Revenue in year t; C_t denotes Cost in year t; T denotes the Life span of the project; t denotes time period in years; r denotes discount rate; $\frac{1}{(1+r)}$ denotes the discount factor. The decision rule for BCR is that if:

BCR>1 for the conventional method then it means that the vegetable produced under this method is financially viable.

BCR>1 for the integrated crop management then it means that the vegetable produced under this method is financially viable.

BCR<1 for the conventional method then it means that the vegetable produced under that method is not financially viable.

BCR<1 for the integrated crop management then it means that the vegetable produced under this method is not viable financially.

$BCR = 1$ for both the convention method and the integrated crop management means that there is a breakeven.

Net Present Value (NPV)

The Net Present Value (NPV) as defined by Gittinger (1982) as the difference between the value today of all present and future benefits and the value today of all present and future costs.

The equation is given as is also given as:

$$NPV = \sum_{t=0}^{t=T} (B_t - C_t) . \frac{1}{(1+r)^t} \quad (3.3)$$

Where: B_t denotes Benefit or Revenue in year t; C_t denotes Cost in year t; t denotes time period in years; T denotes Life span of the project; r denotes discount rate; $\frac{1}{(1+r)}$ denotes discount factor.

The decision rule for NPV is that if:

NPV>0 for conventional method then it means that the vegetables produced under this method is financially viable.

NPV>0 for integrated crop management then it means that the vegetables produced under this method is financially viable.

4. **Sensitivity analysis**

A sensitivity analysis was also conducted with an assumption of 5% reduction in yield and 10% cost over-run. This analysis was conducted to check whether the Net Present Value (NPV) of both enterprises will still be positive if the returns of the vegetable farmers is reduced at 5% or if cost has been increased by 10% which were discounted at 28%. The 28% discount used in the study (for the BCR, NPV, and sensitivity analysis) is the lending rate of the Agricultural Development Bank.

3.6.4 Factors affecting the practice of ICM technology

The logit regression model was used to analyze the fourth objective regarding the factors influencing the farmers' practice of Integrated Crop Management technology. The Logit regression model is used in modeling relationship between a binary response variable and one or more predictor variables (which may be either discrete or continuous). As in multiple regressions, we are interested in finding an appropriate combination of predictor variables to help explain the binary outcome. Theoretical Logit model is specified as follows:

$$P_i = F(Z_i) = F(\infty + \beta_i X_i) = \frac{1}{1+e^{-z_i}} = \frac{1}{1+e^{-(\infty+\beta_i X_i)}} \tag{3.4}$$

In the above equation, e represents the natural logarithms, P_i is the probability that the respondent would make a certain choice (i.e. the choice to practice the ICM technology or not), given, X_i where X_i is set of independent variables and $\beta_i's$ are the coefficients of the independent variables. The Logit model follows a Cumulative Logistic Probability Function and this is denoted by F (Z_i).

To estimate the specified model:

$$(1 + e^{-Z_i})P_i = 1 \tag{3.5}$$

$$e^{-Z_i} = \frac{1}{P_i} - 1 = \frac{1-P_i}{P_i} \tag{3.6}$$

Since $e^{-Z_i} = \frac{1}{e^{Z_i}}$ (3.7)

Hence $e^{Z_i} = \frac{P_i}{1-P_i}$ (3.8)

Taking the natural logarithm of both sides, we have:

$$Z_i = log_e \frac{P_i}{1-P_i} \quad (3.9)$$

$$Z_i = log_e \frac{P_i}{1-P_i} \quad (3.10)$$

(Pindyck and Rubinfeld, 2000)

$$log \frac{P_i}{1-P_i} = PICM = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \varepsilon_i \quad (3.11)$$

The empirical model is expressed as;

$$PICM = \beta_0 + \beta_1 GEN + \beta_2 HH + \beta_3 AGE + \beta_4 EDU + \beta_5 FARMEXPE + \beta_6 AI + \beta_7 POC + \beta_8 AWA + \varepsilon_i \quad (3.12)$$

Where: PICM denotes likelihood that farmer will practice the ICM technology; β_o is the intercept term; β_i denotes the regression coefficient of the independent variables; $X_{i's}$ are the independent variables; ε_i is the error term.

Table 3.1: Description, measurements and a priori expectation of the variables used in the Logit regression model

Variables	Description	Measurement	A priori expectations
GEN	Gender	Male=1, Female = 0	+
HH	Household size	Numbers	+
AGE	Age	Number of years	+/-
EDU	Educational level	No education=0 Educated=1	+
AI	Average annual income from vegetable	GH¢	+
POC	Production of other crops	Yes=1, No=0	+/-
FARMEXPE	Farming Experience	Number of years	+
AWA	Awareness	Yes=1, No=0	+

3.6.4.1 Justification of the variables used in the Logit regression model

Gender: Gender difference is one of the key factors influencing the practicing of new technologies. Numerous studies revealed that gender has a positive relationship with the practicing of new technologies because males are more willing to venture into an enterprise that has to do with new technologies than females (e.g. Doss, 2001; Mehra, 1994). Doss (2001) indicated that females have a lower tendency of practicing new technologies as compared to males. Mehra (1994) revealed that division labour amongst males and females in Sub-Saharan Africa, including Ghana influences the adoption of new technology by males and females, in which the study shows that males are more likely to adopt agricultural technology. Asfaw and Admassie (2004) also revealed that males are able to learn, especially new technologies than their female counterpart because they easily obtain resources and information needed to practice the new technology. This assertion is consistent (Nchinda and Mendi 2008; Von and Sorensen 1993).

Household size: Factors affecting practicing of new technologies also depends on the household size which has a positive relationship. It determines the number of family labour to be used in practicing the new technology. Hence, the larger the household size, the more likely will be the adoption of the technology by the household (e.g. Hicks and Johnson, 1974; Doss and Morris, 1998). Similarly, Croppenstedt *et al*. (2003) revealed that families with larger household size have a higher tendency of practicing new technology especially when the technology requires much labour.

Age: Age is another factor which is key in determining the practicing of new technologies. It was hypothesized to have a positive or negative relationship. This suggests that older people have a higher tendency of practicing new technology as compared to their younger counterparts. Studies have revealed that elders in African traditional societies are recognized as early adopters because of their experience (Kaliba *et al*., 2000; Pannin, 1988). However, other studies have revealed that young farmers being more adventurous to stumble on new ideas and having longer planning horizon are more likely to accept innovations more than older farmers (e.g. Polson and Spencer, 1992). Bayard *et al.* (2007) revealed that age has a positive influence with the practice of new technology and other studies by Anley *et al.* (2007) revealed that one's decision to practice a new technology is negatively influenced by age. This implies that young people tend to explore more into other technologies.

Educational level: With the level of education, there is a high probability of practicing a new technology. It was hypothesized to be positive because higher educational level will enable the practicing of the new technologies. Studies have indicated that the higher the level of education, the higher the probability of learning more about a particular technology which is easily practiced (e.g. Lapar and Ehui, 2003; Adesina et al., 2000).

Average annual income: This is another factor that can also influence the practice of new technologies with a positive relationship because as income increases, there is a high propensity of exploring more into a new technology thereby practicing it. This is consistent with findings of Green and Ng‟ong"ola (1993) who observed access to capital have a positive effect on the practice of new technologies.

Production of other crops: This factor affects the practicing of new technologies and it was hypothesized to have positive or negative relationships because if a high returns is obtained from producing other crops then there is a high propensity to practice other new technologies. Likewise a low returns from the other crops will cause one not to practice any new technology.

Farming experience: The number of years in farming can lead to a high tendency of practicing a new technology. Hence, farming experience was hypothesized to have a positive relationship with the adoption of new technology. In this respect, experience improves one's decision-making skills to determine whether the adoption of the technology will ensure high profit and this influences the farmers' willingness to practice a given technology (Kebede *et al*., 1990; Pannin, 1998; Kaliba *et al*., 2000).

Awareness: Awareness is one of the basic factors that can influence the decision to practice a new technology. It has a positive relationship because the more one is aware of a particular technology, the more information he/she has about its use and the better the understanding required for practicing that technology (Udoh *et al*., 2008).

Marginal Effects Estimation

The marginal effect is the measure of change in the probability of an event occurring as a result of a unit change in the value of the explanatory variables. It is described as change in dependent variable as a result of a unit change in the independent variable. In a linear regression model, the regression coefficient model can be interpreted as a marginal effects whiles in non-linear regression model, the regression coefficient model cannot be interpreted as a marginal effects. STATA, the software used for the analysis provides the marginal effects of the explanatory variables.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the study. It describes the socio-economic characteristics of the respondents with regards to their awareness and the extent to which they understand the use of the Integrated Crop Management (ICM) technology. This chapter also discusses the comparison between the integrated crop management technology with the conventional method using cost-benefit analysis. Finally, this chapter also discusses the factors influencing the practice of the integrated crop management technology.

4.2 Socio-Economic Characteristics of Respondents

Table 4.1 shows the socio-economic characteristics of the respondents. These included household size age, gender, and the average annual income. The household size of respondents ranges from 1 to 12. Majority (60.8%) of the households were between the ranges of 4 to 6 and very few (0.8%) of them ranged from 10 to 12. Considering the ages also of the respondents in table 4.1, considerable proportion (26.7%) was within the range of 36-40 years whereas those who fall within the range of 56-60 years were few (0.8%). Gender of respondents as presented in table 4.1 also indicated that 90 of them were males and 30 were females with percentages of 75 and 25 respectively.

Table 4.1: Socio-economic Characteristics of Respondents

Socio-economics characteristics	Frequency	Percentage
Household size		
1-3	20	16.7
4-6	73	60.8
7-9	26	21.7
10-12	1	0.8
Age		
25-30	22	18.3
31-35	16	13.3
36-40	32	26.7
41-45	22	18.3
46-50	22	18.3
51-55	4	3.3
56-60	2	1.7
Gender		
Male	90	75
Female	30	25

Source: *Author's computation from field*

Table 4.2 also shows the means and standard deviations of household size, age and average annual income of respondents. Household size had a minimum number of 1 and this is common to the farmers who were single and a maximum number of 10, with the mean household size of 5 and standard deviations of 1.662. The minimum age was 25 years and the oldest respondent was 57 years. The mean age was 40 years and the standard deviation was 7.544. The minimum annual income of vegetable farmers sampled was GH¢500 and the maximum income was GH¢ 17,000 with a mean average annual income as 2877.500 and a standard deviation of 3763.328.

Table 4.2: Socio-economic Characteristics of Respondents (Continue)

Socio-economic characteristics	Minimum	Maximum	Mean	Standard Deviation
Household size	1	10	5.192	1.662
Age of respondents	25	57	39.783	7.544
Average annual income (GHS)	500	17000	2877.500	3763.328

4.3 Level of Awareness of Integrated Crop Management (ICM) Technology

Table 4.3 showed the level of awareness of Integrated Crop Management (ICM) technology using percentages. The analysis indicated that majority of the respondents (62.5%) had no idea about the ICM technology. The reason for this result could be due to the low level of agricultural extension activity in the area.

Table 4.3: Level of Awareness of Integrated Crop Management Technology

Level of Awareness	Frequency	Percentage
Aware	45	37.50
Not Aware	75	62.50
Total	120	100.00

4.4 The Extent of Understanding the use of ICM Technology

The respondents indicated their extent of understanding the importance of using the ICM technology through the use of some selected agricultural practices such as crop rotation, intercropping, application of manure and application of crop residues (Table 4.4). Out of 120 respondents, 68% had a complete understanding concerning the use of crop rotation because most of them cultivate other crops whenever the vegetable crop season was over. Considering intercropping only 33% of the respondents had a complete understanding.

Most of the respondents (53%) were using inorganic fertilizer such as NPK 15:15:15 and 47% of the respondent farmers apply organic manure to their vegetable in order to improve yield.

Table 4.4: Extent to which farmers understand the use of integrated crop management technology

Integrated crop management Practices	No understanding	Slight understanding	Complete understanding	Total
Crop rotation				
Frequency	17	22	81	120
Percentages	14.17	18.33	67.50	100.00
Intercropping				
Frequency	49	32	39	120
Percentages	40.83	26.67	32.50	100.00
Manure Application				
Frequency	33	1	56	120
Percentages	27.50	25.83	46.67	100.00
Application of crop residue				
Frequency	38	23	59	120
Percentages	31.67	19.17	49.17	100.00
Weeding				
Frequency	5	31	84	120
Percentages	4.17	25.83	70.00	100.00
Irrigation				
Frequency	6	43	71	120
Percentages	5.00	35.83	59.17	100.00
Mulching				
Frequency	52	21	47	120
Percentages	43.33	17.50	39.17	100.00

Respondents who were incorporating more of the crop residue were about 49% indicating that they had a complete understanding with this practice. Percentage of respondents who were weeding rather than applying herbicides for weed control was 70%. Majority of respondents (59%) did more irrigation as well as depending on rainfall since cabbage and onions needed more water for growth. The percentage of respondents who had a complete understanding with regards to mulching at the early stages to enhance growth was 39%. Further, details of the statistics (i.e. percentages) are reported in table 4.4.

4.5 Capital costs of vegetable produced using the conventional method (CM) and Integrated Crop Management (ICM) Technology

Table 4.5 indicates initial capital cost for the conventional method and the ICM technology. All capital costs are the same for the two methods of production, except that the knapsack sprayer was not used for the ICM technology hence resulting in total capital costs of GHS729.75 and GHS 682.50 respectively.

Table 4.5: Estimated Capital Cost of Vegetable Production

Equipment	Quantity		Unit Price (GHS)	Value (GHS)		Useful Life (Yrs)
	CM	ICM		CM	ICM	
Knapsack	1	-	45.00	45.00	-	3
Watering can	1	1	25.00	25.00	25.00	2
Wellington boot	1	1	20.00	20.00	20.00	2
Pipes	11	11	26.00	286.00	286.00	5
Hoes	2	2	18.00	36.00	36.00	2
Cutlass	2	2	17.00	34.00	34.00	2
Wheelbarrow	1	1	80.00	80.00	80.00	5
Tape measure	2	2	35.00	70.00	70.00	3
Shovel/Spade	2	2	17.00	34.00	34.00	2
Pumping machine	1	1	65.00	65.00	65.00	5
Sub-Total				695.00	650.00	
Contingency (5%)				34.75	32.50	
TOTAL				729.75	682.50	

The initial capital costs for both the conventional method and the ICM technology had a 5% contingency (GHS 34.75 and GHS 32.50 respectively) in order to cater for any additional costs due the unstable prices. Some capitals items such as cutlass, hoe, wellington boots and watering can with a useful life of 2 years are replaced in the third year. For the third year cost of capital was GHS156.45 including the other capital items whose life span not exceeded two years. Tape measure and the knapsack sprayer with a useful life of 3 years are also replaced in the fourth year. An amount of GHS120.75 was spent on the capital item including those whose useful life exceeded 3 years but for the

ICM technology an amount of 73.5 was spent because the cost of knapsack sprayer was not added since no inorganic chemical was used for spraying.

4.6 Cash flow projections

The conventional method and the integrated crop management had cash flow projections for a period of five years and this can be found in appendices 8 and 9. This included firstly the cash flows for the farm with a combination of the cabbage and onion enterprises. Secondly different cash flow projections found in appendices 4, 5, 6 and 7 were prepared for the individual enterprises (cabbage and onion separately). For the conventional method cost of materials, other labour activities and services such as administrative and marketing cost varied with respect to revenue but other activities such as nursery management which had an amount of GHS 60.80 and bed preparation with an amount of GHS 15.98 were constant throughout the years. This was due to the fact that labourers were charging a specific amount and revenue had no effects on them. Repairs and maintenance increased year by year since the capital items depreciated along years. A 10% contingency was estimated to cater for any extra cost since these variable items such as seeds and fertilizers increases with respect to changes in prices. This amounted to GHS 93.87 in the first year and kept increasing till the five years with an amount of GHS 294.19. The total operating cost increased from year one with an amount of GHS 1032.52 to GHS 3236.06 in year five. The total cash outflow included both the total operating cost and the capital costs which increased from year one but decreased in year two because no item capital item was replaced in that year. There was an increase in the third year to the year five. The net cash flow was as a result of the difference between the cash outflows (costs) from the cash inflows (returns).

For the integrated crop management technology, the cost of materials only included seeds and fertilizers because it discourages the use of synthetic chemicals such as insecticides and herbicides. The costs of materials other labour activities also varied with respect to revenue as well as services which included administrative and marketing cost. Nursery management and bed preparation were constant and there was no variation with proportion to revenue. The amount was GHS 51.50 and GHS 11.21 respectively. Repairs and maintenance increased year by year since the capital items depreciated along the years. A 10% contingency was estimated to cater for any additional costs since these variable items such as seeds and fertilizers increases with respect to changes in prices. The 10% contingency estimated amounted to GHS 120.72 in the first year and kept increasing till the five years with an amount of GHS 222.179. The total operating cost increased from the first year to the fifth year with an amount of GHS 1,334.66 to GHS 2,450.71 respectively. The total cash outflow included both the total operating cost and the capital costs as well which decreased in the second year because there was no item replaced in that year. It then increased from year three to year five. The result of the net cash flow was the difference between the cash outflows (costs) from the cash inflows (returns).

The two enterprises were separated and a cash flow projection was prepared for the cabbage and onion using both methods. In the second year for cabbage using the conventional method, there was a decreased in the total cash outflow since no item was replaced in that year. The total cash outflow was high in the first year with a value of GHS 1534.85 as compare to the revenue of GHS 1,384.96 hence leading to a negative net cash flow of GHS149.89. This result indicated that the initial cost of production was high as compared to the revenue obtained from selling the yields at a particular price. The value of the net cash flow was positive from the second year through to the fifth year indicating that the revenues in those years were greater than the costs. Cabbage cultivated under the integrated crop management technology had positive net cash flows for the five years because the costs were lower than the revenues. The net cash flows increased from year one through to year five with an amount of GHS 823.60 and GHS 2,992.80 respectively. The lower costs were as a result of the absence of the insecticides and the herbicides. Onion produced under the conventional also had a negative net cash flow with a value of GHS 186.55 in the first year due to the high initial costs of GHS 1086.64 invested in the first year with lower revenue of GHS 900.09 obtained in that same year. The net cash flow was positive from year two through to year five. As compared to the onion produced under the integrated crop management technology, the net cash flows were positive throughout the five years and increased from GHS 2,270.92 in the first year through to the fifth year with a value of GHS 6,337.86 since the total cash outflows were lower than the revenues in the subsequent years.

4.7 Project worth Analysis under the Conventional and Integrated Crop Management Methods of Production

This section reveals the project worth analyses the two methods of vegetable production.

4.7.1 Net Present Value (NPV), Benefit-Cost Ratio, and Incremental Net Present Value Analyses

Tables 4.6 and 4.7 show the discounted cash flow for cabbage produced under the conventional method and integrated crop management respectively. The Net Present Values for the two methods were GHS 2152.6 and GHS 3054.44, respectively at a discount rate of 28% (lending rate of Agricultural Development Bank). Benefit Cost Ratio (BCR) analysis performed for farmers' producing cabbage under the conventional method and integrated crop management technology indicated ratios of 1.58 and 2.08, respectively.

Table 4.6: Discounted Cash Flow for Cabbage Using the Conventional Method

Cash Flows	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows	1,384.96	2,086.64	2,788.32	3,125.36	3,575.20
Cash Outflow	1,534.96	1103.44	1,554.95	1,672.47	1,718.53
Net Cash Flow	-150.00	983.20	1233.37	1452.89	1856.67
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Flow	-117.19	600.10	588.12	541.24	540.36
NPV@ 28% = GHS 2152.63					
BCR @ 28% = 1.58					

Table 4.7: Discounted Cash Flow for Cabbage Using the ICM Technology

Cash Flows (GHS)	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows	1,384.96	2,086.64	2,788.32	3,125.36	3,575.20
Cash Outflow	1,340.40	800.02	1119.14	1,140.62	1,173.32
Net Cash Flow	44.56	1,286.62	1,669.18	1,984.74	2,401.88
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash flow	34.8125	785.2905	795.927	739.3733	699.0391
NPV@28%= GHS 3054.44perHa					
BCR @ 28% = 2.08					

Tables 4.8 and 4.9 also showed the discounted cash flow for onion produced under the conventional method and integrated crop management respectively. The measures of project worth revealed a Net Present value (NPV) of GHS 5021.34 and GHS 8970.76, respectively. The Benefit Cost Ratio (BCR) analysis performed for onion production under the conventional method and the integrated crop management technology were 2.69 and 4.36, respectively.

Table 4.8: Discounted Cash Flow for Onion Using the Conventional Method

Cash Flows (GHS)	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows	900.09	2,576.97	4,253.85	5,127.23	6,113.40
Cash Outflow	1086.64	753.81	1303.89	1506.32	1650.88
Net Cash Flow	-186.55	1,823.16	2,949.96	3,620.91	4,462.52
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Flow	-145.742	1112.769	1406.651	1348.894	1298.764
NPV@28%= GHS 5021.34					
BCR @ 28% = 2.69					

Table 4.9: Discounted Cash Flow for Onion Using the ICM Technology

Cash Flows (GHS)	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cash Inflows	3,600.36	3,927.11	4,253.85	5,877.30	7,598.55
Total Cash Outflow	1329.44	702.75	910.67	1072.57	1260.69
Net Cash Flow	2,270.92	3,224.36	3,343.18	4,804.73	6,337.86
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Flow	1774.156	1967.993	1594.152	1789.901	1844.56
NPV @28%=GHS 8970.76					
BCR @ 28% = 4.36					

Tables 4.10 and 4.11 showed the combination of the two enterprises of cabbage and onion (whole farm). The Net Present Values for farmers producing both vegetables under the conventional method and the integrated crop management technology were GHS 8127.58 and GHS 14290.23, respectively. The Benefit Cost Ratio (BCR) for farmers

producing both vegetables under the conventional method and the integrated crop management technology were 2.42 and 3.9, respectively.

Table 4.10: Discounted Cash Flow for Whole Farm Using the Conventional Method

Cash flows(GHS)	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflow	2,285.05	4,663.61	7,042.17	8,252.59	9,575.80
Cash Outflow	1,762.27	1735.15	2,615.15	2,949.13	3,236.06
Net Cash flow	522.78	2,928.46	4,427.02	5,303.46	6,339.74
Discount Factor @ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash flow	408.42	1787.39	2110.97	1975.69	1845.11
NPV @ 28% = GHS 8127.58					
BCR @ 28% = 2.42					

Table 4.11: Discounted Cash Flow for Whole Farm using the ICM Technology

Cash Flows	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflow	5,764.36	6,677.28	7,590.20	9,579.20	11,666.87
Cash Outflow	2,017.16	1508.24	1833.25	2,115.57	2,450.71
Net Cash Flow	3,747.20	5,169.04	5,756.95	7,463.63	9,216.16
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Flow	2927.50	3154.93	2745.13	2780.42	2682.26
NPV @ 28% = GHS 14290.23					
BCR @ 28% = 3.93					

Cabbage production under both methods was viable. However, the incremental NPV of GHS 2563.58 as shown in table 4.12 revealed that cabbage produced under the integrated crop management technology is more viable as compared to the cabbage production under the conventional method. Furthermore, the incremental NPV GHS 3949.43 as shown in table 4.13 revealed that onion produced under the integrated crop management technology is more viable than that of the conventional method. The incremental NPV for the whole farm enterprise was GHS 6162.75 as shown in table 4.14 confirming the earlier results that the integrated crop management is more viable as compared to the conventional method.

Table 4.12: Incremental Discounted Cash Flow for Cabbage

Year	NCF of "With" Project (GHS)	NCF of "Without" Project (GHS)	Incremental NCF (GHS)	DF @ 28%	Discounted Incremental (GHS)
1	823.60	-149.89	973.49	0.7813	760.54
2	1,950.15	983.20	966.95	0.6104	590.18
3	2,217.21	1,233.37	983.84	0.4768	469.13
4	2,561.72	1,452.89	1,108.83	0.3725	413.07
5	2,992.80	1,856.67	1,136.13	0.2910	330.66
ΔNPV=GHS 2563.58					

Table 4.13: Incremental Discounted Cash Flow for Onion

Year	NCF of "With" Project (GHS)	NCF of "Without" Project (GHS)	Incremental NCF (GHS)	DF @ 28%	Discounted Incremental (GHS)
1	2,270.92	-186.55	2,457.47	0.7813	1919.90
2	3,224.35	1,823.16	1,401.19	0.6104	855.22
3	3,343.19	2,949.96	393.23	0.4768	187.51
4	4,804.73	3,620.91	1,183.82	0.3725	441.01
5	6,337.86	4,462.52	1,875.34	0.2910	545.80
ΔNPV=GHS 3949.43					

Table 4.14: Incremental Discounted Cash Flow for Whole Farm

Year	NCF of "With" Project (GHS)	NCF of "Without" Project (GHS)	Incremental NCF (GHS)	DF @ 28%	Discounted Incremental (GHS)
1	3,747.20	522.78	3,224.42	0.7813	2519.1
2	5,169.20	2,928.46	2,240.74	0.6104	1367.6
3	5,756.95	4,427.02	1,329.93	0.4768	634.16
4	7,463.63	5,303.46	2,160.17	0.3725	804.73
5	9,216.16	6,339.74	2,876.42	0.2910	837.15
ΔNPV=GHS 6162.75					

Table 4.15 presents a summary of the measures of project worth (NPV and BCR) performed for farmers' operating under the conventional method (CM) and the Integrated Crop Management (ICM) Technology. This shows the production of vegetables using the ICM technology is more financially viable than using the conventional method.

Table 4.15: Summary of Project worth for both Methods of Production

	NPV@ 28%		BCR@ 28%		ΔNPV@ 28%
	CM	ICM	CM	ICM	
Cabbage	2152.63	3054.44	1.58	2.08	2563.58
Onion	5021.34	8970.76	2.69	4.36	3949.43
Whole farm	8127.58	14290.23	2.42	3.93	6162.75

Figure 4.1 gives a graphical representation the Net Present Values of famers' producing cabbage, onion and the combination of the two enterprises under the ICM technology and the conventional method. Both vegetables produced under the two methods of production had positive NPV's with the ICM technology showing high values of GHS 5021.34, GHS 8970.76, 14290.23 for cabbage, onion and the combination of the two enterprises, respectively.

Figure 4.1: Net Present Analyses for Cabbage, Onion and the Whole Farm under CM and ICM

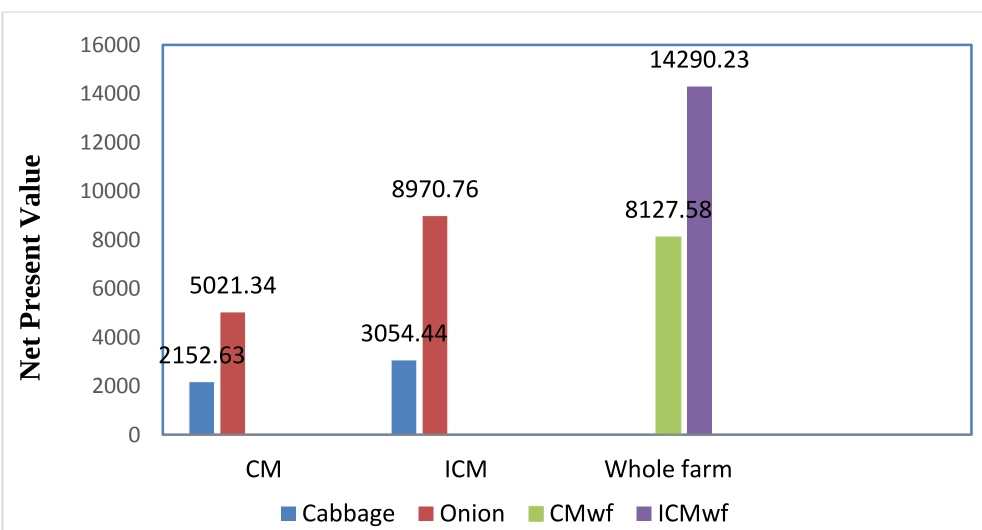


Figure 4.2 shows the benefit cost ratios for farmers' producing vegetables under both methods. Though both methods had their BCR's greater than one, the ICM technology was higher with values of 2.08, 4.36 and 3.93 than the conventional method.

Figure 4.2: Cost-Benefit Analyses for Cabbage, Onion and the Whole Farm under CM and ICM

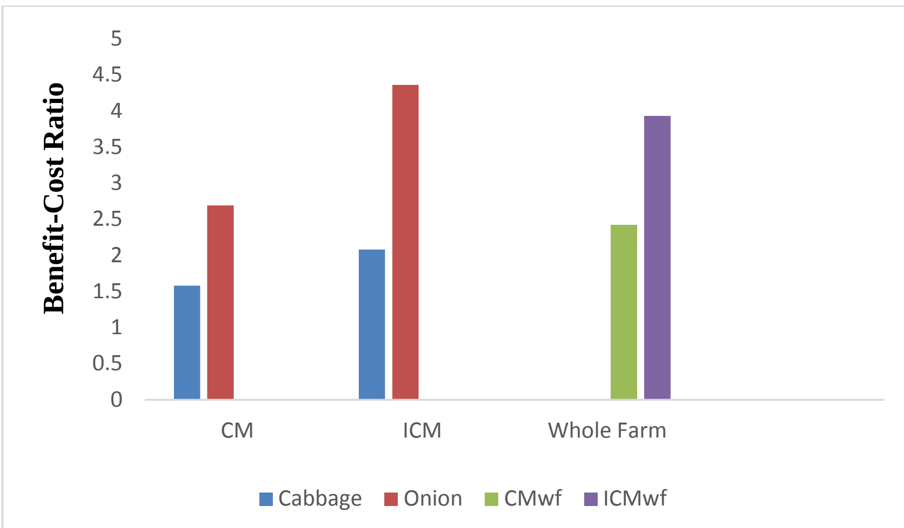
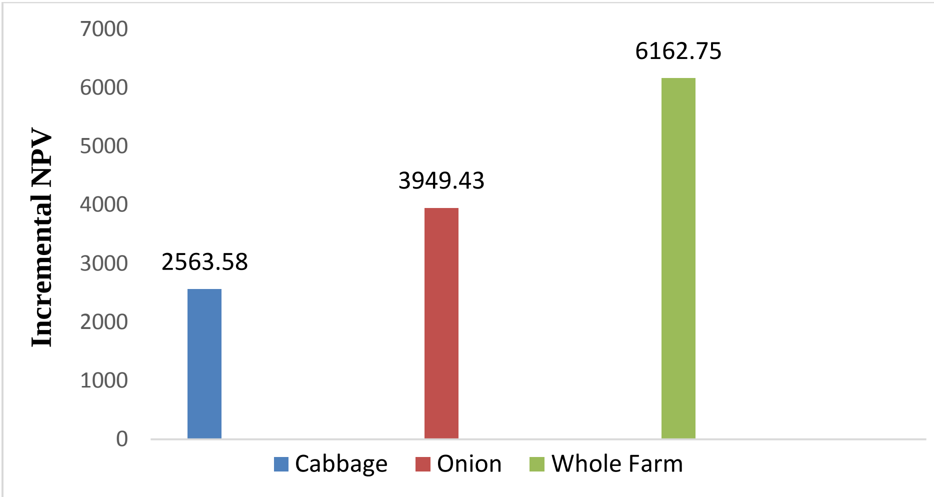


Figure 4.3 presents the incremental NPV performed for farmers' producing cabbage, onion and the combination of the two enterprises under the conventional method and the integrated crop management technology. The incremental NPV's revealed that vegetables produced under the ICM technology are more viable as compared to the vegetable production under the conventional method.

Figure 4.3: Incremental Net Present Value Analyses for Cabbage, Onion and the Whole Farm under CM and ICM



4.7.2 Sensitivity Analysis of project worth

The sensitivity analyses under the assumption of 5% reduction in yield and a 10% cost over-run found in tables 4.16 and 4.17 also indicated positive NPV's for cabbage produced under the conventional method and integrated crop management technology with values of GHS 257.11 and GHS 4055.16 respectively.

Table 4.16: Sensitivity Analysis for Cabbage Using the Conventional Method

Cash Flow	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows	2,286.88	3,054.51	3,822.14	4,496.35	5,170.56
5% Reduction	2172.54	2901.78	3631.03	4271.53	4912.03
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Inflow	1697.29	1771.11	1731.41	1591.27	1429.59
Cash Outflow	1,534.96	1103.44	1,554.95	1,672.47	1,718.53
10% Cost over-run	1611.71	1158.61	1632.70	1756.09	1804.46
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Outflow	1611.71	1158.61	1632.70	1756.09	1804.46
NPV @ 28% = GHS 257.11					

Table 4.17: Sensitivity Analysis for Cabbage Using ICM Technology

Cash Flow	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cash Inflows	2,164.00	2,750.18	3,336.35	3,702.34	4,166.12
5% Reduction in yield	2055.8	2612.671	3169.533	3517.223	3957.814
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Inflow	1606.09	1594.65	1511.35	1310.27	1151.88
Cash Outflow	1,340.40	800.02	1119.14	1,140.62	1,173.32
10% Over-run	1474.44	880.02	1231.05	1254.68	1290.65
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Outflow	1151.91	537.12	587.01	467.41	375.63
NPV @ 28% =GHS 4055.16					

Tables 4.18 and 4.19 also showed the sensitivity analyses under the assumption of 5% reduction in yield and a 10% cost over-run. This was performed for onion farmers' producing under the conventional method and the integrated crop management technology. The Net Present Value (NPV) for the ICM technology was still higher at a value of GHS 8121.99 than the conventional method which also recorded an NPV of GHS 4324.41.

Table 4.18: Sensitivity Analysis for Onion Using the Conventional Method

Cash Flow	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows	900.09	2,576.97	4,253.85	5,127.23	6,113.40
5% Reduction	855.09	2448.12	4041.16	4870.87	5807.73
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Inflow	668.04	1494.21	1926.97	1814.54	1690.27
Cash Outflow	1086.64	753.81	1303.89	1506.32	1650.88
10% cost over-run	1195.30	829.19	1434.28	1656.95	1815.97
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Outflow	933.83	506.10	683.92	617.26	528.52
NPV @ 28% = 4324.41					

Table 4.19: Sensitivity Analysis for Onion Using the ICM Technology

Cash Flow	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cash Inflows	3,600.36	3,927.11	4,253.85	5,877.30	7,598.55
5% Reduction in yield	3420.34	3730.75	4041.16	5583.44	7218.62
Discount Factor@ 27.9%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Inflow	2672.14	2277.07	1926.97	2079.99	2100.90
Total Cash Outflow	1329.44	702.75	910.67	1072.57	1260.69
10% cost over-run	1462.38	773.03	1001.74	1179.83	1386.76
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Outflow	1142.49	471.82	477.67	439.52	403.60
NPV @ 28% = 8121.99					

Tables 4.20 and 4.21 also show the sensitivity analyses performed for the whole farm enterprise (i.e. combination of cabbage and onion production) for both the conventional method and the integrated crop management technology under the assumption of 5% reduction in yield and a 10% cost over-run. The Net Present Value for the whole farm vegetable production under the integrated crop management technology was revealed to have a higher value of GHS 12844.92 as compared to the conventional method (GHS 6862.71).

Table 4.20: Sensitivity Analysis for Whole Farm Using the Conventional Method

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows	2,285.05	4,663.61	7,042.17	8,252.59	9,575.80
5% Reduction in Yield	2170.80	4430.43	6690.06	7839.96	9097.01
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Inflow	1695.94	2704.12	3190.07	2920.61	2647.58
Cash Outflow	1,762.27	1735.15	2,615.15	2,949.13	3,236.06
10% cost over-run	1938.50	1908.67	2876.67	3244.04	3559.67
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Outflow	1514.451	1164.95667	1371.701	1208.5	1035.9992
NPV @ 28% = 6862.71					

Table 4.21: Sensitivity Analysis for Whole Farm Using the ICM Technology

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflow	5,764.36	6,677.28	7,590.20	9,579.20	11,666.87
5% Reduction In Yield	5476.14	6343.42	7210.69	9100.24	11083.53
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Inflow	4278.24	3871.71	3438.32	3390.10	3225.73
Cash Outflow	2,017.16	1508.24	1833.25	2,115.57	2,450.71
10% Cost over-run	2218.88	1659.06	2016.58	2327.13	2695.78
Discount Factor@ 28%	0.7813	0.6104	0.4768	0.3725	0.2910
Discounted Cash Outflow	1733.50	1012.61	961.58	866.92	784.58
NPV @ 28% = GHS 12844.92					

4.8 Logit Regression of the factors influencing farmers' practice of Integrated Crop Management Technology

Table 4.22 presents the results of the Logit regression model. The pseudo R^2 of 0.6141 indicates that about 61% of the variation in the farmers' practice of the ICM technology is jointly influenced by the independent variables. The probability value of 0.000 of the Wald chi-square statistic (38.18) suggests that the independent variables jointly explained the farmers' practice of the ICM technology. The empirical results revealed that gender and awareness were statistically significant at 10% and 1% respectively. Both significant variables showed a positive relationship with respect the practice of integrated crop management (ICM) technology by the vegetable farmers. Thus, being aware of the technology and being a male farmer had a positive influence on farmers' practice of ICM technology. The marginal effect of the gender variable indicates that being a male vegetable farmer in the area will increase the likelihood of practicing the ICM technology by 5.8%. Gender being positive implies that more of male vegetable farmers will practice the ICM technology than females. This result is consistent with Doss (2001) that males are able to use or practice new technology as compared to females. Awareness had a positive influence on the practice of the ICM technology. The marginal effect of the awareness variable suggests that being aware will increase farmer's probability of practicing the ICM technology by 36.3%. This result is consistent with Udoh *et al.*, (2008) on socio-economic factors influencing the adoption of new technology.

It is worthy to note that, the variables "Extension", "Level of Understanding", an interaction term of "Extension and Level of understanding" and an interaction term of "Extension and Awareness" were not significant and also distorted the parsimonious specification of the regression model. Hence, these variables were treated as redundant variables and therefore eliminated from the model.

Table 4.22: Logit regression model estimates of the factors influencing farmers' practice of ICM technology

Variables	Marginal effect	Std. Err	P-value
GEN	0.058*	0.035	0.099
HH	-0.005	0.011	0.673
AGE	0.004	0.003	0.147
EDU	-0.003	0.024	0.909
AI	-0.000	0.000	0.106
FARMEXPE	-0.009	0.000	0.183
POC	-0.099	0.084	0.235
AWA	0.363***	0.117	0.002

Note: *, *** signifies 10% and 1% significant levels Pseudo R^2 = 0.6141
wald chi-squared =38.18 Prob > chi-squared = 0.000 N = 120

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of major finding, conclusions, recommendations, limitations and suggestions for future research.

5.2 Summary of Major Findings

In comparing cost benefit analysis of using the Integrated Crop Management (ICM) technology and the convention method among vegetable farmers in the Lower Manya Krobo District, four objectives were achieved for the study. The study described the level of awareness of the ICM technology among the vegetable farmers. In addition, the study described the extent to which the vegetable farmers understand the importance of using the ICM technology. Furthermore, the study compared the costs and benefits of the ICM technology with the conventional method. A Cash flow projection was estimated for five years for the whole farm and the individual enterprises for both methods of production. The discounting measures of project worth were used. The results indicate that production of vegetables under both methods appears financially viable. However, the results further suggest that vegetable production under the ICM technology is more financially viable than the conventional method. Moreover, the incremental NPV showed that the ICM technology is more financially viable for both cabbage and onion enterprises, as well as for the whole farm enterprise. A sensitivity analysis was also conducted with a 5% decrease in yield and a 10 % cost over-run but the NPV for both methods were positive, for which the NPV obtained for the ICM technology was higher

NPV for the conventional method. Finally the study also identified and estimated the factors influencing the practice of the ICM technology among the vegetable farmers using the Logit regression model. The empirical results revealed that gender and awareness were statistically significant at 10% and 1% respectively. Both significant variables showed a positive relationship with respect to the practice of Integrated Crop Management (ICM) technology by the vegetable farmers. Thus, being aware of the technology and being a male farmer had a positive influence on farmers' practice of ICM technology.

5.3 Conclusions

The outcome of the study showed that the Integrated Crop Management (ICM) technology had a higher BCR as compared to the conventional method. Even though both methods are financially viable, the ICM technology is more viable financially.

The two methods had positive NPVs but the incremental NPV showed that the ICM technology is more viable financially as compared to the conventional method.

The discounted cash flow for cabbage produced under the conventional method and integrated crop management respectively. The Net Present Values for the two methods were GHS 2152.6 and GHS 3054.44, respectively at a discount rate of 28% (lending rate of Agricultural Development Bank). Benefit Cost Ratio (BCR) analysis performed for farmers' producing cabbage under the conventional method and integrated crop management technology indicated ratios of 1.58 and 2.08, respectively.

The discounted cash flow for onion produced under the conventional method and integrated crop management respectively. The measures of project worth revealed a Net Present value (NPV) of GHS 5021.34 and GHS 8970.76, respectively. The Benefit Cost Ratio (BCR) for onion production under the conventional method and the integrated crop management technology were 2.69 and 4.36, respectively.

The NPV and BCR of the combination of the two enterprises of cabbage and onion (whole farm) were also computed. The Net Present Values for farmers producing both vegetables under the conventional method and the integrated crop management technology were GHS 8127.58 and GHS 14290.23, respectively. The Benefit Cost Ratio (BCR) for farmers producing both vegetables under the conventional method and the integrated crop management technology were 2.42 and 3.9, respectively.

Although, cabbage production under both methods was viable, however, the incremental NPV of GHS 2563.58 revealed that cabbage produced under the integrated crop management technology is more viable than the cabbage production under the conventional method. Furthermore, the incremental NPV GHS 3949.43 revealed that onion produced under the integrated crop management technology is more viable than that of the conventional method. The incremental NPV for the whole farm enterprise was GHS 6162.75 confirming the earlier results that the integrated crop management is more viable as compared to the conventional method.

Moreover, the sensitivity analyses also indicated a positive NPVs for both methods even though the there was a 5% reduction in yield and a 10% cost over-run. The NPV of the ICM technology was still higher than that of the conventional.

The empirical results of the Logit regression revealed that gender and awareness were statistically significant at 10% and 1% respectively. Both significant variables showed a positive relationship with respect the practice of Integrated Crop Management (ICM) technology by the vegetable farmers. Thus, being aware of the technology and being a male farmer had a positive influence on farmers' practice of ICM technology.

5.4 Recommendations

The study provides the following recommendations.

Extension officers should do their best to inform farmers about the use of the ICM technology since it combines most of the best farming practices to improve crop yield. This can be effective when training sessions are organized for these farmers since awareness is a significant variable influencing the practice of the ICM technology. In this respect, the extension programs should target male farmers as they are more likely to practice the ICM technology than their female counterparts.

Farmers are also encouraged to use the ICM technology in order to reduce the cost of insecticides and herbicides used in controlling insects and weeds respectively. Its use should be encouraged because incremental NPV resulting from the practice of ICM technology was positive, indicating that the ICM technology is more financially viable.

5.5 Limitations

First, the study is limited to only two commodities (i.e. cabbage and onion) in the Manya Krobo District of the Eastern Region of Ghana.

The second limitation stems from the lukewarm attitude of some of the farmers in providing information for the study.

5.6 Suggestions for future research

This study has been carried out among vegetable farmers in the Manya Krobo District of the Eastern Region of Ghana. Therefore, extending this research to other agricultural commodities in other regions of Ghana is an opportunity for future research agenda.

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APPENDICES

APPENDIX 1

SAMPLE QUESTIONNAIRE

Please tick where necessary.

Date of interview: ……………………………….

Code [ ]

A. Socio – Economic characteristics of the farmers

1. Gender 1 = Male [ ] 0 = Female [ ]

2. Household size …………………………………………

3. Age of respondent ………………………………………….

4. Highest Educational Qualification obtained
0 = None [ ] 1 = Primary [ ] 2= JHS [ ] 3 =SHS/Vocational/Technical [ ]
4= Tertiary [ ] Other (specify) ……………………………………………

5. Marital status 1=Single [ ] 2=Married [ ] 3=Divorce/separated [ ]
4=Widow/widower [ ]

6. What is your average annual income from your vegetable crop(s)? ……………………………

B. Information from respondents on farm-level basis

7. For how long have you been cultivating vegetables? ………………. years

8. What land form do you use for your vegetable cultivation?

1= Flat land [ ] 2= Beds [ ] 3= Ridges [ ] 4= Other (specify)…………………..

9. If bed is applicable how many beds do you cultivate your vegetable(s) on? ………………..

10. What is the dimension of the beds used for cultivation? ………………………….

11. Are you part of any membership of association? 1= Yes [ ] 0= No [ ]

12. If yes what is the name of that membership of association? ………………………………….

13. Do you have contact with extension officer(s)? 1= Yes [ ] 0= No [ ]

14. If yes, how often do they contact you? 1= weekly [ ] 2. Monthly [ ]

3. Others (specify) ……………………..

15. Do you own the land for your vegetable production? 1= Yes [ ] 0= No [ ]

16. Do you cultivate other crops aside vegetables? 1= Yes [ ] 0= No [ ]
17. How much do you get……………………………………………………..

17. How often do you harvest your produce during a cropping season?
1= Daily [ ] 2= Weekly [ ] 3= Twice a week [ ] 4= Monthly [ ]
Other (specify)…………………………………………

18. What is your minimum yield for the cropping season? ……..........................

19. What is your maximum yield for the cropping season? ....

20. Do you do any other business apart from farming? 1= Yes [ ] 0= No [ ]

If yes indicate the source of your income from your business.

Source	Amount
Remittance	
Salary	
Off-farm investment	

C. General Information on Vegetable Production

Information on Vegetables production and soil condition

21. What type of vegetable(s) do you cultivate?

1= Cabbage [ ] 2 = Onion [ ]

22. Reasons for cultivating that vegetable……………………………………………..

23. Where do you get your seeds for cultivation?

1 = Govt. agency (MoFA) [ ] 2 = Certified seed dealer [ ] 3 = Own field or old stock [ ] 4 = Friends or other farmers [ ] 5 = Others (specify) ……………………………………………..

24. In which months/season do you cultivate vegetable in your locality?

Please tick where appropriate crop with its corresponding months of cultivation

Vegetables	**Months/season of cultivation**
Cabbage	
Onion	

25. Do you irrigate your vegetable? 1= Yes [ ] 0= No [ ]

26. Which type of irrigation do you use?

1= flood [ ] 2 = Drip [ ] 3= Sprinkler [ ] 4 = Furrows [ ] 5=Manual [ ]

27. Which of the source (s) of water do you use for your irrigation?

1 =Volta lake [ ] 2= Rainwater or runoffs [ ] 3= Wells or boreholes [ ]

4 = Streams or rivers [ ] 5= Other specify ………………………………………………
28. How often do you irrigate your vegetables?

1 = Once daily [ ] 2 = Twice daily [ ] 3= every two days [ ]
4 = every three days [ ] 5 = other (specify) …………………………………….

29. Which of the following best describes the type of soil in your area?

Please tick and rank them in order of 1= most applicable and 3= least applicable

Soil type description	Tick where appropriate	Rank
Hard and cracks easily when dry		
Waterlogged		

Sticky when wet		
Massive(heavy)		
Low Fertility		
Other(specify)		

D. Information on Conventional Method and Integrated Crop Management of vegetable production

30. Do you use fertilizer for your vegetable production? 1= Yes [ ] 0 = No [ ]

31. If yes which type of fertilizer do you use? 1= Organic [ ] 0=Inorganic[ ]

32. If no why? ……………………………………………………………………………...

33. State the names of the fertilizers used for your vegetable production…………………

34. Do you know any possible side effect associated with the use of the conventional (traditional) method? 1 = Yes [ ] 0 = No [ ]

35. Do you experience any of side effects? 1= Yes [ ] 0= No [ ]

36. Are you aware of integrated crop management? 1= Yes [ ] 0= No [ ]

37. Do you practice integrated crop management? 1= Yes [ ] 0= No [ ]

38. Are you willing to use (adopt) the integrated crop management technology?

1= Yes [ ] 0= No [ ]

39. If yes to question Q37 which types of crops do you use in the integrated crop management?…………………………………………………………………………………

40. If no why?...

41. If yes to Q37 which of the following intercrops represent a practice of integrated crop management technology?

Please tick where appropriate

Vegetable	Intercrops	Tick
Cabbage	Onion	
	Pepper	
	Ginger	
	Tomato	
Onion	Lettuce	
	Cabbage	
	Tomato	
	Okro	

42. Do you intercrop your vegetables with other crops? 1= Yes [ ] 0= No [ ]

43. If yes which type of crop(s) do you intercrop with your vegetable(s)? ……………………

44. In using conventional method, do you attract any financial support to expand your vegetable production?

1= Yes [ ] 0= No [ ]

45. If yes where do ypu get your support from? ....

46. If no why? ....

47. Do you get other incentives besides the financial support provided?

1= Yes [ ] 0= No [ ]

48. If no why? ....

49. How do you transport your vegetable(s) from the farm to the market?

1=In Lorries and trucks [ ] 2= Head loads [ ] 3= Carts [ ]

4= other (specify)………………………………..

50. Do you think the integrated crop management approach is affordable? Yes [ ] No [ ]

51. Do you know that vegetables produced under the integrated crop management approach do not encourage the use inorganic inputs? Yes [ ] No [ ]

52. Do you support the idea of using the integrated crop management to achieve food safety? 1= Yes [ ] 0 = No [ ]

53. If yes to Q52, kindly give reasons for your support of integrated crop management technology?…………………………………………………………………………………

54. Which of the following would be your reason for practicing the integrated crop management technology? Please tick where appropriate.

Reasons for adopting ICM technology	Tick
Quality produce	
Requires minimal inputs	
Safe environment	
Sustainable management of pest and diseases	
Food safety	
Food security	

55. Do you know of any benefits of vegetables produced under the integrated crop management? 1= Yes [ ] 0= No [ ]

56. If yes to Q 52, please list them……………………………………………………

57. Do you know of a ready market for vegetable produced using the integrated crop management technology? 1= Yes [ ] 0=No [ ]

E. To measure the extent to which farmers understand the importance of using the ICM Technology

58. Please tick where appropriate.

Activities under the ICM	1= No Understanding 2= Slight understanding 3= Complete understanding
Crop rotation	
Intercropping	
Application of manure	
Applying crop residues	
Weeding	
Watering/irrigation	
Mulching	

F. To compare the costs and benefits of using the ICM technology with the conventional method

59. Please indicate the quantities and unit prices of the materials used for your vegetable cultivation.

MATERIAL INPUTS

	Conventional Method		**ICM Technology**	
	Quantity	**Unit Price(¢)**	**Quantity**	**Unit Price(¢)**
Land				
Seeds				
Other seeds for intercropping				
Fertilizer				
Pesticides				
Herbicide				
Number of beds				
Permanent labour				

	LABOUR					
	Conventional Method			**ICM Technology**		
Activities	**Quantity**		**Unit Price(¢)**	**Quantity**		**Unit Price(¢)**
	No.of workers	Duration of work	Rate ¢/manday	No. of workers	Duration of work	Rate ¢/manday
Ploughing						
Nursery management						
Herbicide application						
Bed preparation						
Transpl anting						
Fertilizer application						
Daily watering						
Harvesting						

Capital Item	**Quantity**	**Unit Price(¢)**	**Duration of usage**	**Year of acquisition**
Knapsack sprayer				
Watering can(s)				
Wellington boot(s)				
PVC pipes				
Hoes				
Cutlasses				
Garden Fork				
Garden Line				
Wheel barrow(s)				
Shears				
Hand Trowel				
Rake				
Tape Measure				
Shovel/Spade				
Other (specify):				

58. What is the revenue for your vegetable production?

Wet season					Dry season			
Types of vegetables harvested	Frequency of harvest per season	Number of harvest per season	Quantity per harvest	Unit Price	Frequency of harvest per season	Number of harvest per season	Quantity per harvest	Unit Price
Cabbage								
Onion								

APPENDIX 2

Average Operating Cash Flow for Whole Farm (Conventional Method)

	Quantity	Unit price (GHS)	Value (GHS)
Revenue:			
Wet season onion	1035	4.110	4,253.85
Wet season cabbage	2989	0.541	1,617.05
Dry season cabbage	2165	0.541	1,171.27
Residual value			112.8
Total inflows:			7,154.96
Operating cost:			
Materials:			
Wet season onion	0.9 Kg		362.3
Wet season cabbage	0.05Kg		100
Dry season cabbage	0.05 Kg		100
			562.3
Fertilizer:			
Wet season onion	138 Kg		178
Wet season cabbage	183 Kg		136
Dry season cabbage	188 Kg		160
			474
Pesticides:			
Wet season onion	3 Litres	15.00	45.00
Wet season cabbage	4 Litres	15.00	60.00
Dry season cabbage	3 Litres	15.00	45.00
			150.00
Herbicides:			
Wet season onion	4 Litres	15.00	60.00
Wet season cabbage	4 Litres	15.00	60.00
Dry season cabbage	4 Litres	15.00	60.00
			180.00
Sacks			
Wet season onion	1035		43.00
Wet season cabbage	2989		28.00
Dry season cabbage	2165		20.00
			91.00
Ploughing:			
Wet season onion	0.4 ha		64.00
Wet season cabbage	0.4 ha		69.00
Dry season cabbage	0.4 ha		72.00

205.00

LABOUR

	Quantity (man-hrs)	Unit price(GHS)	Value(GHS)
Nursery management:			
Wet season onion	10	2.08	20.8
Wet season cabbage	10	2.00	20
Dry season cabbage	10	2.00	20
			60.80
Bed preparation (onion only)			
Wet season onion	34	0.47	15.98
Wet season cabbage	-	-	-
Dry season cabbage	-	-	-
			15.98
Transplanting:			
Wet season onion	18	2.59	46.62
Wet season cabbage	15	2.88	43.20
Dry season cabbage	16	2.66	42.56
			132.38
Daily watering:			
Wet season onion	7	3.68	25.76
Wet season cabbage	6	3.00	18.00
Dry season cabbage	8	3.00	24.00
			67.76
Fertilizer application:			
Wet season onion	12	2.11	25.32
Wet season cabbage	10	3.00	30.00
Dry season cabbage	14	2.00	28.00
			83.32
Herbicide application:			
Wet season onion	7	3.00	21.00
Wet season cabbage	5	3.00	15.00
Dry season cabbage	5	3.00	15.00
			51.00
Harvesting:			
Wet season onion	16	2.63	42.08
Wet season cabbage	19	2.40	45.6
Dry season cabbage	18	2.00	36.00
			123.68

Total Operating Cost	2,197.22
Average Net Cash Flow	4,957.74

APPENDIX 3

Average Operating Cash Flow for Whole Farm (ICM Technology)

	Quantity	Unit price(GHS)	Value(GHS)
Revenue:			
Wet season onion	1035	4.110	4,253.85
Wet season cabbage	3607	0.541	1,951.39
Dry season cabbage	2560	0.541	1,384.96
Residual value			97.80
Total inflows:			7,688.00
Operating cost			
Materials:			
Major season onion seeds	0.69		289
Major season cabbage seeds	0.05		100
Minor season cabbage seeds	0.05		100
			489
Fertilizer:			
Major season onion	967 Kg		141.00
Major season cabbage	922 Kg		126.00
Minor season cabbage	933 Kg		138.00
			405.00
Sacks			
Major season onion	1035		43.00
Major season cabbage	3607		34.00
Minor season cabbage	2560		24.00
			101.00
Ploughing:			
Major season onion	0.4 ha		68.00
Major season cabbage	0.4 ha		68.68
Minor season cabbage	0.4 ha		58.33
			195.01

LABOUR

	Quantity (man-hrs)	Unit price(GHS)	Value(GHS)
Nursery management:			
Major season onion	13	1.40	18.20
Major season cabbage Minor season cabbage	11	1.50	16.50

	12	1.40	16.80
			51.50
Bed Preparation (onion only)			
Major season onion	19	0.59	11.21
Major season cabbage	-	-	-
Minor season cabbage	-	-	-
			11.21
Transplanting:			
Major season onion	10	2.00	20
Major season cabbage	7	2.00	14
Minor season cabbage	7	2.00	14
			48
Daily watering:			
Major season onion	3	2.00	6.00
Major season cabbage	3	2.00	6.00
Minor season cabbage	3	2.32	6.96
			18.96
Fertilizer application:			
Major season onion	8	2.00	16.00
Major season cabbage	8	2.00	16.00
Minor season cabbage	8	2.00	16.00
			48.00
Weeding:			
Major season onion	8	2.61	20.88
Major season cabbage	8	3.00	24.00
Minor season cabbage	8	3.00	24.00
			68.88
Harvesting:			
Major season onion	8	1.98	15.84
Major season cabbage	7	2.40	16.80
Minor season cabbage	8	2.33	18.64
			51.28
Total Operating Cost			1,487.84
Average Net Cash Flow			6,200.16

APPENDIX 4

Cash Flow Projections for Cabbage Using the Conventional Method

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue(GHS)					
Wet season cabbage	865.60	1241.33	1,617.05	1,847.25	2,077.44
Dry season cabbage	519.36	845.32	1,171.27	1,278.12	1,384.96
Residual value					112.8
Total Cash inflows	1,384.96	2,086.64	2,788.32	3,125.36	3,575.20
Capital Cost(GHS)	729.75	0	156.45	120.75	0
Operating Cost (GHS)					
Materials:					
Seeds	99.34	149.67	200.00	224.18	228.79
Fertilizer	147.02	221.51	296.00	331.78	379.53
Pesticide	52.15	78.58	105.00	117.69	134.63
Herbicide	59.60	89.80	120.00	134.51	153.86
Sacks	23.84	35.92	48.00	53.80	61.55
Ploughing	141.00	141.00	141.00	141.00	141.00
Nursery Management	40.00	40.00	40.00	40.00	40.00
Herbicide application	14.90	22.45	30.00	33.63	38.47
Transplanting	42.10	63.43	84.76	95.01	108.68
Fertilizer application	28.81	43.40	58.00	65.01	74.37
Daily watering	24.78	33.1	41.42	48.73	56.03
Harvesting	41.47	55.39	69.31	81.54	93.76
Repairs and maintenance	6.95	13.90	17.87	21.37	28.32
Administrative & marketing	9.93	14.97	20	22.42	25.64
Contingencies (10%)	73.19	100.31	127.14	141.07	153.90
Total Operating Cost	805.10	1103.44	1398.50	1551.72	1718.53
Total Cash Outflow	1534.85	1103.44	1554.95	1672.47	1718.53
Net Cash Flow	-149.89	983.20	1,233.37	1,452.89	1,856.67

APPENDIX 5

Cash Flow Projections for Cabbage Using the ICM Technology

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue(GHS)					
Major season cabbage	1,298.40	1,624.90	1,951.39	2,144.26	2,337.12
Minorseason cabbage	865.60	1,125.28	1,384.96	1,558.08	1,731.20
Residual value					97.80
Total Cash inflows	2,164.00	2,750.18	3,336.35	3,702.34	4,166.12
Capital cost(GHS)	682.50	0	156.45	73.5	0
Operating cost (GHS)					
Materials:					
Seeds	129.72	164.86	200	221.94	225.05
Fertilizer	171.23	217.62	264.00	292.96	329.66
Sacks	37.62	47.81	58.00	64.36	72.42
Ploughing	82.38	104.70	127.01	140.94	158.60
Nursery Management	33.30	33.30	33.30	33.30	33.30
Weeding	31.13	39.57	48.00	53.27	59.94
Transplanting	40.79	23.08	28.00	31.07	34.96
Fertilizer application	20.76	26.38	32.00	35.51	39.96
Daily watering	8.37	10.63	12.90	14.32	16.11
Harvesting	22.99	29.21	35.44	39.33	44.25
Repairs& maintenance	6.83	13.65	16.52	20.92	27.42
Administrative& marketing	12.97	16.49	20.00	22.19	24.97
Contingency (10%)	59.81	72.73	87.52	97.01	106.67
Total Operating Cost	657.90	800.02	962.687	1067.12	1173.32
Total Cash Outflow	1340.40	800.02	1119.14	1140.62	1173.32
Net Cash Flow	823.60	1,950.15	2,217.21	2,561.72	2,992.80

APPENDIX 6

Cash Flow Projections for Onion Using the Conventional Method

	YEAR1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue(GHS)					
Major season onion	900.09	2,576.97	4,253.85	5,127.23	6,000.60
Residual value					112.8
Total Cash inflows	900.09	2,576.97	4,253.85	5,127.23	6,113.40
Capital Cost(GHS)	729.75		156.45	120.75	0
Operating Cost (GHS)					
Materials:					
Seeds	76.66	219.48	362.30	436.69	520.68
Fertilizer	37.66	107.83	178.00	214.55	255.81
Pesticide	9.52	27.26	45.00	54.24	64.67
Herbicide	12.70	36.35	60.00	72.32	86.23
Sacks	9.10	26.05	43	51.83	61.80
Ploughing	64.00	64.00	64.00	64.00	64.00
Nursery Management	20.80	20.80	20.80	20.80	20.80
Bed preparation	15.98	15.98	15.98	15.98	15.98
Herbicide application	4.44	12.72	21.00	25.31	30.18
Transplanting	9.86	28.24	46.62	56.19	67.00
Fertilizer application	5.36	15.34	25.32	30.52	36.39
Daily watering	6.98	12.61	18.24	25.41	32.59
Harvesting	40.2	72.6	105	146.3	187.61
Repairs and maintenance	6.95	13.90	17.87	21.37	28.32
Administrative & marketing	4.23	12.12	20	24.11	28.74

Contingencies (10%)	32.44	68.53	104.31	125.96	150.07982
Total Operating Cost	356.89	753.81	1147.44	1385.57	1650.88
Total Cash Outflow	1086.64	753.81	1303.89	1506.32	1650.88
Net Cash Flow	-186.55	1,823.16	2,949.96	3,620.91	4,462.52

APPENDIX 7

Cash Flow Projections for Onion Using the ICM Technology

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue(GHS)					
Major season onion	3,600.36	3,927.11	4,253.85	5,877.30	7,500.75
Residual value					97.80
Total Cash inflows	3,600.36	3,927.11	4,253.85	5,877.30	7,598.55
Capital cost(GHS)	682.50	0	156.45	73.5	0
Operating cost (GHS)					
Materials:					
Seeds	244.60	266.80	289.00	399.29	516.23
Fertilizer	119.34	130.17	141.00	194.81	251.86
Sack	36.39	39.70	43.00	59.41	76.81
Ploughing	68.00	68.00	68.00	68.00	68.00
Nursery Management	18.20	18.20	18.20	18.20	18.20
Bed preparation	11.21	11.21	11.21	11.21	11.21
Weeding	17.67	19.28	20.88	28.85	37.30
Transplanting	16.93	18.46	20.00	27.63	35.73
Fertilizer application	13.54	14.77	16.00	22.11	28.58
Daily watering	5.078	5.54	6.00	8.29	10.72
Harvesting	13.41	14.62	15.84	21.89	28.29
Repairs and maintenance	6.83	13.65	16.52	20.92	27.42
Administrative & marketing	16.93	18.46	20	27.63	35.73
Contingencies (10%)	58.81	63.89	68.57	90.82	114.61
Total Operating Cost	646.94	702.75	754.22	999.07	1260.69
Total Cash Outflow	1329.44	702.75	910.67	1072.57	1260.69
Net Cash Flow	2,270.92	3,224.35	3,343.19	4,804.73	6,337.86

APPENDIX 8

Cash Flow Projections for Whole Farm Using the Conventional Method

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue(GHS)					
Wet season onion	900.09	2,576.97	4,253.85	5,127.23	6,000.60
Wet season cabbage	865.60	1241.33	1,617.05	1,847.25	2,077.44
Dry season cabbage	519.36	845.32	1,171.27	1,278.12	1,384.96
Residual value					112.8
Total Cash inflows	2,285.05	4,663.61	7,042.17	8,252.59	9,575.80
Capital Cost(GHS)	729.75		156.45	120.75	0
Operating Cost (GHS)					
Materials:					
Seeds	182.46	372.38	562.30	658.95	764.60
Fertilizer	153.80	313.90	474.00	555.47	644.54
Pesticide	48.67	99.34	150.00	175.78	203.97
Herbicide	58.41	119.20	180.00	210.94	244.76
Sacks	29.53	60.26	91.00	106.64	123.74
Ploughing	205.00	205.00	205.00	205.00	205.00
Nursery Management	60.80	60.80	60.80	60.80	60.80
Bed Preparation(onion only)	15.98	15.98	15.98	15.98	15.98
Herbicide application	16.55	33.77	51.00	59.77	69.35
Transplanting	64.86	87.67	132.38	155.13	180.01
Fertilizer application	27.04	55.18	83.32	97.64	113.30
Daily watering	21.99	44.87	67.76	79.41	92.14
Harvesting	40.13	81.91	123.68	144.94	168.18
Administrative & marketing	6.49	13.24	20	23.44	27.20
Repairs and maintenance	6.95	13.90	17.87	21.37	28.32
Contingency (10%)	93.87	157.74	223.51	257.13	294.19
Total Operating Cost	1032.52	1735.15	2458.60	2828.38	3236.06
Total Cash Outflow	1762.27	1735.15	2615.05	2949.13	3236.06
Net Cash Flow	522.78	2,928.46	4,427.12	5,303.45	6,339.74

APPENDIX 9

Cash Flow Projections for Whole Farm Using the ICM Technology

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue(GHS)					
Wet season onion	3,600.36	3,927.11	4,253.85	5,877.30	7,500.75
Wet season cabbage	1,298.40	1,624.90	1,951.39	2,144.26	2,337.12
Dry season cabbage	865.60	1,125.28	1,384.96	1,558.08	1,731.20
Residual value					97.80
Total Cash inflows	5,764.36	6,677.28	7,590.20	9,579.64	11,666.87
Capital cost(GHS)	682.50	0	156.45	73.5	0
Operating cost (GHS)					
Materials:					
Seeds	371.37	430.18	489.00	617.17	751.64
Fertilizer	307.58	356.29	405.00	511.15	622.52
Sacks	76.70	88.852	**101.00**	127.47	176.47
Ploughing	195.01	195.01	195.01	195.01	195.01
Nursery Management	51.50	51.50	51.50	51.50	51.50
Bed Preparation(onion only)	11.21	11.21	11.21	11.21	11.21
Weeding	52.31	60.60	68.88	86.93	105.88
Transplanting	36.45	42.23	48.00	60.58	73.78
Fertilizer application	36.45	42.23	48.00	60.58	73.78
Daily watering	14.40	16.68	18.96	23.93	29.14
Harvesting	38.94	45.11	51.28	64.72	78.82
Administrative & marketing	15.19	17.59	20.00	25.24	30.74
Repairs and maintenance	6.83	13.65	16.52	20.92	27.42
Contingency (10%)	120.71	137.11	152.44	185.64	222.79
Total Operating Cost	1,334.66	1,508.24	1,676.80	2,042.07	2,450.71
Total Cash Outflow	2,017.16	1,508.24	1,833.25	2,115.57	2,450.71
Net Cash Flow	3,747.20	5,169.04	5,756.95	7,464.07	9,216.16