THE ECONOMIC IMPACT OF GROUP BASED IPM TRAINING ON SMALLHOLDER HORTICULTURAL PRODUCTION IN KENYA

Nigat Bekele Abebe

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DECLARATION AND RECOMMENDATION

Declaration

I hereby declare that this is my original work and has not been presented in this or any other university for the award of a degree.

Candidate

Mrs. Nigat Bekele Abebe

Reg. No.: KD/0213/07

Signature: …………………………………………

Date………………………………………………..

Recommendation

This work has been prepared under our supervision and is submitted with our approval as supervisors:

Supervisor

1. Prof. Gideon A. Obare (Egerton University)

Signature: ……………………………………………..

Date: ………………………………………………

2. Dr. David M. Amudavi (Egerton University/ICIPE)

Signature: ………………………………………………..

Date: ……………………………………………….

3. Dr. Dagmar Mithöfer (ICIPE)

Signature: ………………………………………………..

Date: …………………………………………………

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DEDICATION

I dedicate this work to the Lord Jesus Christ, who is my all

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ABSTRACT

The horticultural sub-sector in Kenya is a key source of foreign exchange earnings, employment creation and also plays a major role in ensuring food security to many Kenyan households. However, the sector faces serious growth constraints including pests and diseases that are limiting its potential to improve horticultural productivity and livelihoods. In a bid to address these constraints and improve productivity, different extension training approaches, have been implemented in an effort to address the sub-sector challenges. Previously, heavily donor funded approaches were used but were found to be ineffective and financially unsustainable. In realization of these limitations, the Government of Kenya categorized extension service as one of the priority functions of the agriculture and rural development sector where group based training approaches such as Farmer Field School (FFS) and Common Interest Groups (CIG) were to be promoted. The two approaches were expected to be effective in enhancing the adoption of environmental friendly practices like Integrated Pest Management (IPM). However, empirical evidence of whether social or human capital acquired through farmer participation in FFS and CIG stimulates IPM technology adoption among the Kenyan smallholders engaged in horticulture farming and their impact on production levels and household income is scanty. The objective of this study was therefore to examine how the group based training approach, a source of social capital, and socio economic characteristics influenced IPM knowledge diffusion and farmer adoption of IPM technologiesIt also assessed the impact of adoption decisions on yield, household income and integrated pest management practices. Data were collected from four hundred and ninety five FFS, CIG and Control farmers in Central and Eastern province of Kenya. The data were analyzed using one-way ANOVA, principal component analysis, recursive simultaneous binary choice model, logit model and propensity score matching method. The result showed that the average age of farmers' across FFS, CIG and control farmers were 49, 48 and 45 years respectively representing a typical age among Kenyan farmers and that membership in FFS and CIG groups were significantly and positively associated with knowledge and adoption of integrated pest management techniques. Furthermore, adoption of IPM was also linked to age, gender, information sharing as well as locality of the farmer. Results on the impact of IPM training through group based approaches on yield and income did not show significant results, which might be attributed to constraints to market access, which affects most farmers in rural Kenya.This study recommends improving the capacity of extension workers in terms of IPM, which will enable extension workers to train farmers in the concept and application of IPM. The study also recommends formation of farmer groups and encouraging farmers to share IPM knowledge. These are critical in the diffusion and adoption of IPM technologies to enhance sustainable production and environment in general.

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ACRONYMS AND ABBREVIATIONS

AEZ	-	Agro Ecological Zones
ARED	-	Agriculture and Rural Enterprise Development
BAT	-	British American Tobacco
BDS	-	Business Development Sector
CBK	-	Coffee Board of Kenya
CBOs	-	Community Based Organizations
CIG	-	Common Interest Group
FAA	-	Focal Area Approach
FAO	-	Food and Agricultural Organization of the United Nations
FBOs	-	Faith-based Organizations
FEWs	-	Frontline Extension Workers
FFS	-	Farmer Field School
FPEAK	-	Fresh Produce Exporters Association of Kenya
FPTCs	-	Farmer and Pastoralist Training Centre
FS	-	Farming System
GDP	-	Gross Domestic Product
GHA	-	Global Horticulture Assessment
GOK	-	Government of Kenya
HCDA	-	Horticulture Crop Development Authority
IAD	-	Integrated Agricultural Development
ICIPE	-	International Centre of Insect Physiology and Ecology
ILRI	-	International Livestock Research Institute
IPM	-	Integrated Pest Management
IPPM	-	Integrated Production and Pest Management
IRDP	-	Integrated Rural Development Programme
IRRI	-	International Rice Research Institute
JKU	-	Jomo Kenyatta University
KARI	-	Kenya Agricultural Research Institute
KHDP	-	Kenya Horticulture Development Program
KTDA	-	Kenya Tea Development Authority
KVDA	-	Keiyo Valley Development Authority
LBDA	-	Lake Basin Development Authority

MOA	-	Ministry Of Agriculture
NALEP	-	National Agriculture and Livestock Extension Programme
NN	-	Nearest Neighbour
NGOs	-	Non-governmental Organizations
PCA	-	Principal Component Analysis
PSM	-	Propensity Score Matching
ROK	-	Republic of Kenya
SFAA	-	Shifting Focal Area Approach
SNV	-	Netherlands Development Organization
SRA	-	Strategy for Revitalizing Agriculture
TLU	-	Tropical Livestock Unit
T&V	-	Training and Visit
TOT	-	Training of Trainers
UNCED	-	United Nations Conference on Environment Development
USAID	-	United States Agency for International Development
WFEA	-	The Whole Farm Extension Approach

CHAPTER ONE
INTRODUCTION

1.1 Background

Agriculture is the main sector of the Kenyan economy employing up to 80% of the entire population and contributes about 26% of gross domestic product (GDP) (ROK, 2005). The horticultural sector on the other hand is one of the most important sectors of the Kenyan economy contributing 13% to the country's economic GDP (FPEAK, 2006; ROK, 2006) and 58% of agriculture's GDP (Wasilwa, 2008). Horticulture offers opportunities for employment creation, enables access to education and health care and provides women with economic opportunities in rural economies where the highest production of fruits and vegetables takes place (Weinberger and Lumpkin, 2007). However, productivity of the sub-sector in Kenya is considered to be below the optimal potential. Recently, the volume of horticultural production in Kenya was recorded as 194.73 and 161.16 tonnes in 2008 and 2009 respectively (USAID/KHDP, 2009). The low and reduced productivity has been attributed partly to low adoption of productive technologies caused by low resource outlays in households, poor information flow, lack of well-trained effective extension personnel, and inaccessibility of extension and education networks as well as problems with pests and diseases (HCDA, 2009).

Efforts to improve the productivity of the sub-sector have focused on adoption of improved and appropriate technologies. This has led to increased allocation of resources to horticulture research to develop high yielding technologies that stimulate increased technology adoption (ROK, 2007).

Many crop pests cause substantial yield losses (Oerke, 2006) and to curb these losses, both smallholder and large-scale producers in Kenya tend to use chemicals for their control. However, increased concerns on chemical residues in food crops, prohibitive costs of chemicals and adverse effects of chemicals on the environment, have necessitated the search for safer and sustainable integrated pest control strategies. Integrated Pest Management (IPM) is the preferred option for many damaging pests and provides an opportunity to control the pests using fewer chemicals and is being encouraged for use in the Kenyan situation (Varela *et al.,* 2003). According to Malena, (1994), IPM is a flexible and holistic approach that utilizes a variety of biological, cultural, genetic, physical, and chemical techniques as required to hold pests below economically damaging levels with a minimum amount of disruption to the cropping ecosystem and the surrounding environment.

Studies have shown that the process of technology adoption within a system cumulatively often follows a sigmoid shape (Rogers, 1995). The time taken for a technology to be adopted depends on among other factors, the information about the technology, adaptability of the technology to farming conditions, capacity for investment and an individual's perception about the technology (Prokopy *et al.*, 2008; Adesina and Baidu-Forson, 1995). Without relevant training, benefits from a technology may not be obviously realized by farmers. In horticultural production, farmer training aims at increasing adoption of high yielding technologies, avoiding product losses and low quality.

In the past, the primary policy tool for sharing information about new agricultural technologies in developing countries has been the training and visit (T&V) system of extension (Birkhaeuser *et al.,* 1991). The World Bank introduced the T&V system in Kenya in 1982 as a pilot project with the aim of enhancing institutional development to increase agricultural productivity. However, this system became ineffective due to high operational costs. It was also noted that the T&V extension had no significant impact on the production efficiency of the farmer and farm productivity in general, leading to unmet demand for general agricultural extension services in Kenya (Gautam, 2000).

Extension methods have increasingly diversified over time to magnify impacts of new technologies. They are increasingly drawing the attention of policy makers, donors and researchers (Thiele *et al.,* 2001). The type of training and dissemination methods used by various institutions may determine the number of farmers reached and the extent to which the message transmitted influences farmers' decisions to adopt new technologies. While direct visits to farmers by extension agents are still widespread, other alternatives that are participatory and less expensive are quickly gaining ground (ROK, 2002). These include group-based methods where farmers are trained collectively, or where farmers train each other. The amount of resources required to implement a training program differs depending on among other factors that the training approach used. The costs of training are justified by the effectiveness of the training approaches in terms of technology adoption and impact achieved through this and any other benefits that might be associated with the training.

Adoption and diffusion of a technology depends on effective and financially stable extension approaches and the ability of the adopter to process and share agricultural information. However, due to the failure by previous extension approaches such as T&V largely attributed to limited and unsustainable financial resources (financial capital) alternative approaches that utilizing social capital promise to partly address this limitation.

Social capital is a feature of social life, which includes networks, norms and trust that enable people to act together more effectively to pursue a shared objective (Putnam, 1993). Social capital has been recognized as one of the factors that can affect the process of information exchange and also influence information diffusion as it reduces the cost of information acquisition (Katungi *et al*., 2008). They also argued that social capital can play a major role in reducing the uncertainty about the reliability of information. Therefore, the main objective of this dissertation was to explore the contribution of group-based training approaches to the diffusion of IPM information and adoption of IPM technology and assess their impact on crop yield, income and adoption of pest management practices among smallholder horticulture farmers in Kenya.

1.2 The statement of the problem

In the past, various institutions and organizations, including the private and public sector, and civil society organizations (i.e., NGOs, CBOs, and FBOs) provided the Kenyan extension services. Previously, various approaches such as the T&V approach, which involves farmer contact on a one-to-one basis extension system and farmer led extension were used to stimulate adoption of technologies that were capable of improving agricultural productivity. However, due to the financial unsustainability of the previous approaches, the government of Kenya and other stakeholders promoted the recent group based training approaches such as Farmer Field School (FFS) and Common Interest Group (CIG). Given the reliance on financial capital to support implementation and sustenance of extension approaches for agriculture in general and horticulture in particular, this study proceeded to empirically establish the extent to which social capital acquired through memberships in new economic institutions such as FFS and CIG contributed to expected livelihood improvement outcomes such as crop yield, household income and adoption of pest management practices.

1.3 Objectives of the study

The overall objective of this study was to asses the effect of the two group-based training approaches on diffusion and adoption of IPM technologies and assesses the impact of the training approach on yield, income and adoption of pest management practices among smallholder horticulture farmers in Kenya. To achieve these main objectives, this study was guided by four specific objectives:

1. Identify information sources accessed by farmers about integrated pest management (IPM) through farmer field schools and common interest groups.

2. Explore factors that affect diffusion of agricultural information on pest management practices in vegetables and fruits production among farmers attending FFS and CIG.

3. Assess the role of social capital and other factors in adoption of IPM technologies/practices

4. Evaluate the impact of group-based IPM training on crop yield, household income and intensity of adoption of IPM practices.

1.4 Research questions

This study used a research question approach to address the study objectives. Thus, the research sets out to answer:

1. What kinds of information sources are accessed by FFS and CIG farmers about integrated pest management?

2. What are the factors that affect diffusion of agricultural information on pest management practices in vegetables and fruits production among farmers attending FFS and CIG?

3. What role does social capital and other factors play in the adoption of IPM technologies/practices?

4. What is the impact of IPM training on crop yield, household income and intensity of adoption of IPM practices?

1.5 Justification of the study

The value of agricultural research findings is only realized after it is transmitted to the farmer who uses it in production practices. One of the key areas of the Strategy for Revitalizing Agriculture (SRA) is to improve the extension delivery systems that aim to enhance agricultural productivity in Kenya. According to the ROK (2005), the SRA is a strategy developed to transform the agriculture sector through well co-coordinated, decentralized and multi-sectoral approaches that include profitable, commercially and internationally competitive economic undertakings. Control of pests is one of the strategies mentioned to improve agricultural productivity through early warning systems. Farmer Field School and Common Interest Group are thought to be able to improve the extension delivery system in the country since through group formation more farmers can be reached. With the increased focus on use of group approaches such as FFS and CIG, this study analyzes the socio-economic factors and social capital structures may change amongst the rural population, which in consequence may impact on adoption of innovations. The present study provides insights into this process to the scientific community, the general public and policy makers and analyzes on the impacts of FFS and CIG training approaches on adoption of IPM technologies. The study thus contributes to analyzing the effectiveness of group based training approaches for diffusion of information, technology uptake as well as contributing to achieving impact.

1.6 Methodology and Scope of study

This study was carried out in two provinces namely Central and Eastern provinces in 2008 targeting major horticulture production districts and farmers who produce for the domestic market. The area chosen considered resource constraints of the researcher. The researcher expects that the study may be replicated elsewhere in Kenya if there will be resources and need for such study. The lessons and insights generated are valuable in evaluating the two training approaches.

This study used various analytical methods to answer the study objectives. In chapter four, analysis of variance method was used to analyze farmer characteristics. In chapter five, Principal Component Analysis (PCA) and recursive simultaneous binary choice model were used to reduce the data dimension and assess factors affecting IPM knowledge acquisition and sharing respectively. Further, principal component analysis and binomial logit model were used to assess the role of social capital on adoption of IPM technology in chapter six and propensity score matching method in chapter seven respectively.

1.7 Definition of terms

Training: It is a process of acquiring specific skills to perform a job better (Jucious, 1963). In this study, training is defined as a training that is conducted by Agricutural extension officers to a group of farmers who belongs to FFS and CIG about IPM technology and its application.

Innovation: An innovation is an idea, practice or object that is perceived as new by individual or other unit of adoption (Rogers, 1995). In this study IPM is considered as an innovation.

Integrated Pest Management: It is a flexible and holistic approach that utilizes a variety of biological, cultural, genetic, physical, and chemical techniques as required, to hold pests below economically damaging levels with a minimum amount of disruption to the cropping ecosystem and the surrounding environment (Malena, 1994). This study adopted this definition.

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Institution: An institution is any collectively accepted system of rules (procedures, practices) that enable to create institutional facts (Searle, 2005) and humanly devised constraints made up of formal constraints (laws, rules and constitutions) informal constraints (i.e. norms of behavior, conventions and self imposed codes of conduct) that structure human interactions and their enforcement characteristics.

Social capital: A feature of social life that includes networks, norms and trust that enable people to act together more effectively to pursue a shared objective (Putnam, 1993). Social capital in this study however is defined as social relations or farmer to farmer interaction in the FFS and CIG groups.

Diffusion: Is the process by which an innovation spreads to individuals in a social system (Rogers, 1995). In this study the diffusion term is defined as a flow of knowledge or information about IPM technology (IPM knowledge acquisition and IPM knowledge sharing) to farmers.

Horticulture: Is the industry and science of plant cultivation. The work involves fruits, Berries, nuts, vegetables, flowers, trees (Adams *et al.*, 2008). However, this study defined horticulture as vegetables and fruit production including cabbage, kales, snow peas, passion, mangoes etc.

Smallholder: Farm holdings less than 10 acres (Harris *et al.*, 2001). In this study following consultations with agriculture extension personnel adjusted to farm holdings with farm size of less than one acre.

Household: A household is a group of people living in the same residence (Arthur *et al*., 2003). This study defined household as all people that are dependent on the specific farm for incomes and food including permanent laborers living on the farms and members working and living away but depending on the farm and/or providing revenues to support the family.

Extension: Agricultural extension can be defined as the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and well-being (Birner *et al*., 2006). The study adopted this definition.

Adoption: Is a mental process as well as a decision to continue full use of an innovation (Rogers, 1995). The study defined adoption as an uptake of IPM technology.

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CHAPTER TWO
LITERATURE REVIEW

2.1 Agricultural extension approaches

Agricultural extension plays a major role in agricultural development. It contributes to facilitating adoption of technologies (Anderson and Feder, 2003; 2004) and information transfer (Van den Ban and Hawkins, 1996) to help farmers make better decisions and become better farm managers. The extension service is, therefore, crucial in the transformation of subsistence farming to modern and commercial agriculture. This is critically important in promoting household food security, improving incomes and poverty reduction (ROK, 2005). In Kenya, different extension approaches have been used to improve agricultural productivity and market access. These include: the Training and Visit (T&V) system, Integrated Rural Development Programme (IRDP), Focal Area Approach (FAA), Common Interest Groups (CIG) and Farmer Field Schools (FFS) (Muyanga and Jayne, 2006).

Since the late 1970s, the primary policy tool for sharing information about new agricultural technologies in developing countries has been the training and visit (T&V) system of extension (Birkhaeuser *et al*, 1991). In the mid-1970s, T&V was introduced in many developing countries with the help of donor funding. The significant increase in extension staff and their re-training seemed to offer considerable improvements over traditional extension methods. Furthermore, the T&V provided a mechanism for farmer involvement in the extension process which something the previous traditional approaches lacked (Rouse, 1996). Rouse also added that the increases in per capita cereal output in countries like the Philippines, India and Pakistan seemed to confirm T&V's effectiveness. However, follow-up studies indicated that T&V was only appropriate at channeling extension messages to large and middle-sized growers than reaching small-scale or tenant farmers. The T&V allowed for more farmer participation than other extension methods. The system however then criticized due to using a contact farmer approach rather than reaching out a wider community. In addition to direct contact, the T&V methodology relies on indirect dissemination through contact between farmers. The expected effects of the spread of information from contact to non-contact farmers appear to have been limited because of poor communication between the two groups. Farmers get most of their information from public fora, primarily *barazas*, which is a practice that NEP I and II were supposed to change.

Barazas are useful for broadcasting simple messages, but are not conducive to substantive interaction on technical problems (Gautam, 2000).

Training and Visit (T&V) method also involved a top downward approach, which is effective in getting farmers to test and adopt new technologies. Nevertheless, the T&V wasn't effective in getting extension officers to listen and learn from farmers, especially small farmers (Rouse, 1996).

The World Bank introduced the T&V system in Kenya in 1982 as a pilot project with the aim of enhancing institutional development to increase agricultural productivity. The Bank supported the first phase of the project under the National Extension Project (NEP I), which was approved in 1983 followed by the National Extension Project (NEP II), in 1991 for the second phase. The T&V in particular, and public extension systems in general, was criticized in the 1980s due to the cost of financing coupled with criticisms of irrelevance, inefficiency, ineffectiveness, and lack of equity (Rivera, 2001). It was also noted that the T&V extension had no significant impact on the production efficiency of the farmer and farm productivity in general, leading to unmet demand for general agricultural extension services in Kenya (Gautam, 2000).

The Integrated Rural Development Project (IRDP) approach was also implemented as an integrated extension approach. The IRDP’s aims were to address constraints of smallholders by working synergistically in health, nutrition, agriculture, and education. In agriculture, this included inputs such as extension, research, irrigation, credit, roads, water, electricity, and sometimes schools and health centers. The focus was technical, however, and left out crucial issues such as training, linkages with research, and management (Davis, 2008). The IRDPs’ weaknesses were that they were supply-driven, inflexible, disregarded many institutions (including NGOs), were multi-sectoral but not holistic, disregarded cost-recovery or privatization, had an enclave mentality, and had limited sustainability (Anderson, 2002).

Besides the challenge of seeking responsive and cost-effective extension approaches agriculture sector in many countries is changing due to the growing demands for agricultural produce as a result of growing population. In recent years have been further, drastic changes in the horticulture sector due to new regulations on allowable chemical residue levels on horticulture crops, certification standards, technologies, information providers, as well as on policy level. These changes have many implications for agricultural extension. For example, knowledge and capabilities of farmers have become a major factor in their ability to compete in national and international markets. This requires a change in extension methods and in the information sources that extension agents use. Agricultural development implies changes in the way of farming and of living for many farm families (Van den Ban, 1999). It is a challenge for extension agencies to help farm families to realize and adjust to this. A major task for leaders of extension organizations therefore is to manage a process of change in agricultural extension. Often the role extension plays in agricultural development cannot be performed by one extension organization, but only by a pluralistic extension system. In realization of this need, the Kenya Government implemented the National Agriculture Sector Extension Policy (NASEP) to improve the agriculture sector through providing an effective extension delivery system. The NASEP embraces a sector-wide approach that recognizes a pluralistic system of extension service provision where private and public service providers are active participants in the delivery system (ROK, 2005).

2.2 Public and private extension services

The Government of Kenya through the Ministry of Agriculture has over the years initiated different extension programmes. The National Agriculture and Livestock Extension programme (NALEP), which is one of the main government extension programmes, is implemented by the Ministry of Agriculture (NALEP-GoK) and Swedish International Development Agency (NALEP-Sida). This programme aims at improving the contribution of agriculture and livestock to social and economic development and poverty alleviation by promoting pluralistic, efficient, effective and demand-driven extension services to farmers and agro-pastoralists (Muyanga and Jayne, 2006). In this Programme, all extension service providers come together and provide extension in a coordinated manner in order to gain synergy effects. Government of Kenya (2002-2008) outlines the government's position in encouraging greater community and private sector participation. The Private agricultural extension services providers include: religious organizations such as the Catholic Diocese and the World Vision, NGOs, private companies such as Kenya Breweries, British American Tobacco (BAT), horticultural export companies and sugar companies, as well as parastatal organizations, such as the Kenya Tea Development Authority (KTDA), the Keiyo-Valley Development Authority (KVDA), the Lake Basin Development Authority (LBDA), the Coffee Board of Kenya (CBK) and others also provide extension services.

2.3 Group based approaches

In Kenya, the extension system faces challenges in delivering information services to large numbers of smallholder farmers scattered over wide and sometimes inaccessible areas. Farmer groups make extension services more accessible to small-scale farmers. Farmer groups as examples of organizations increase bargaining power of members in order to access information (Lapar *et al*., 2006). Farmer groups also put emphasis on adult learning principles and encourage farmers to own solutions. Knowles (1992) asserts that adult learning requires active participation in the inquiry process and the process should build on the learners' background, needs, interests, problems and concerns.

In the recent years the farmer groups approach has become popular among many extension service providers in Kenya (e.g. the Ministry of Agriculture, NGOs and private service providers). Extension provider organizations either start these groups or work with groups that have been in existence. Farmer groups generally draw members from a village to locational level.

Many development agencies and NGOs have promoted use of farmer groups in order to strengthen the capacity of smallholder farmers. The roles of farmer groups entail facilitating delivery of services, providing services to members and/or financing services (Muyanga and Jayne, 2006). Farmer groups are considered to be vehicles and entry points for new technologies (Davis, 2004). Farmer groups are crucial to acquiring basic skills for problem solving and enterprise management. Farmer group approach can be an efficient channel for delivering extension services (FAO, 2001). Bukenya *et al*., (2007) showed that group approach was the most preferred in extending technologies to farmers in Kingo sub county Masaka, Uganda. It was the most preferred method because it promoted sharing of experiences and knowledge. Some farmers mentioned that the use of this method helped in pooling of resources collectively, since most of the group members shared common interests. These features make group method more attractive than the other conventional extension methods. Nyirenda *et al.*, (2001) also, argue that in communities where groups have already been organized for various tasks, a group approach is preferred and it is more feasible than individual approach.

2.3.1 Farmer Field School

The Farmer Field School (FFS) approach evolved in the 1980s in Southeast Asia to address insecticide overuse. Research by the International Rice Research Institute (IRRI) had shown that excessive use of broad-spectrum insecticides in irrigated rice, stimulated by the lack of pest resistance of earlier introduced high-yielding varieties, was disrupting the ecosystem and hurting farmers' yields and profits. The FFS approach stresses experiential learning of fundamental agro ecological principles, which is crucial for sustainable production (Gallagher, 1999). FFS are "schools without walls" where a group of about 25 farmers meet weekly with facilitators. The aim of FFS is to impart new skills and practices, an understanding of ecological principles and concepts so that farmers can experiment with, and adapt management practices to their own specific farm conditions (David, 2007). Hence, FFS seek to improve farmers' problem solving abilities by sharpening their observational skills and decision-making ability. In the FFS farmers are trained in weekly sessions throughout the cropping season by conducting hands-on experimentation in the field.

FAO has promoted the FFS approach since the late 1980s through its Asian inter-country IPM programs for rice, vegetables, and cotton. Following a global IPM conference in 1993, FAO and other donors initiated the creation of the Global IPM Facility to enhance worldwide access to the Asian experience and to disseminate farmer-centered approaches to other parts of the developing world. The facility emphasizes the FFS model for farmer training in IPM. In 1999, the Food and Agriculture Organization (FAO) Global integrated pest management (IPM) Facility started its East African Sub-Regional project for Farmer Field School focusing on integrated production and pest management (IPPM). In Kenya, the project has been working in Busia, Bungoma and Kakamega districts. There are over 1000 FFS with 30,000 farmer graduates (FAO-KARI-ILRI, 2003). Currently, the FFS program runs in many parts of the country.

2.3.2 Common Interest Group

The term Common Interest Group (CIG) was first coined in Nghean Vietnam in 2001 and was initiated by the Agricultural and Rural Enterprise Development Program (ARED) in Vietnam. The CIG aims to help farmers come together to exploit the existing resources to enhance agricultural production. In a CIG, farmers who have common interests volunteer to join together and help one another (Hoang and Graham, 2006). They also noted a CIG is a self-managed, independent group of farmers with a shared goal and interest. The members work together to achieve this goal by pooling their existing resources, gaining better access to other resources and to share in the resulting benefits. CIG helps farmers to address production and marketing issues as well as provide a forum of training and information sharing (SNV, 2005).

In Kenya, the CIG approach has been introduced nationwide and promoted by the Government of Kenya and partly sponsored by the Swedish International Development Authority (SIDA). Within the Ministry of Agriculture, Kenya Agricultural Productivity Project (KAPP) and the National Agriculture and Livestock Extension Programme (NALEP) use group approach where groups are formed within the focal areas that receive extension services.

In Kenya, CIGs are enterprise-based and the group members must have the common goal for promoting the enterprise as a business. It is a participatory extension approach promoting farmer interaction and involves them fully as partners in determining demand and agendas for response by extension service providers (ROK, 2005). Common Interest Groups mostly focus on the commercialization of minor agricultural businesses; and provide intensive extension services to CIG farmers for a limited period of time (Cuellar *et al*., 2006). The CIG approach is enterprise-based and aims at empowering farmers to take up agribusiness enterprises that are market-oriented and demand-driven (Githaiga, 2007). The CIG approach enhances access to food markets and market information. Farmers in this group want to grow what the market demands in terms of quantity, quality and reliability (ROK, 2001).

2.4 Integrated pest management

Integrated Pest Management (IPM) is an approach that focuses on the use of as many compatible methods as possible with minimal pesticide input (Varela *et al*., 2003). IPM is defined as a sustainable approach to managing pests by combining biological, cultural, mechanical and chemical techniques in a way that minimizes economic, health and environmental risks. IPM is a more holistic approach that connects the long-term sustainability of agricultural production with environmental, economic, and social issues, including public health (Sorby *et al*., 2003). IPM is seen as the way forward to achieve sustainable agricultural production with less damage to the environment. Thomas (1990) describes IPM, a more advanced approach than chemical pesticide use for pest management. The IPM approach is universally recognized as a requirement for agricultural development projects within the context of the United Nations Conference on Environment Development Agenda 21, affirming its global recognition (UNCED, 1992). Integrated Pest Management was first developed by entomologists in response to growing concerns over adverse health and environmental effects of pesticides and limitations of the singular reliance on chemical pest control (Kennedy, 1999; Stern and others 1959). According to Varela *et al*., (2003) the method of IPM involves:

Biological control: This is augmentation and conservation of natural enemies of pests such as insect predators, parasitoids, pathogens and weed feeders. In IPM programmes, native natural enemy populations are conserved and non-native agents are released with utmost caution.

Chemical control: Pesticides are used to keep the pest population below economically damaging levels when the pests cannot be controlled by other means. Chemical is applied only when the pest's damaging capacity is nearing to the threshold.

Mechanical control: These are based on the knowledge of pest behavior and involve hand picking, installation of bird perches, mulching and installation of traps.

Cultural pest control: This includes crop production practices that make crop environment less susceptible to pests, including crop rotation, cover crop, row and plant spacing, planting and harvesting dates, and destruction of old crop debris. Cultural controls are based on pest biology and development.

2.4.1 Integrated pest management (IPM) training in horticultural production

The concept of IPM in the recent years has gain popularity for its enormous contribution in the area of crop productivity and pesticide reduction that are crucial for sustainable production and environment. The first (IPM-FFS) was conducted in1989 in the rice fields of Indonesia as a response to the emergence of problems associated with the reliance on chemical controls for insect pests (Braun and Duveskog, 2008). The Indonesian National IPM Programme initiated the IPM-FFS in Indonesia, with funds from the Government of Indonesia–United States Agency for International.

Started in Indonesia to reduce pesticide reliance among rice farmers, the spread of IPM has taken place with the focus of the FFS moving from primarily rice IPM in Asia to vegetable and cotton IPM (Ooi, 2003) in Asia to vegetable IPPM in Africa, (Jiggins *et al.*, 2005).

In the latter years, IPM was introduced in Central and Coast Provinces of Kenya under the Global IPM facility/FAO and World Bank funding (Loevinsohn *et al*., 2000)**.** A pilot IPM training project in coffee and vegetable cropping systems was initiated in 1995 (Loevinsohn, 2000). The project targeted the coffee and vegetable smallholder farmers in three districts of Central Province and one district of Coast Province, Kenya. The aim of the project was to introduce sustainable pest management methods to farmers to enable them to avoid the hazards posed by pesticides to their own health and, through residues in produce, to domestic and foreign consumers. The Kenya-based International Centre of Insect Physiology and Ecology (ICIPE), has also been working for over a decade on IPM. From June 2006 to 2008 Integrated Pest Management (IPM) Farmer Field School in vegetable production was conducted and farmer groups in Taita Hills and Western Usambara mountains were trained in integrated pest management (IPM). Extension workers in the area also participated in the training sessions. Furthermore, field days also conducted to raise farmer awareness in IPM vegetable production and to enhance spread about the environment friendly practice like IPM. Integrated Pest Mangement (IPM) was found to be suitable for smallholder horticulture production in export and domestic market crops since it holds pests below the economic damaging level and subsequently improves horticultural production (Nyambo and Nyagah, 2006).

On the impact of IPM-FFS, other study by CIP and FAO have shown important contributions about IPM-FFS to farmer knowledge and increased productivity (van den Berg, 2004). Other studies in market and input intensive areas have shown that IPM-FFS has enabled farmers to significantly decrease dependence on pesticides without harming production per area and in many cases improving overall productivity (Barrera *et al*., 2001). Another evidence also showed that the impact of IPM-FFS training on pesticide reduction, resulted increases in productivity, knowledge gain among farmers (Rola *et al*., 2002; Praneetvatakul and Waibel, 2003) and empowerment (Züger, 2004).

2.4.2 Characteristics of IPM practices

It has been demonstrated by Varela *et al*., (2003) that integrated pest management technologies comprise a range of practices, which include chemical, biological, mechanical and cultural techniques that bring the pest populations below the economic damaging level.

Further, in this study, a range IPM practices are characterized (Table 2.1) to analyze farmers'level of knowledge and adoption on each of the IPM practices. Each of the practices in the data was coded as a dummy variable to indicate farmers' knowledge and adoption toinvestigate farmers' understanding of IPM technology on each of the practices. These ranges of IPM practices are described further in Table 2.1

Table 2.1: Description of integrated pest management practices (IPM)

Practice	Description
Pesticide application	Using selected pesticides including, fungicides, insecticides, acaricides, etc.
Mass trapping	Use of traps to catch large proportion of pest population
Hand picking	Manual removal of pests
Deep ploughing	Exposing the pupae of caterpillars and thrips by exposing them to the sun and natural enemies
Plant resistance	Plant breeding for increased genetic resistance to pest damage
Mixed cropping	Mixed cropping of plants with other plants less susceptible or even antagonistic to certain pests and diseases
Timely planting	Planting crops during the proper season
Sanitation	Destroying sources of infestation such as crop residues such as steams and leaves
Crop rotation	Rotating of crops in different seasons with same purpose as for mixed cropping
Solarization	Cover soil with clear or transparent polyethylene sheets (mulch) for a period of three month, exposure to sunshine reduces soil born pests and diseases
Ash application	Applying ash
Plant extract	Using plant extracts such as neem, aloe vera, chili

Source: *Varela et al. (2003).*

2.5 Theoretical background

2.5.1 Diffusion theory

Diffusion is the process by which an innovation is adopted by members of a social system. It is a dynamic process that focuses on the penetration of a social system thereby causing an alternation in the system (Rogers, 2003). Diffusion is defined as the path of aggregate adoption by a multiplication of decision units. According to the general diffusion theory, the spread of an innovation usually follows a sigmoid shape (Rogers, 2003). Diffusion studies analyze the adoption of a technology in a region or population (Feder, *et al*., 1985; Sunding and Zilberman, 2001). One measure of diffusion may be the percent of potential users that adopted the innovation in a region or population. An example can be the percentage of farmers who adopted IPM technology in the study area.

Diffusion of knowledge innovations or technologies usually is preceded by awareness. While at the beginning the flow of information may be slow, the message spreads more rapidly when a greater proportion of the population is aware of the new idea. It is assumed that the impact of information can be far reaching since it is a major driving force of human behavior, and especially of learning process (Bandura, 1986).

According to Rogers, (1995) there are four factors that influence adoption of an innovation. These are 1) the innovation itself, 2) the communication channels used to spread information about the innovation, 3) time, and 4) the nature of the society to whom it is introduced. Rogers (*ibid*) defines diffusion (aggregate adoption) as the process by which a technology is communicated through certain channels over time among the members of the social system. This definition recognizes the technology that represents the new idea, practice and object being diffused, communication channels which represent the way information about the new technology flows from change agents (extension agents, technology suppliers) to final users or adopters (e.g., farmers), the time period over which the social system adopts a technology, and the social system. Furthermore, the author also posits four major theories that deal with the diffusion of innovations. These are the innovation-decision process theory, the individual innovativeness theory, the rate of adoption theory, and the theory of perceived attributes.

The innovation-decision process theory: The stages of the decision process involves: learning about the innovation, persuasion as to the merits of the innovation, a decision to adopt the innovation and implement and finally confirm the adoption decision was appropriate. One these stages are achieved then diffusion results (Rogers, 1995).

The individual innovativeness theory: this refers to the percentage of individuals that adopt an innovation. This is illustrated using a bell-shaped curve. The first group comprises of 2.5% who are the risk-takers and pioneers who lead the way, the innovators. The second group, 13.5%, is known as the early adopters. They adopt early and help spread the word about the innovation to others. The third and fourth groups, each 34% of the adopters, are the early majority and late majority respectively. The innovators and early adopters convince the early majority. The late majority waits to make sure that adoption is in their best interests. The final group is the laggards. These are the individuals who are highly skeptical and resist adopting until absolutely necessary (Rogers, 1995).

The theory of rate of adoption: It refers that the adoption of innovations is best represented by an s-curve on a graph. The theory holds that adoption of an innovation grows slowly and gradually in the beginning. It will then have a period of rapid growth that will taper off and become stable and eventually decline (Rogers, *ibid*).

The theory of perceived attributes: Here, individuals will adopt an innovation if they think that the innovation has some *advantage* over an existing innovation and if it is *compatible* with existing values and practices. In addition, the innovation will be adopted if it is too *complex* and passes the *trialability* property. This means the innovation can be tested for a limited time without adoption. Fifth, the innovation must offer observable results (Rogers, 1995).

2.5.2 Adoption of technologies

Rogers (1983) defines the adoption process as the mental process through which an individual passes from first hearing about an innovation or technology to final adoption. Feder *et al*., (1985) defined adoption as the integration of an innovation into farmers' normal farming activities over an extended period of time. An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption (Rogers, 1995). Final adoption at the level of the individual farmer is defined as the degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential (Feder *et al*., 1985). This indicates that adoption is not instantaneous but a process of its own. Farmers are known to take time before they make the final decision to adopt or reject a given technology. Adoption of a new technology is subject to its profitability and the degree of risk and uncertainty associated with it, and is highly influenced by the socio-economic characteristics of farmers. Adoption behavior of individuals can be attributed to factors such as aversion to risk, limited access to credit, inadequate farm size, insufficient farm size, density of farms, human capital, insufficient information about the new technology and labor shortages (Feder *et al*., 1985).

Some studies on adoption of new technology have found results confirming the findings of Griliches (1957) and Mansfield (1963) that the adoption of new technology increases with the demonstrated technology’s profitability. However, there are also other studies, which found that a new technology might not be adopted even if it has higher returns than the traditional technology. The contrary results show that there are factors other than profitability that also impact the adoption decision, which have necessitated theoretical studies that attempt to explain adoption of new technology with human capital, labor supply, and risk. Abdulai and Huffman (2005) showed that the adoption of crossbred-cow technology by Tanzanian farmers is delayed by the current price of the new technology. Moreno and Sunding (2005) found the fixed investment cost of adoption has large negative effect on the adoption of modern irrigation technologies; drip technology, gravity technology and sprinkler technology.

Farm size has been included in the analysis of adoption of new technology due to its relation with fixed investment cost, credit constraint, risk aversion, information cost, human capital and off-farm income (Feder *et al*., 1985). Some studies found results that confirm adoption of new technology increases with farm size, whereas others found that the adoption of new technology is not related to farm size.

The study by Rahm and Huffman (1984) found that larger farms are more likely to adopt reduced tillage, as the expected profitability increases with farm size. Qaim and de Janvry (2003) showed that Bt cotton is more likely to be adopted by large farmers, due to high costs of adoption. Abdulai and Huffman (2005) found that as the size of the farm increased, the adoption of crossbred technology became faster. Hua *et al.*, (2004) found that the number of conservation programs the farmers participate in is positively and significantly related to farm size. Soule *et al*., (2000) found adoption of conservation tillage, with benefits realized in the short term, is positive and significantly related to farm size. Soule *et al*., (2000) attributed this result to economies of scale.

Education also helps individuals to better evaluate the economic benefits and costs of adopting a new technology (Wozniak, 1984). Overall, Wozniak (*ibid*) hypothesized that education, experience and information can enhance the innovative ability of individuals and lead to efficient adoption decisions. The author also explains the insignificance of experience with the fact that younger farmers, who have less experience, have longer streams of benefits from adopting the new technology and this effect outweighs the uncertainty effect on which experience is effective.

Rahm and Huffman (1984) define the efficiency of adoption decision as adopting the practice when it is economically feasible. Hence, human capital may not always be associated with higher adoption rates, but with higher adoption rates when it is feasible to adopt. Rahm and Huffman (1984) analyze the impact of human capital variables on adoption of reduced tillage and the efficiency of the adoption decision. The regression results of their study show that farmers with more years of formal schooling are more likely to make efficient adoption decisions.

Qaim and de Janvry (2003) results also show that as the number of years in school increases, the farmers become more likely to adopt Bt Cotton. Khanna (2001) found that adoption of variable rate application technology is impacted positively and significantly by the education, innovativeness and experience of the farmer. As the adoption of variable rate technology happens after adoption of soil testing, farmers with higher human capital can get better use of the results of the soil testing (Khanna, 2001). Hua, *et al.*, (2004) found that farmers with college education are more likely to adopt conservation tillage. Huffman (2005) show that as the number of years of schooling of the farmer increases, the faster the adoption happens.

The results of Abdulai and Huffman (2005) also show that the extension services also speed the diffusion of new technology. Farmers' education and interaction with agricultural extension services increased the probability of adoption of new irrigation technology Koundouri *et al*., (2006). Khanna (2001) found that adoption of soil testing is not affected by the education, innovativeness and experience of the farmer. Hua *et al*., (2004) found no significant relation between education and participation in a conservation program.

Age is also included in analyses of adoption of new technology to represent the experience and innovativeness of the farmer. Soule *et al.*, (2000) found that age had a negative and significant impact on adoption of practices for medium and short-term benefit practices for owners but not for renters. Qaim and de Janvry (2003) found that age had no impact on adoption of Bt Cotton. Hua *et al*., (2004) found no significant relation between age and participation in a conservation program. Hua *et al*., (2004) also found that farmers younger than 60 years old were more likely to adopt conservation tillage.

On the other hand, several studies indicated adoption of technologies influenced by social capital factors. In addition, evidence from rural sociologists suggests that social structures critically affect the adoption decision (Rogers, 1995). Other studies looked at the effect of social capital on adoption of technologies. Nyangena (2004) used social capital indicators such as trust and increased group activity to assess adoption of increased adoption of conservation practices. The concept of "adoption" in this study is used to refer to the decision by farmers to use, or not to use, IPM technologies.

2.5.3 The New Institutional Economics and the concept of collective action

The NIE represents an expanded economics that focuses on choices people make, while at the same time allowing for factors as pervasiveness of information, evolution of, norms, and willingness of people to form bonds of trust (Nabil and Nugent, 1989, North, 1990). Through collective action, individuals operate as an institution, which taken collectively influence economic growth. In turn economic growth and development act to influence change in the institution. Thus, institutions provide the basic structure by which human beings create order and attempt to reduce uncertainty in exchange. Together with technology employed, they determine transaction and transformation costs and hence the profitability and feasibility in engaging in economic activity (North, 1990). Transaction costs include the costs of information, negotiation, monitoring, coordination, and enforcement of contracts. Because institutions are rules of conduct (norms, traditions, shared values, kinships, religions, affiliations and cultural trends) that facilitate relationship between individuals collective action provide for more certainty human interaction and shape the behaviour of which influence outcomes (Runge, 1984)

The NIE perspective of institutional theory emphasizes the social and legal norms and rules that shape the external environment of economic activities. Under the NIE methodological principles, the meaning of the term institution is twofold. First, institutions are the rules, procedures, and arrangements of the game (Shepsle, 1986), or prescriptions about which actions are required, prohibited, or permitted (Ostrom, 1986). Therefore, the concept of institution could also be coined as institutional frameworks. Second, institutions could be labelled as social organizations including legislatures, government agencies, and even societies (Ahrens, 2002). These two definitions relate to each other. The social entities in the second definition create and shape the normative rules in the first definition. Those norms, rules and arrangements, in turn, influence the decision and behaviour of individuals and organizations in the society.

North also describes institutions as the rules of the game that set limits on human behaviour and a way to reduce uncertainty. Further, institutions can be informal (norms of behaviour, societal codes of conduct) or formal (laws, rules) and they are designed by people with different bargaining strength. According to North (1990) institutions play a major role in reducing transaction costs of accessing information. On the other hand, the Kherallah and Kirsten (2001) study showed the conjecture of the aspect of the NIE about institutions being a transaction cost-minimizing arrangement, which may change and evolve with changes in the nature and sources of transaction costs. In addition Kherallah and Kirsten (2001) emphasized that "the NIE (including especially the literature on property rights and collective action, transaction costs, and the organizational/contracting theories of Williamson, Grossman and Hart can inform the design of organizations and cooperatives to prevent their failure".

According to North (1990) the purpose of NIEs and concept of collective action is to explain what institutions are and how they influence individual performance. Farmer organizations are specific examples of the role of institutional approach to societal problems. Various studies used collective action based research. Shiferaw *et al.*, (2008) used the concept of collective action to evaluate the role of effective action forged between institutions to address rural market imperfections in Kenya. Narayan and Pitchett (1997) used the concept of collective action as a social capital for development and inventory improvement in Ghana and Uganda.

The concept of collective action is also widely used in diffusion and adoption studies. Karahanna *et al.,* (1999) used collective action concept to assess adoption of innovation and found that potential adopter intention is solely determined by normative pressure. Parthasarathy and Chopde (2008) used collective action concept and discovered that collective action actually provides the means to adopt agricultural innovations, generate economic and human capital, and make the development process sustainable and provides institutional access to information, and credit.

It is, therefore, farmer organizations such as FFS and CIGs that are considered institutions that generate social capital and are likely to contribute to reducing cost of accessing information and adoption of IPM technology among the smallholder horticulture farmers in Kenya.

2.5.4 Social capital

Putnam (1993) defines social capital as a feature of social relations that contribute to the ability of a society to work together and accomplish its goals. In addition, the World Bank defines social capital as the "institutions, relationships, and norms that shape the quality and quantity of a society's social interactions and it is the glue that holds them together" (World Bank, 1999). Study by Coleman (1990) shows, institutions help to ease transaction by reducing costs associated with acquiring information. According to Kherallah and Kirsten (2001) social capital is incorporated in transaction cost economics as an important element to reduce on the costs and uncertainty of market exchange.

The study by Palis (2002) points out that adoption and diffusion of technologies has long been a problem in the agriculture set up. Adoption is a decision to continue full use of an innovation while diffusion is the process by which an innovation spreads to individuals in a social system (Rogers, 1995). In the context of social capital, farmer interactions and interrelations can stimulate adoption as well as diffusion of technologies (Palis, 2002). Putnam (1995; 2000) also indicates that social capital is a way of enhancing the efficiency of farmer to farmer extension and thereby enhances adoption of technologies and reduces transaction costs. In addition, Yli Renko *et al*., (2002) argue that social capital facilitates the willingness and cooperation to share information, thereby revealing the tacit information that would be difficult to exchange otherwise. According to Katung *et al*., (2006) social capital also plays a major role in information flow among the developing economies. A study by Fafchamps and Minten (1999) found how social capital influenced the economic performance through interactions among agricultural traders in Madagascar. Therefore, the social capital acquired through FFS and CIG can contribute to stimulating technology adoption.

A study by Bingen *et al*., (2003) indicated social capital could be generated through farmer groups or farmer organizations. The group based approaches such as FFS and CIGs are expected to generate social capital since farmer organized and trained through groups. In addition farmer organizations help to intensify information sharing (World Bank, 2002). We assume therefore, that when farmers are trained collectively information on IPM technology may more easily move from farmer to farmer. However, the purpose of any training is to help farmers acquire knowledge of the technology to enable the farmer make informed decision of adopting or not adopting the technology. Therefore, the social capital acquired through FFS and CIG can contribute to stimulating technology adoption.

2.5.5. Selection bias

Selection bias is a distortion of results that arises from non-randomly selected samples (Heckman, 1979). Selection bias simply means that the data collected does not represent the population in question. Because during sampling there were some distortions that led to the sample selecting having some characteristics not necessary same as that of the universe.

According to Heckman bias may arise from self-selection by individual or data units being investigated and sample selection decision by analysts and data processors. In this study selection bias may arise from the following situation because the sampling was stratified according to FFS, CIG and control farmers because at every point we exclude others in selecting the sample. In addition, there could also be so many farmers with IPM knowledge (or the opposite) and thus when sampling we might have a higher probability of getting a farmer who knows about IPM. When doing the analysis, then there is a high probability of analyzing a large proportion of IPM farmers (or less when they are few). In this case if there are very many farmers with IPM, then the conclusion will actually be the farmer group (FFS and CIG).

2.5.6. Difference-in-Difference (DD) Estimates

The DD estimation consists of identifying a specific intervention or treatment. One then compares the difference in outcomes after and before the intervention for groups affected by it to this difference for unaffected groups. This method solves the problem of selection bias by comparing pre and post data on change in performance. The DD estimator relies on comparing changes in outcomes between participants and non-participants; it is not affected by selection biases that arise from time-invariant household or village unobservable (Glewwe, 2001). According to Wooldridge, (2007) one of the groups is exposed to a treatment in the second period, but not in the first period. The second group is not exposed to the treatment during either period. In the case in which the same units within a group are observed in each time period (panel data), the average gain in the second (control) group is subtracted from the average gain in the first (treatment) group. This removes biases in second period comparisons between the treatment and control groups that could be the result of permanent differences between those groups, as well as biases from comparisons over time in the treatment group that could be the result of trends. The application of DD estimation comes from its simplicity as well as its potential to avoid many of the endogeniety problems that typically arise when making comparisons between heterogeneous individuals. The DD estimation usually relies on long time series data and the most commonly used dependent variables in DD estimation are typically highly positively serially correlated. Reporting DD estimates and their standard errors without accounting for serial correlation will generate false results (Bertrand *et al*., 2004).

According to Rosenbaum and Rubin (1983) an alternative method that solves the problem of selection bias is matching on the propensity score P(X). Using the propensity score, participants from the treatment group with participants from the control group can be matched, so that the treatment group and control group can be balanced. This study involved a cross sectional data and used the propensity score matching method to assess the impact of the group based IPM training on household income, crop yield and adoption of pest management practices.

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CHAPTER THREE
GENERAL METHODOLOGY

3.1 The study area

A household survey was carried out on a random sample of 495 fruit and vegetable producers in major horticulture districts in the Central and Eastern provinces of Kenya. The horticulture farmers were grouped in three categories, i.e. FFS members, CIG members and farmers who operated individually (control) and were not members of the two group-based training approaches. In order to check the effect of group training on information flow within the community, samples were drawn from the same village as the FFS and CIG farmers.

The study was conducted in five districts in Kenya, namely Muranga, Thika, and Maragua in Central province and, Makueni and Embu in Eastern provinces, which are major horticulture production districts (Figure 3:1). Central province covers an area of 13,176 km^2 with population of 3.7 million. The area has 965,000 ha of potential agricultural land of which 78% is devoted to agricultural activities. The province is characterized by both intensive and extensive agricultural activities involving cash and food crops including horticulture, dairy, poultry, and pig production. The areas receive average annual rainfall of 2600 mm and a mean annual temperature of 20^{o}C. Soil characteristics include humic nitisol, eutric nitisol, ando-humic and nitisol, nito-rhodic ferralsol. Eastern province covers an approximate area of 3,952 km^2 with a projected population of 5,587,781 (Republic of Kenya, 2006) and receives rainfall ranging from 190 mm to 390 mm (ROK, 2010). The mean temperature is 26^{o}C and much of the province is characterized by loamy sand soil type.

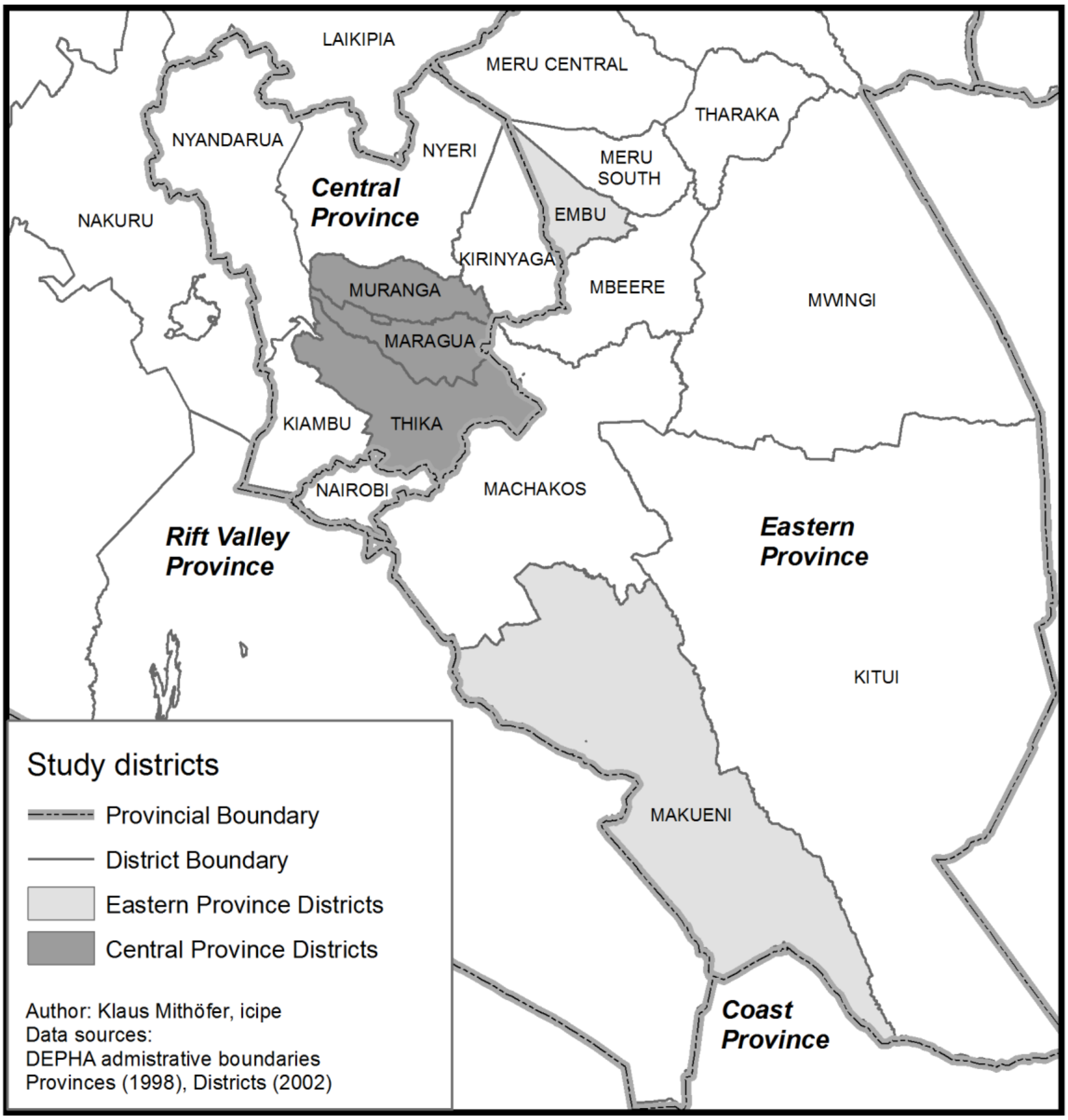

Figure 3.1: The study area

3.2 Sampling Procedure

For this study, five districts were purposely selected. A sampling frame containing all active FFS and CIG horticulture groups and their members was compiled during the formal and/or informal meetings held in 2007 by district and divisional horticulture extension officers. The sampling units consisting of small-scale FFS and CIG horticultural producers were selected from the sampling frame using systematic random sampling. CIG and FFS farmers were selected first; then a sampling frame for control farmers was compiled for the sub locations selected. From each district 50% of sub-locations were randomly selected to get the representative sample. Control farmers were selected following the same procedure as for the group farmers. Overall, 33 FFS, 33 CIG, and 33 control farmers were selected per district to yield a sample of 99 farmers giving a total sample of 495 horticulture farmers in five survey districts from the two provinces. For this study and following Rea and Parker (1997), the sample size was determined as:

$$n = \left(\frac{Z_\alpha \sqrt{p(1-p)}}{Cp} \right)^2 \qquad (3:1)$$

where *n* is sample size, *Cp* is confidence interval in terms of proportions and was set at 5% as this was enough to remove 95% bias in sampling. Z_α is *Z* score for various levels of confidence (α) and Z = 1.96, and *p* is the proportion of population containing the major attribute or the population and set at 0.5. The sample size proposed was: [1.96 x 0.5 x 0.5] / 0.05^2] = 392. However, this figure was approximated to 495. Eight questionnaires out of 495 were dropped due to insufficient information leaving a total of 487 farmers for the data analysis.

To avoid respondent bias 20 field research assistants who were conversant with the local language of the respondents undertook a three day intensive training session on the data collection techniques prior to the survey. During the survey each of the 20 research assistants completed an average of 25 questionnaires. The survey covered demographic information on farmers such as farmers' age, total number of years of schooling, land size, household size and on-farm labour. In addition, information on asset and wealth, farmer's main farm and off-farm income sources, pesticide and fertilizer application, horticulture crop portfolio, farmer's horticultural training, information access and knowledge of IPM was solicited. Information on group membership, social capital, and diffusion of information among farmers was also gathered.

3.3 Conceptual framework

Decision-making at farmer's or individual level to adopt and diffuse a given technology depends partly on his/her access to relevant information, membership in farmer groups, farmer's social capital and other socio-economic factors. Farmer groups are considered important in creating social relationships that generate social capital (Njuki *et al*., 2008), which is essential for information access. To model the environment in which agricultural information flows, we distinguished four main stages in an information cycle: a) the information generation stage, b) information flow stage, c) adoption of technologies stage, and d) assessment of the impact of the adoption of new technologies. The schematic illustration in Figure 3.2 depicts the process from generation of information to assessment of the impact of the adoption. The relative importance and magnitude of the effects of the process outcomes from the components of this system vary depending on the complexity of technology, farming resources and effectiveness of the training channel adopted. We assume that the farmers' objective to maximize their production in an environment of risk and uncertainty. However, prior to the maximization outcome a farmer makes a decision on whether or not to adopt a training channel from a bundle of available channels. Generally, farmers adopt technologies when the expected benefits from the new technology are higher than those from the current technology (Feder *et al*., 1985).

In this study, it was assumed that the promise of higher output embodied in information on a technology is a sufficient motivation for farmers to undergo training to learn about this innovation. Both the information generation factors and information flow have an effect on the farmer's decision-making behaviour in adopting a technology. Furthermore, it was also assumed that farmers rely on group membership, personal experience and comparison with friends and neighbours to make adoption decisions.

Having access to information is therefore one of the factors that determine adoption of a new idea. Without availing information, farmers may believe that technologies are unprofitable and risky (Negatu and Parikh, 1999). In addition, inefficiencies in the delivery of information can discourage adoption of technologies (Nowak, 1987).

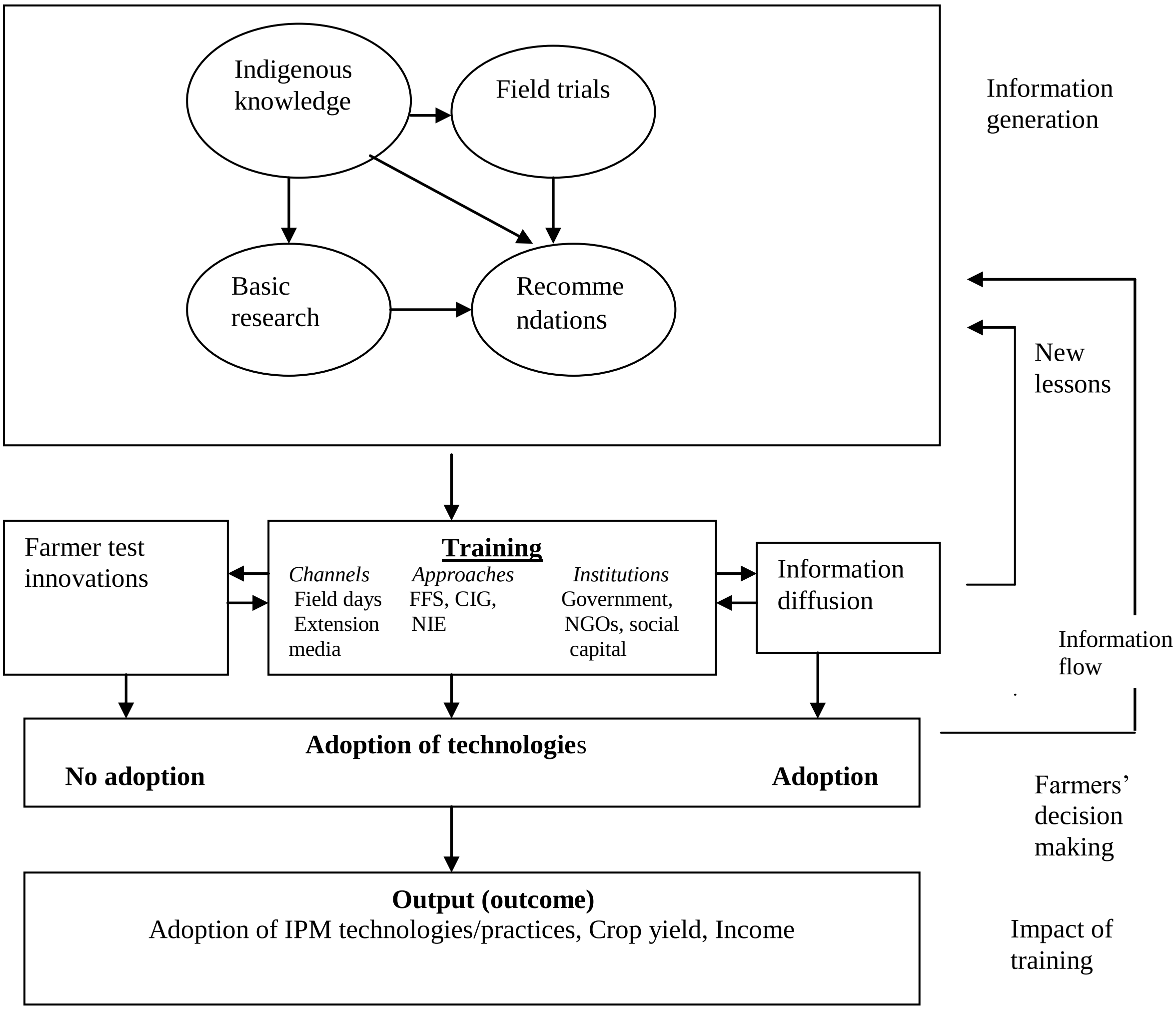

Figure 3.2: The flow of information on new technologies

Note: Outcomes are the dependent variables of the study; Socio-economic characteristics and membership in FFS and CIG are the independent variables of the study

Source: *Author, 2008*

3.4 Analytical tools

In this section, various analytical methods that were used to address the study objectives are briefly introduced. The methods are discussed in the subsequent chapter in detail.

Descriptive statistics, including ANOVA, were first used to identify farmers' characteristics across the FFS, CIG and the control farmers. In addition, principal component analysis (PCA) procedure was used to reduce IPM knowledge and its adoption on range of IPM practices into fewer variables. Similarly, various social capital indicators were also reduced into fewer variables. The knowledge index, adoption index and social capital index generated from the PCA were then used as dependant variables in regression analysis. The knowledge and adoption indexes were used to assess factors affecting IPM knowledge acquisition and sharing while the social capital index was used to assess the role of social capital in adoption of IPM technologies.

A recursive simultaneous binary choice model was used to assess the relationship between IPM knowledge sharing and acquisition. This is based on our assumption that knowledge sharing preceded by knowledge acquisition i.e. the knowledge has to be acquired first before it can be shared.

A logit model was used to analyze farmer decision on adopting IPM technology. The Logit model involves binary response variables and investigates the relationship between independent variables and the log odds of the binary outcome variable. Previous studies that analyzed social capital and adoption of technology used either logit or probit models (e.g. Gerhart 1975; Jamison and Lau, 1982). These models specify a functional relationship between the probability of adoption and various explanatory variables. The model has been used by other researchers to explain adoption rates. Gerhart (1975) used a probit analysis to explain adoption rates of hybrid maize in three different regions in Kenya. Jamison and Lau (*ibid*) applied logit analysis to investigate factors affecting the adoption of chemical inputs among Thai farmers.

The propensity score matching (PSM) method was used to evaluate the impact of FFS and CIG participation on farmers yield, income and adoption of pest management practices. This method minimizes the potential of self selection bias that could arise from non random sampling and can also be used to evaluate the impact of the training program.

3.4.1 Principal component analysis

The principal component analysis (PCA) as described by Jolliffe, (2002) was used to reduce the size of the data set. According to the author, the PCA can be used to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible the variation present in the data set. This is obtained by transforming into a new set of variables, the principal components (PCs), which are uncorrelated so that the first few components retain most of the variation present in all of the original variables. This means that several variables that measure one major construct are likely to be correlated with one another since they measure one variable. Then it is appropriate to reduce them to fewer variables that capture as much as possible of the variation in the original data set. In PCA, a new set of variables is created as linear combinations of the original set. The linear combination that explains the maximum amount of variation is called the first principal component. A second principal component (another linear combination) is then created, independent of the first, which explains as much as possible, the remaining variability. Further components are then created sequentially, each new component being independent of the previous ones. If the first few components explain a substantial amount of the variability among the original set of variables, then essentially, the number of variables to be analyzed has been reduced from the original number to the reduced number.

3.4.2 Recursive simultaneous binary choice model

Recursive simultaneous binary choice model is a two-stage model that estimates the relationship between dependent and independent variables. This method is used to model two dependant variables against a set of independent variables simultaneously. In doing recursive model, the dependant variable in the first stage becomes an independent variable in the second stage. Being a two-stage model the recursive model is a suitable model for correcting selection bias. However, there are various methods used to address the problem of selection bias including the two-stage Heckman estimator. Heckman's two-stage estimator is the most widely used approach in correcting selection bias that occurs from using nonrandom selected samples (Heckman, 1979). The first stage involves a selection equation which is a probit model to predict the probability. From the probit estimation the inverse mills ratio (IMR) is generated then included in the second stage as a regressor to solve the sample selection problem. However, the model requires an exclusion restriction to generate reliable estimates of a variable which appears with a non-zero coefficient in the selection equation but does not appear in the outcome equation. Thus, the recursive modeling approach imposes less restrictive assumptions than the Heckman approach (Greene, 1997).

3.4.3 The Binomial logit model

Logistic regression or logit type models are used to analyse functional relationships involving qualitative variables. Specifically, they are used to investigate the relationship between independent variables and the log odds of the binary outcome variable. In analyzing farmer decision of adopting a technology, the logit model, which is based on cumulative logistic probability functions, is computationally easier to use than qualitative response model types of model and it also has the advantage to predict the probability of farmers adopting a a given technology.

Previous studies that analyzed social capital and adoption of technology used either logit or probit models. These models specify a functional relation between the probability of adoption and various explanatory variables. Gerhart (1975) used a probit model to explain adoption rates of hybrid maize in three different regions in Kenya. Jamison and Lau (1982) applied logit analysis to investigate factors affecting the adoption of chemical inputs among Thai farmers.

Logistic regression applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of the dependent occurring or not). The impact of predictor variables is usually explained in terms of odds ratios. The logit model takes the following form

$$Logit(p_i) = \ln(p_i / 1 - p_i) = \beta_1 Y_1 + ... + \beta_k Y_k \qquad (3:2)$$

The unknown parameters β_i are usually estimated by likelihood. The interpretation of the β parameter estimates is as the additive effect on the log odds ratio for a unit change in the *X* explanatory variable.

3.4.4. Propensity score matching for evaluating average effect of the program

The propensity score is the conditional probability of assignment to a particular treatment given a vector of observed covariates (D'Agostino, 1998). The purpose of matching is to select a subset of the control sample that has covariate values similar to those in the treated group. Matching on all covariates (pretreatment measurements) may be difficult when the set of covariates is large. In order to reduce the matching problem, Rosenbaum and Rubin (1983) suggested an alternative method which is based on matching on the propensity score $P(X)$ that solves the problem of selection bias. Using the propensity score, participants from the treatment group with participants from the control group can be matched, so that the treatment group and control group can be balanced.

The model is appropriate for addressing the problem of possible occurrence of selection bias. The selection bias problem arises because the aim is to determine the difference between the participant's outcome with and without a programme. Nonetheless, with cross sectional data it is impossible to observe the participants and non participant's outcome for a given household simultaneously. This is because participants and non-participants usually differ even in the absence of the programme. This is the problem of selection or selectivity bias. However, the propensity score approach can significantly reduce bias in observational studies (Rosenbaum, 1987**,** 2004**;** Rosenbaum and Rubin, 1985; Rubin and Thomas, 1992) through identification of non-participants who are similar to participants in all relevant pre-participation characteristics.

A number of studies have tried to capture the effect of training on productivity by using econometric measures on farm-level data, focusing largely on contributions of training to harvested yield. Barrett and O'Connell (2001) anaysed the effects of the level of training intensity on productivity changes and found out that the effect of training, days/total employment, was positive and significant on changes in labor productivity.

Other studies, like Godtland *et al*., (2004) used propensity score matching method to analyze the impact of FFS participation on farmers' IPM knowledge by creating a comparison group similar to the FFS participants in observable characteristics. Davis *et al.*, (2010) used propensity score matching method to evaluate the impact of FFS on crop productivity, farmers' empowerment and poverty. Praneetvatakul and Waibel (2006) used Difference in Difference (DD) estimator to evaluate the impact of FFS participation on crop yield and pest management practices and found significant impact on pesticide reduction and environment. Feder *et al*., (2004) used DD to evaluate the impact of the FFS participation on yields and pesticide use before and after the program. An appropriate methodology for such analysis should consider the selection bias arising from non random selected samples by controlling for farmers' differences when examining the impact of a programme. To address the self-selection bias problem, we make use of a variety of propensity score matching methods.

The first step in a propensity score analysis is to estimate the individual scores using logistic or probit regression. However, for this study a logit model was chosen for its computational simplicity. The conditional probability that the individual assigned to treatment 1 i.e. the propensity score of vector X can be defined as:

$$P(X) = \Pr(D = 1 \mid X_i) = \mathrm{E}(D / X_i) \tag{3:3}$$

where $P(X)$ is the propensity score of participation and $\Pr(D=1 \mid X_i)$ denotes the participation dummy equaling 1 if the individual participates, and 0 otherwise. Propensity score is a balancing score, the probability of participation conditional on X will be balanced such that the distribution of observables will be the same for both participants and non-participants. The probability of participation is conditional on X covariates that influence the probability of qualifying as a participant. The higher the probability, the higher is the likelihood of participation. This however does not imply that non-participants have equal propensity scores, but the scores may fall within a given range known as blocks of the propensity scores, generated during the estimation process. Then the logit model for our analysis is expressed as:

$$P(X) = \Pr(D = 1 | X) = F(\beta_1 \chi_1 + ... + \beta_i \chi_i) \quad (3:4)$$

where $P(X)$ and $\Pr(D=1 | X_i)$ are as defined above, $F(\cdot)$ is the logistic cumulative distribution function. However, this study was to estimate the average treatment effect on the treated. In order to achieve this and following Rosenbaum and Rubin (1983), we established two conditions: the balancing hypothesis and the conditional independence assumption. The balancing hypothesis dictates that the propensity score must be a precondition for the evaluation of effect of the program. And the distribution of pre-treatment characteristics must be the same across control and treated groups and thus

$$D \perp X | P(X) \quad (3:5)$$

This means that the pre-treatment charcteristics of the treated and control group must be the same it is conditional on the propensity score and each individual has the same probability of assignment to treatment. This ensures that persons with the same X values have a positive probability of being both participants and non-participants (Heckman *et al.*, 1999). This implies that the probability of FFS and CIG participation is conditional on farmer's socio-economic and institutional factors. Rosenbaum and Rubin (1983) have shown that if potential outcomes are independent of participation conditional on covariates they are also independent of participation conditional on a balancing score (X) or Average Effect of the Programme (AEP). The balancing assumption dictates that the propensity score of participation P(D=1 for FFS , Z=1 for CIG)= P(X) must be conditional for the evaluation of the effect of the programme.

On the other hand, the conditional independence assumption (CIA) requires that the independent variables are independent of participation but conditional on propensity score. It also assumes that selection is exclusively based on observable characteristics and the model is expressed as:

$$Y_1Y_0 \perp D \mid P(X) \tag{3:6}$$

where, Y_1Y_0 are the potential outcomes with or without program, D is the participation variable and $P(X)$ the propensity score. For a given propensity score, exposure to the program is random and therefore participants and non - participants smallholder farmers should be on average observationally identical (Caliendo and Kopeinig, 2005). Once the propensity score has been computed the Average effect of participation (AEP) can be estimated as follows:

$$\begin{aligned} AEP &= E\left\{Y_{1i} - Y_{0i} \setminus D_i = 1\right\} \\ &= \mathrm{E}\left\{\mathrm{E}\left\{Y_{1i} - Y_{0i} \setminus D_i = 1, P\left(X_i\right)\right\}\right\} \\ &= \mathrm{E}\left\{\mathrm{E}\left\{Y_{1i} / D_i = 1, P\left(X_i\right)\right\} - \mathrm{E}\left\{Y_{0i} \setminus D_i = 0, P\left(X_i\right)\right\} \setminus D_i = 1\right\} \end{aligned} \tag{3:7}$$

where (AEP) is the average effect of participation, Y_{1i} is the potential outcome if farmer is an FFS or CIG participant, and Y_{0i} is the potential outcome if the farmer is neither a participant in FFS nor in CIG.

The average treatment effect on the treated ATT indicates the mean differences between the scores among participants and non-participants who are identical in observable characteristics. In order to see the effect of the treatment of the propensity score technique, Becker and Ichino (2002) proposed different matching methods that include Nearest Neighbor Matching, Radius Matching, Kernel Matching and Stratification Matching. These methods are discussed as follows:

Nearest Neighbor Matching

The most straightforward matching estimator is the nearest neighbor (NN) matching. The individual from the comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score. This procedure is repeated for all the treated units.

This method guarantees that a match is always found for all the treated units even if the propensity scores are not close, provided there are enough controls available. Several variants of NN matching are proposed, e.g. NN matching `with replacement' and `without replacement'. When using NN matching with replacement, the untreated individual can be used more than once as a match, while for matching without replacement, an individual is considered (choosen) only once. However, allowing replacement increases the average quality of matching and decrease the bias in the data. For example, if we have a lot of treated individuals with high propensity scores but only few comparison individuals with high propensity scores, we get bad matches as some of the high-score participants will get matched to low-score non-participants. This can be overcome by allowing replacement, which in turn reduces the number of distinct non-participants used to construct the counterfactual outcome and thereby increases the variance of the estimator (Smith and Todd, 2005). Nonetheless, following Backer and Ichino (2002) the Nearest Neighbor Matching is computed as $C_i = \min_j \| p_i - p_j \|$, where C_i is asset control units matched to the participating units

Radius matching

The radius method is implemented by imposing a tolerance level on the maximum propensity score distance (caliper). Caliper means a propensity range where by an individual from the comparison group is chosen as a matching partner for a treated individual that lies within the caliper. Imposing a caliper works in the same way as allowing for replacement. Bad matches are avoided and hence the matching quality rises. This method has been used by Dehejia and Wahba (2002). The radius method is similar to caliper matching but removes the restriction of of matching a treated unit with its closest control within a caliper and instead accounts for and selects all units that fall within the caliper or radius. According to Dehejia and Wahba (2002) a caliper method is a variant of radius matching. The Radius matching is expressed as:

$$AEP = \sum_{t \in T} \left[y_i^{\mathrm{T}} - \sum_{j \in C_i} y_j^c \right] = \sum_{i \in t} y_i^{\mathrm{T}} - \sum_{j \in C_i} y_j^c \qquad (3:8)$$

Stratification matching method

According to Rosenbaum and Rubin (1983) the stratification method is also known as interval matching, blocking and subclassication. Stratification method is used to partition the common support of the propensity score into a set of intervals or strata and to calculate the impact within each interval by taking the mean difference in outcomes between treated and control observations. Cochrane and Chambers (1965) shows that five subclasses are often enough to remove 95% of the bias associated with one single covariate. Bias under unconfoundedness is normally associated with the propensity score and this suggests that under normality the use of five strata removes most of the bias associated with all covariates (Imbens, 2004). One way to justify the choice of the number of strata is to check the balance of the propensity score or the covariates within each stratum (Aakvik, 2001). The estimation of the stratified matching method is as follows:

$$AEP_q^s = \frac{\sum_{i \in I(q)} y_i^T}{N_Q^T} - \frac{\sum_{j \in I(q)} y_j^C}{N_q^C} \tag{3: 9}$$

Kernel matching method

The Kernel method uses weighted averages of all cases in the control group to estimate counterfactual outcomes. The weight is calculated by the propensity score distance between a treatment case and all control cases. The closest control cases are given the greatest weight. In this method of matching, each participant is matched with a weigted average eof all controlswith weights that are inversely proportional to the distance between the propensity score of participants and conrols. The average places higer weight on controls close in terms of propensity score of a participant and a lower weight on more distant observations. One major advantage of this approach is the lower variance, which is achieved because more information is used (Heckman, Ichimura and Todd, 1988). According to Smith and Todd (2005) Kernel method is a weighted regression of the counterfactual outcome on an intercept with weightsgiven by the Kernel weights. When applyingthis Kernel method one has to choose the Kernel function and the bandwidth parameter (Silverman, 1986; Pagan and Ullah, 1999). A high bandwidth values yield asmoother estimated density function, therefore leading to a better fit and decreases variance between the estimated and the true density function. The bandwidth choice is therefore a comparison between a small variance and unbiased estimate of the true density function. The function is given as follows:

$$AEP^{K} = \frac{1}{N^{T}} \sum_{i \in T} \left\{ y_i^{T} - \frac{\sum_{i \in c} y_j^{c} G\left(\frac{P_j - P}{h_n}\right)}{\sum_{K \in c} G\left(\frac{P_K - P_i}{h_n}\right)} \right\} \tag{3:10}$$

where AEP^{k} is average effect of the program, G is the Gaussian kernel function and h_n is a bandwidth parameter (default 0.06). N^{T} is the number of participants, y_i^{T} is the outcome of i^{th} *ith* participant, the total function on the right of the total function y_i^{T} reflects the weighted average of outcomes of all control units with $(pj, k - p_i)$ as distance or deviation between the propensity scores of participants and controls.

It is worth nothing that none of the approaches does result in a perfect solution. Rather, each method has its limitation and to reach a compromising frontier of the trade-off between quality and quantity of the matches, a joint consideration of all of the approaches to assess the robustness of the estimates is necessary (Becker and Ichino, 2002). Therefore, in this study all the matching approaches were used to arrive at quality and robust results.

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CHAPTER FOUR

SOCIO-ECONOMIC CHARACTERISTICS OF FARMERS AND INTEGRATED PEST MANAGEMENT (IPM) INFORMATION SOURCES USED BY HORTICULTURE FARMERS IN KENYA

4.1 Introduction

From the past, efficient access to agricultural information to farmers has been one of the major concerns to governments in the sub-Sahara Africa region including Kenya, where many consider agriculture as a source of livelihood. Hence, the availability of extension information is crucial in agricultural production (World Bank, 1994) as it enhances farmer production practices. As noted by Feather and Amacher (1994), providing information to producers can change their perceptions and reduce uncertainty about the technology. It is not in dispute that agricultural information is important and creates a positive influence on agricultural productivity. Thus, the aim of any agricultural extension strategy centered towards increasing production by providing farmers with training, information, access to inputs and services would generally enable farmers make better decisions on their production systems which would then improve their agricultural productivity.

The transfer of technical information, from the source to the desired audience requires appropriate channels of communication. Therefore, selection of effective information sources before hand is crucial to ensuring that it reaches the intended beneficiary without any distortion. The availability of agricultural information among researchers or policy makers does not impact the knowledge of the farmers until used with sources that are efficient. According to Rollins (1993) certain information sources can be “more effective change agents” than others. Therefore, for the successful adoption of technology to occur appropriate information sources are needed. Conversely, since the late 1970s, the primary policy tool for sharing information about new agricultural technologies in developing countries had been the training and visit (T&V) system of extension (Birkhaeuser *et al.,* 1991). This system is built around scheduled meetings between extension agents and ‘contact’ farmers, on the assumption that these farmers will then share the information about new technologies with other farmers in their villages. However, this system was found to be ineffective in disseminating agricultural information due to high cost and lack of sustainability (Gautam, 2000).

Extension information in Kenya is provided in the public sector by the Ministry of Agriculture (MOA) and in the private sector by the non-governmental organizations

(NGO's). These sectors use various methods, including field days, pamphlets, group discussions, workshops, on-farm demonstrations, audio-visual materials, printed materials and extension agents to disseminate agricultural information.

Nonetheless, the government of Kenya adopted the group-based approach namely FFS and CIG that are expected to facilitate dissemination of IPM information. The FFS approach is a form of adult education, which evolved from the observation that farmers learn optimally from field observation and their own experimentation (Simpson and Owens, 2002). It is a participatory method of learning originally designed in Asia to help farmers become better in utilizing Integrated Pest Management (IPM) (FAO, 2001; Van de Flirt *et al*., 1995) and has since then, in the African context, been extended to cover a broader range of plant production and management issues (Witt *et al*., 2008). The CIG approach is enterprise-based and aims to empower farmers to take up agribusiness enterprises that are market oriented and demand driven (Githaiga, 2007). It is a participatory extension approach which promotes farmer interaction by involving them fully as partners in determining demand and agendas for response by extension service providers (ROK, 2005).

One of the important strategies that need to be disseminated effectively using appropriate channels to farmers is the IPM technology. Previous study by Mauceri (2007) indicated that integrated pest management (IPM) is an approach that can help lower production costs, reduce exposure to pesticides and improve long-term sustainability of the agricultural system. Integrated pest management (IPM) is believed to be the best way to achieve good agricultural practices while protecting the environment. Mauceri (*ibid*) also notes that the IPM techniques are relatively complex and therefore require proper information dissemination channels for successful implementation to occur. The complexity of the IPM message can influence which method of diffusion will have the greatest impact.

Recently adopted group based training approaches such as FFS and CIG are believed to be appropriate sources to acquire and disseminate IPM information. Therefore the first research question of this study helped identify information sources used by FFS and CIG groups. Indeed it might be a reason that agricultural technologies did not disseminate effectively because the sources or channels used did not have an impact on disseminating agricultural information. By identifying the information sources between the two groups we are able to test whether the information sources used are different from each other. If the sources are different between the two groups then there is need to have specific information channels used by each group. However, there is little information on which sources that FFS and CIG farmers used to acquire IPM knowledge. Therefore, this chapter demonstrates the IPM information sources used by farmers who are participating in FFS and CIG groups.

4.2 Methodology

In assessing farmer characteristics, this study used, Analysis of Variance (ANOVA) especially Bonferroni method of correction to identify farmer distinct characteristics. This method was found to be appropriate to address the problem of multiple comparisons. Therefore, this method was used to identify farmers' characteristics among FFS, CIG and control farmers. The Bonferroni method of correction is useful in testing each of the individual farmer groups at a statistical significance level, which will enable to identify farmer's distinct characteristics of the farmer groups. In addition, descriptive statistics and chi–square were used to analyze sources of IPM information used by farmers.

4.3 Results and Discussions

4.3.1 Farmers' characteristics

The study sample consisted of 487 complete data sets. The descriptive results in Table 4:1 show that the majority (66%) of FFS sample farmers were female. In contrary, CIG and control farmers had fewer female farmers representing 37% and 24% respectively. The average age of FFS respondents was 49 years and ranged from 21 to 80 years. While the average age of a CIG farmer was 48 years and it ranged from 20 to 82 years representing a typical age among Kenyan farmers. The average numbers of years of schooling among FFS, CIG and control farmers were 9.2, 10.1 and 9.5 years, respectively. Land allocated for horticulture farming among FFS, CIG and non-group-based farmers were 0.97, 1.03 and 1.01 hectares.

Farmers of the three groups grow a range of horticulture crops including kales, cabbages, tomatoes, bananas, mangoes, passion fruit, French beans, avocados, butternuts etc. However, a higher share of control farmers (47%) grows kales compared to FFS and CIG farmers though all farmers ranked kale as the most important crop. Kale is a major vegetable consumed by majority of the households in Kenya. FFS farmers also grow a smaller variety of crops as compared to CIG and control farmers. This is possibly due to the fact that farmers in FFS rely on key agro-ecosystem relationships as the basis for making informed management decisions before planting various crops. Total horticulture yield per hectare among FFS, CIG and control farmers were recorded as 1,804, 2,711 and 3,254 kg per hectare, respectively. The differences in yield among the three groups might be attributed to the variety of crops that farmers grow. On the other hand, income from sale of vegetables across FFS, CIG and control farmers were US$ 405, 361 and 322 per household per year respectively, while income from sale of fruits generated an average income of US$ 329, 383 and 361 per household per year respectively. Then again the negative correlation between crop yield and income might also be attributed to the variety of crops and the different selling price of their produce.

Table 4.1: Characteristics of FFS, CIG and control smallholder horticulture farmers

Variable	FFS (N=157)	CIG (N=159)	Control (N=171)	*P*-value
Age (years)	49.3 (11.6)[a]	48.7 (13.4)[a]	45.1 (13.2)[b]	0.006
Schooling (years)	9.2 (0.4)[a]	10.1 (0.4)[a]	9.5 (0.4)[a]	0.069
Household literacy (number)	1.6 (0.6)[a]	1.5 (0.6)[a]	1.5 (0.7)[a]	0.287
Children in the household (number)	0.8 (0.5)[a]	0.9 (0.5)[a]	0.7 (0.5)[a]	0.638
Adult household members (number)	1.3 (0.6)[a]	1.3 (0.6)[a]	1.2 (0.6)[a]	0.403
Horticulture farming practice (years)	20.3 (12.5)[a]	17.3 (12.7)[b]	15.3 (11.5)[b]	0.001
Land under horticultural production (log hectare)	0.91 (2.3)[a]	0.87 (2.2)[a]	0.81 (2.4)[a]	0.533
Total horticulture crops output per year (kg per hectare)	1804 (3.6)[a]	2711.5 (4.2)[a]	3254.6 (3.9)[a]	0.468
Inorganic fertilizer use (kg per hectare)	25.55 (5.15)[a]	44.49 (4.40)[a]	52.32 (5.36)[a]	0.453
Organic fertilizer use (kg per hectare)	195.90 (8.1)[a]	426.62 (6.1)[b]	654.37 (7.1)[b]	0.001
Pesticide use (kg per hectare)	0.27 (6.9)[a]	0.34(8.3)[a]	0.37(5.3)[a]	0.288
Overall income	386.3 (1.1)[a]	341.4 (1.0)[a]	349.7 (0.8)[a]	0.703
Total expenditure on inorganic and organic fertilizer (US $)	26.50 (3.2)[a]	36.87 (3.6)[b]	50.90 (3.5)[b]	0.244
Total expenditure on pesticide (US $)	10.21(2.6)[a]	19.02(3.3)[b]	17.09 (3.1)[b]	0.001

Note: Figures in parenthesis are the standard errors. Figures in a row followed by the same letter are not significantly different at p<0.1 (ANOVA).

Source: *Computed from own survey data, 2008*

Table 4.1: Characteristics of FFS, CIG and control smallholder horticulture farmers continued

Variable	FFS (N=157)	CIG (N=159)	Control (N=171)	*P*-value
Distance to extension service (km)	8.21 (8.8)[a]	7.3 (7.3)[a]	6.1 (1.6)[b]	0.045
Distance to Agrovet (km)	6.3 (11.2)[a]	9.1 (40.3)[a]	15.0 (71.5)[a]	0.235
Distance to telephone (km)	3.2 (2.9)[a]	10.5(51.9)[a]	18.0 (86.3)[a]	0.371
Income from sale of vegetables (US$ per year)	405.3(2.1)[a]	361.4(2.9)[a]	322.3(2.6)[a]	0.716
Tropical livestock units per total land holding (TLU per hectare)	0.4 (2.11)[a]	0.5 (1.9)[a]	0.5 (2.7)[a]	0.083
Number of permanent labourers engaged (number)	0.3 (0.7)[a]	0.3(0.8)[a]	0.3(0.7)[a]	0.605
Number of casuals engaged (number)	2.4 (3.7)[a]	2.8(4.9)[a]	2.5 (3.0)[a]	0.608
Number of family labourers engaged (number)	2.6(2.3)[a]	2.1(1.7)[a]	2.2(1.5)[a]	0.097

Note: Figures in parenthesis are the standard errors. Figures in a row followed by the same letter are not significantly different at p<0.1 (ANOVA).

Source: *Computed from own survey data, 2008*

On fertilizer use, farmers in FFS used significantly less organic fertilizer than CIG and Control farmers. This is probably because FFS farmers go under intensive training and learn agro ecosystem analysis, which enables them to understand the soil nutrient requirements and the breakdown time frames. In addition, the result on total expenditure on pesticides was less for farmers in FFS as compared to CIG and Control framers. This is possibly because FFS farmers have better knowledge on the applicable and recommended quantities and therefore less wastage of pesticides. The descriptive results further showed that the three most important pesticides used across the three groups were Dimethoate, Karate and Atom respectively. The average number of tropical livestock units (TLU) among FFS, CIG and non-group-based farmers were recorded as 0.4, 0.5 and 0.5 per hectare respectively. Number of casual labourers engaged in farming activities across the three groups was 2.4, 2.5 and 3.2 respectively.

4.3.2 Sources of information and their accessibility

Farmers of the three groups have different access to information as shown by results in Table 4.2. On the use of newspaper 7.1%, 5.7% and 1.8% of FFS, CIG and control farmers read at least a newspaper daily on horticulture production and pest management information respectively. While the other 14.8%, 19.8% and 20% of FFS, CIG and control farmers read newspaper few times a week. In addition, 67.1%, 58.0%, and 64.7% of FFS, CIG and control farmers had never read any newspaper on horticulture production and pest management information respectively.

On farm accessibility, fifty four percent (54%), 60.8% and 50% of FFS, CIG and control farmers' farms were accessible all through the year respectively. However, the majority of FFS and CIG farmers' farms were more accessible all through the year as compared to Control farmers. On the other hand, 44.6%, 38.6% and 45.8% of FFS, CIG and control farmers' farms were accessible only during dry season respectively. About 0.6%, 0.6% and 4.2% of FFS, CIG and control farmers' farms respectively were never accessible all year round. These results were significantly different at 5%. This may be because some farmers live near the main road and they have a better chance of getting agricultural information as compared to others who live in the interior. On the use of newspaper, the results showed that 67.1%, 58% and 64.7% of FFS, CIG and Control farmers never read newspaper on horticultural production information. This is probably because FFS and CIG farmers get horticulture farming information since farmers are organized in groups.

Table 4.2: Accessibility of farms and information sources among FFS, CIG and control horticulture farmer

Variable	FFS (N=157) %	CIG (N=159) %	Control (N=171) %	χ^2	*P*-value
Gender of household head					
Male	34.39	63.58	76.02	60.866^{***}	0.000
Female	65.61	36.48	23.98		
Accessibility of farm					
All year	54.80	60.80	50.00	10.258^{**}	0.036
Dry season only	44.60	38.60	45.80		
Never accessible	0.60	0.60	4.20		
Adequate access to horticulture information					
Yes	22.90	17.00	12.30	6.515^{**}	0.038
No	77.10	83.00	87.70		
Use of news papers					
Daily	7.10	5.70	1.80	9.646	0.140
Few times a week	14.8	19.80	20.00		
Once a week	11.0	16.60	13.50		
Never	67.1	58.00	64.7		

*** and ** indicate statistically significant at 1% and 5% probability level

Source: *Computed from own survey data, 2008*

Forty four percent (44%), 41% and 35.3% of FFS, CIG and control farmers respectively cited Ministry of Agriculture staff as the first most important source of IPM information whereas NGOs and personal experience stood as the second and third important sources of IPM information among FFS, CIG and control farmers, respectively. Other information sources used included farmer groups, radio, books, NGOs, field days, newspapers, organic institutions, University and school. However, during informal group discussion held in 2007 with district and division horticulture officers, we observed that the majority of extension officers in the study area had not gone for IPM seminars or trainings, yet they were the first most important source of IPM information to farmers.

Munyua and Adams (2007) found out that extension officers in Kenya had low to moderate confidence in teaching the IPM concept. They attributed this to limited access to information or training on the concept. This implies that the appropriate IPM training of extension workers can greatly improve farmers' knowledge of IPM and good farm management skills.

On the other hand farmers' were asked to rank the three most important sources of horticulture production and pest management information. Thirty five percent (35%), 31% and 30% FFS, CIG and control farmers ranked ministry of agriculture extension staff as the first most important sources of information followed by friends, neighbours and relatives friends and radio stood third respectively.

Farmers were also asked to rank the three most important sources of market information for prices of horticulture crop. About 40.4%, 28.5% and 45.0% of FFS, CIG and control farmers, respectively, ranked local markets as the first most important source of information followed by friends and radio stood third. On ranking the three most important sources of horticulture farming information 34.6%, 44.44%, 28.74% of FFS, CIG and control farmers, in that order, ranked the Ministry of Agriculture as the first most important sources of horticulture farming information followed by friends and radio came last.

Farmers across all the three groups ranked similar information sources for their horticultural production information as well as for their market information for prices of horticulture crops. This result means that there are certain information sources that farmers are able to accees easily. The important sources of information that farmers ranked in this section might be available whenever farmers require agricultural information. In addition, farmers' confidence on the sources of information is instrumental here since farmers are risk averse and they intend to look for the best information surces that can provide them with relevant agricultural information. The various IPM information sources indicated in Table 4.3.

Table 4.3: Integrated Pest management Information sources across farmers

IPM information sources	FFS (N=157)	CIG (N=159)	Control (N=171)	χ^2	*P*-value
Pamphlet	0.75 (1.35)	0.00 (-0.69)	0.00 (-0.69)		
Mass media (radio)	0.00 (-2.26)	0.83 (-1.36)	6.6 (3.66)		
Newspaper	0.75 (-0.08)	0.00 (-1.19)	1.64 (1.27)		
Field days	5.97 (1.71)	2.5 (-0.86)	2.46 (-0.90)		
MoA	44 (1.06)	41.7 (0.34)	35.3 (-1.42)		
Seminars	1.49 (-0.12)	0.00 (-1.69)	3.28 (1.81)		
Books	0.75 (1.35)	0.00 (-0.69)	0.00 (-0.69)		
NGOs	12.69 (-0.15)	22.5 (3.73)	4.10 (-3.57)		
Personal experience	11.19 (-0.99)	18.33 (1.85)	11.48 (-0.82		
FFS	9.70 (4.93)	0.00 (-2.51)	0.00 (-2.54)		
CIG	0.00 (-1.68)	1.67 (0.39)	2.46 (1.33)	105.4821	0.000
JKU	1.49 (-0.75)	2.5 (1.46)	4.92 (-0.69)		
Organic institutions	0.00 (-1.50)	2.50 (1.86)	0.82 (-0.32)		
Friends, relatives & neighbors	9.7 (-1.63)	6.67 (-2.67)	24.59 (4.33)		
Community leaders	0.75 (0.43)	0.00 (-0.97)	0.82 (0.53)		
Agrovets	0.00 (-1.06)	0.83 (0.55)	0.82 (0.53)		
Chemical companies	0.75 (0.43)	0.00 (-0.97)	0.82 (0.03)		
College	1.49 (1.13)	0.00 (-1.19)	0.82 (0.03)		

Note: Figures in brackets are the standardized residuals with cut of value of 1.96; JKU means Jomo Kenyatta University;

Source: *Computed from own survey data, 2008*

4.4 Summary and conclusions

The objective of this analysis section was to identify farmer characteristics and assess the range of farmers' sources of IPM information. From the findings it was found that the majority of FFS and CIG participants were female and male respectively. About the level of education the average years of schooling among FFS and CIG farmers were 9.2 and 10.1 years respectively. The average land size of horticulture cultivated land holdings was 0.91 and 0.87 hectare respectively. In addition, smallholder horticulture farmers across FFS, CIG and control farmers ranked Ministry of agriculture extension staff, NGOs and friends as the three most important sources of IPM information respectively. On the other hand, ministry of extension staff, NGOs and personal experience were ranked as the three most important sources of horticultural production and pest management information.

About awareness of market information for prices of horticulture crop local markets, friends and radio were ranked as the three most important sources of information. The ministry of agricultural extension staff, friends and radio were ranked as the three most important sources of horticulture farming information. Therefore, it is recommended that agricultural extension services providers such as ministry of agriculture and NGOs should consider improving the capacity of extension workers in terms of IPM training through seminars and agricultural workshops. This is because, Ministry of Agriculture extension staffs are the most important sources of IPM and horticultural production information mentioned by the majority of farmers in the study area. Thus, this study suggests the need to strengthen the existing system of agricultural extension. In addition, other information source such as radio should be used efficiently to reach out farmers who reside far from the extension service station. In addition, the findings of this study may be used to provide researchers and extension providers on the best information sources that can be efficient to disseminate important agricultural information to farmers.

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CHAPTER FIVE
FACTORS AFFECTING DIFFUSION OF IPM INFORMATION AMONG SMALLHOLDER HORTICULTURE FARMERS IN KENYA

5.1 Introduction

In chapter 1 it is demonstrated that the horticultural sub-sector is key to foreign earnings and it has the potential to improve household welfare through providing income, satisfying domestic food needs as well as providing opportunities for improving human health and household economic and social development (GHA, 2005). The sector however faces serious constraints, of which pests are of major concern largely due to overreliance on pesticides for pest and disease control (Raini *et al*., 2005). Thus, there is increasing need for alternative production systems such as integrated pest management (IPM) to reduce the reliance on pesticides (Lumpkin, 2006). Apparently, such systems are available for a range of horticultural crops produced in Eastern Africa (Sithanantham, 2004). However, what is needed is appropriate training for farmers to utilize such systems.

Various training approaches have been applied in Kenya in order to improve agricultural production through uptake of new production technologies. The approaches include Training and Visit (T&V), Integrated Rural Development Program (IRDP) and face-to-face extension approaches. According to recent assessments, these approaches were perceived as being too top-down, lacking participatory possibilities and not always tailored towards clientele's demands (ROK, 2005; Gautum, 2000). The approaches also had a tendency of centralized management system, which could not fit diverse conditions and needs (Chambers, 1997; Antholt, 1993). Due to these limitations, the Government of Kenya and other stakeholders have switched to group-based participatory training approaches that emphasize clientele's needs and demands. The group based participatory training approach provides opportunity to increase bargaining power of members in order to access information (Lapar *et al*., 2006). Overall, farmer groups are considered crucial to acquiring basic skills for problem solving and enterprise management as well as serving as an efficient channel for delivering extension services (FAO, 2001). Two approaches, the Farmer Field Schools (FFS) and the Common Interest Groups (CIGs), have become popular in Kenya as they are considered effective in disseminating information through farmer to farmer interaction aiding production making decisions.

The FFS approach is a form of adult education in which farmers learn optimally from field observation and their own experimentation (Simpson and Owens, 2002). It is a participatory method of learning (FAO, 2001) originally designed in Asia to help farmers become better in utilizing Integrated Pest Management (IPM) (van de Flirt *et al*., 1995). It has since, in the African context, been extended to cover a broader range of plant production and management issues (Witt *et al*., 2008). The CIG approach is enterprise-based and aims at empowering farmers to take up agribusiness enterprises that are market oriented and demand driven (Githaiga, 2007). It is a participatory extension approach promoting farmer interaction and involves them fully as partners in determining demand and agendas for response by extension service providers (Republic of Kenya, 2005). Moreover, the formation of CIGs is usually undertaken by farmers themselves and sometimes facilitated by agricultural extension officers. The group members must have the common goal of promoting the enterprise as a business, which is flagged as a commercial opportunity by using pamphlets, posters and media (ROK, 2001). The CIG approach was initially designed in 2000 to target marginalized group of farmers in Kenya. In this approach, extension officers identified a wide range of opportunities to accommodate various categories of farmers with respect to resource endowments and socio economic status (Githaiga, 2007).

In general, farmers obtain information either through formal sources such as the mass (radio) and print media and through inter-personal media (Rogers, 1995). They also obtain information through informal sources. For example, in Nigeria, neighbors, organized groups, extension agents, other farmers and opinion leaders are important sources for information sharing (Ekoja, 2003). Similar findings hold for Kenya, for example, farmers' main source of IPM information is their neighbors (Raini *et al*., 2005). In addition, NGOs, friends, chiefs' barazas (public meetings), and agricultural companies are common sources of agricultural information (Rees *et al*., 2000). In chapter 4 as well as partly in this chapter, sources of IPM and horticulture production information among FFS and CIG Kenyan smallholder horticulture farmers are demonstrated. This chapter analyzes the extent to which the two participatory group based approaches enhance uptake and diffusion of IPM knowledge in horticultural production needs to be evaluated. Further, this chapter further assesses the factors linked to the acquisition of IPM knowledge and sharing amongst the two different group-based farmers as well as individually (control) operating farmers.

5.2 Methodology

5.2.1 Construction of IMP knowledge index using principal component analysis

Principal component analysis (PCA) is a variable reduction procedure for data sets with a large number of variables, which may be correlated to each other. PCA helps to reduce the observed variables into a smaller number of principal components that account for most of the variance in the observed variables. PCA can be applied to integrated pest management, which requires knowledge of different practices. Each of the practices has a knowledge component contributing to the integrated knowledge of the IPM practices. However, measuring the knowledge level about each practice by horticulture farmers directly is difficult since all the practices simultaneously contribute to the integrated knowledge. This study therefore, chose to use the principal component analysis (PCA) to obtain IPM knowledge index that would proxy for knowledge acquired from a range of IPM practices for further analysis.

The PCA method has been used in a number of studies (e.g., Amudavi 2005; Amudavi and Kroma, 2005) which investigated on propensity of farmers to adopt integrated natural resource management practices in Vihiga, Baringo and Embu districts of Kenya. In this study, the PCA procedure was used to generate two components from the 12 IPM ractices. Kher

The PCA procedure begins with a set of K variables, a^{*}_{1i} to a^{*}_{Ki} representing knowledge on K IPM practices by the *ith* farmer. This is represented by binary scale: 1 if the farmer knows about each of the practices measured by checking whether the farmer is able to explain how the practice is to be implemented and otherwise 0.

The knowledge variable represents the knowledge index of the range of IPM practices. Each variable, a^{*}_{1i}, is specified by its mean and standard deviation, a_{1i} i = $\left(a^{*}_{1i} - a^{*}_{1}\right)/\left(s^{*}_{1}\right)$ where (a^{*}_{1} is the mean of a^{*}_{1i} across all N farmers and s^{*}_{1} is the standard deviation. The selected variables are linked with latent components (factors) for each farmer i through the equation:

$$a_{1i} = v_{11} \text{ x } A_{1i} + v_{12} \text{ x } A_{2i} + ... + v_{iK} \text{ x } A_{Ki}$$
$$\vdots \qquad (5:1)$$
$$a_{Ni} = v_{N1} \text{ x } A_{Ni} + ... + v_{KK} \text{ x } A_{Ki}$$

where A are the components; v the coefficients on each component for each variable and these are constant across all households; i = 1, …., N are the number of farmers; and k = 1, ….., K, are the number of IPM practices. It is only the left hand-side which is observed, making the solution to the problem indeterminate. The PCA solves this by determining specific linear combinations of the variables with maximum variance accounted for in the first principal component A_{1i} (Lawley and Maxwell, 1971). The procedure is repeated for each successive component accounting for the maximum of variance remaining. Reversing equation (1) yields factor loading from the model that are estimates for each of the K principal components:

$$A_{1i} = f_{11} \times a_{1i} + f_{12} \times a_{2i} ...... + f_{1K} \times a_{ki}$$
$$A_{K1} = f_{K1} \times a_{1i} + f_{K2} \times a_{2i} ...... + f_{KK} \times a_{Ni} \qquad (5:2)$$

where A_{1i} is the first principal component, a_{1i} the normalized variable, f_{1i} is the factor score coefficient (weight) by which the normalized variable is multiplied to obtain a factor score in the linear combination. Thus, the IPM knowledge index for each farmer is based on the expression:

$$A_{1i} = f_{11} \times (a^*_{1i} - a^*_1) / (S^*_1) + ... f_{1N} \times (a^*_{ni} - a^*_N) / (s^*_N) \qquad (5:3)$$

Further, for purposes of interpretation the principal components were rotated using varimax rotation as proposed by Kaiser. The reason for using varimax rotation is to determine which IPM practices loaded heavily with each of the components. The two principal components with eigenvalue greater than one were extracted and considered as proxy indices for knowledge. They were then used as dependent variables in the recursive binary choice model to assess factors affecting IPM knowledge acquisition and sharing.

5.2.2 Recursive simultaneous binary choice model

Assessing knowledge acquisition and sharing or diffusion of IPM can be analyzed using the Heckman two step sample selection model and the recursive regression model. Heckman's two-stage estimator is the most widely used approach in correcting selection bias that occurs from using nonrandom selected samples (Heckman, 1979).

The first stage involves a selection equation which is a probit model to predict the probability. From the probit estimation the inverse mills ratio (IMR) is generated then included in the second stage as a regressor to solve the sample selection problem. However, the model requires an exclusion restriction to generate reliable estimates of a variable which appears with a non-zero coefficient in the selection equation but does not appear in the outcome equation.

Recursive modeling on the other hand is an analytic tool for studying the relationship between a dependant variable and a collection of predictor variables (Hawkins, 1994), whereby the dependent variable in the first stage becomes an independent variable in the second stage (Heckman, 1978; Maddala, 1983; Greene, 2003). In this study and following Greene (1997), a recursive simultaneous binary choice model is specified to assess relationship between IPM knowledge acquisition and sharing of the acquired knowledge as:

$$\begin{aligned} y_1 &= x_1^{'}\beta_1 + \varepsilon_1 \qquad y_1 = 1 \text{ if } \quad y_1^* > 0, 0 \text{ otherwise} \\ y_2 &= x_2^{'}\beta_2 + \delta y_1 + \varepsilon_2 \qquad y_2 = 1 \text{ if } \quad y_2^* > 0, 0 \text{ otherwise} \end{aligned} \qquad (5:4)$$

where y_1 is the binary variable (knowledge index) that was generated by using the first two principal components of the twelve IPM practices (see Table 5.1) and y_2 is the dependent variable depicting a binary information sharing outcome, y_1^* and y_2^* are latent variables for information reception and sharing respectively, $x_1^{'}\beta_1$ $x_2^{'}\beta_2$ are index functions of the two equations, δy_1 is the estimated coefficient of the first y and ε_1 and ε_2 are the corresponding disturbance terms assumed to be not normally distributed.

This specification is grounded on the assumption that information acquisition is a necessary condition for sharing the knowledge acquired. This recursive modeling approach imposes less restrictive assumptions than the Heckman approach (Greene, 1997).

Variables in the Model

Variables included in this model are shown in Table 5.1. Independent variables that were hypothesized to explain knowledge acquisition included dummies for membership in FFS or CIG with control farmers (farmer_grp), number of groups a farmer belonged at the time of the study (grpnumber), total number of school years of the household head (scholyrs), household member's (children, wife or husband and relatives excluding the farmer) literacy level (the number of household members who read and write) , gender, household size (hhsize) distance to extension services (distextn), land size(loghectare), number of permanent labourers (permtlbr), number of casual labourers (hwmcaslb), access to horticulture production and pest management information (access) frequency of listening to radio on horticulture production program (hwofnrdio), frequency of listening to radio on horticulture production and pest management information (freqnewspaper), and farmer's locality (district).

Variables explaining knowledge sharing included memberships in FFS and CIG, total number of school years (scholyrs), age, gender, household size, knowledge acquisition (knowledge index), number of casual labours engaged (hwmcaslb). A district dummy variable was used if a farmer lived in a particular district (Muranga, Thika, Maragua or Makueni) equaling 1, otherwise 0, with (Embu) being reference district.

Table 5.1: Description of variables and expected signs

Variable	Description	Knowledge acquisition	Knowledge sharing
Dependent			
Knowlge index (y_1)	Acquisition of IPM knowledge (1=yes, 0=no)		
Passinfo (y_2)	Sharing of IPM knowledge (1=yes, 0=no)		
Independent			
Control	Base, not being FFS or CIG member		
FFS	Being FFS member	+	-
CIG	Being CIG member	+	+
Grpnumber	Number of groups farmer belongs to excluding FFS and CIG (number)	+	+
Scholyrs	Total number of school years (number)	+	+
Hhmbrdwt	Household literacy (Number)	+	+
Gender	Gender of the farmer (1= male, 0=female)	_	_
Age	Age of the farmer	_	_
Hhsize	Number of household members (number)	+	+
Loghectare	Total land under horticulture farming (ha(log)	+	+
Permtlbr	Permanent labourers employed (number)	+	+
Hwmcaslb	Number of casual labourers (number)	+	+
Freqradio	Frequency of listening to radio on horticulture production and pest management information (1=every day, 2=few times a week, 3=once a week, 0=never)	+	
Freqnewspaper	Frequency of reading newspaper on horticulture production (1=every day, 2=few times a week, 3=once a week, 0=Never)	+	

Table 5.1: Description of varibles and expeted signs continued

Variable	Description	Knowledge acquisition	Knowledge sharing
Dependent Knowlge index (y_1)	Acquisition of IPM knowledge (1=yes, 0=no)	+	
Passinfo (y_2)	Sharing of IPM knowledge (1=yes, 0=no)	-	
Independent	Whether farmers receive visitors to share IPM (1=yes, 0=no)		+
Embu	Base/reference district		
Maragua	Maragua (1=yes, 0=otherwise)	+	+
Makueni	Makueni (1=yes, 0= otherwise)	_	_
Thika	Thika (1=yes, 0=otherwise)	+	+
Muranga	Muranga (1=yes, 0=otherwise)	+	+

Participation in FFS and CIG: This was expected to positively and significantly influence knowledge acquisition and sharing. A higher intensity of training and interaction with trainers enhances knowledge acquisition. Further, participation in FFS and CIG group membership was expected to create social relationships through farmer-to-farmer interaction leading to information exchange.

Association of belonging more than one group*:* It was hypothesized that belonging to many groups could have a significant and positive influence on the acquisition and sharing of IPM knowledge. Farmer groups were expected to facilitate farmer interaction through creating social relations, which is a prerequisite for knowledge acquisition and sharing.

Education: Following earlier findings (e.g. Schultz, 1975) we hypothesized that education of a farmer positively and significantly influenced information acquisition since education enhances the ability of a farmer to acquire, comprehend and process information. Similarly, household member literacy was also expected to increase the probability of knowledge acquisition on IPM and was measured as the number of persons who could read and write in the farmers' household.

Household literacy: This was measured as the number of household members who reads and writes and was hypothesized to have a positive effect since it is crucial in acquiring and sharing information.

Gender: This is a dummy variable that refers to the sex of the farmer. It was hypothesized to influence IPM knowledge acquisition and sharing since female-headed compared to male-headed households were likely to be disadvantaged in information exchange. For example a study in Uganda showed that women had a high opportunity cost of time making them become less motivated in information exchange due to limited time available for interaction (Katungi *et al*., (2008). For women to build and maintain a social network was also costly in terms of both time and other resources (Dasgupta, 2005).

Age**:** Age of the farm decision maker was also expected to influence IPM knowledge acquisition and sharing among smallholder horticulture farmers. Our assumption was that older farmers were less likely to exchange information effectively due to lack of ability to communicate sufficiently about the new innovation to other farmers. On the other hand, younger farmers were likely to participate in information exchange behavior since they were capable of interacting with fellow farmers. Thus, the younger the farmer the better she/he could receive or share information on the new technology.

Household size: It was also another important determinant that expected to affect information flow among farmers. We hypothesized that larger households positively affected information flow activities since such households had more contacts and a wider social network which was a prerequisite to information flow. This claim was in agreement with Ketema (2008) who reported about the importance of an increased number of household members in creating more contact with different social networks that meant better access to input and information.

Farm size**:** Land size under horticulture production was expected to influence farmers' decision to acquire or not acquire IPM knowledge. Thus, land holding was hypothesized to have a positive influence on acquiring agricultural information such as IPM.

Labour: It was also expected to positively influence acquisition and sharing of IPM knowledge. A farmer with a large number of permanent labourers was more likely to be in a position to interact with other farmers due to sufficient manpower, which eventually frees up time.

***Access to information*:** Access to horticultural production and pest management information was hypothesized to have a positive influence in IPM knowledge acquisition. Farmers who had adequate access to information could overcome information scarcity through exposure. This could enable them to acquire new agricultural techniques. On the contrary, farmers with no adequate access to information would find it very difficult to acquire and adopt IPM knowledge. This is because access to information was expected to increase the probability of acquiring knowledge on IPM. It was measured by assessing if a farmer had adequate (farmers get sufficient horticulture information whenever they need) access to horticulture production and pest management information equaling one and zero otherwise.

***Distance to extension services*:** Distance was hypothesized to have a negative effect on the probability of IPM knowledge acquisition. This is possibly because farmers who resided closer to extension service were at a greater advantage in getting agricultural information. To the contrary, the farthest the farmer resided the lesser he or she got agricultural information. This supposition is in agreement with Ransom *et al*., (2003) who reported that farmers were known to gain access to new information provided through extension services suggesting, the important role that extension play in disseminating agricultural information.

***Listening to radio on horticulture production and pest management information*:** This was expected to positively influence IPM knowledge acquisition. This has been shown to create awareness among farmers who deal with brassica crops in East Africa (Nyambo and Löhr, 2005). We expected this variable to enhance the ability of farmers to quickly acquire, synthesize and respond to new information, thereby also increasing the probability of IPM knowledge sharing.

***Frequency of reading newspapers on horticulture production and pest management information*:** It was also hypothesized to positively influence knowledge acquisition on IPM. A possible explanation to this is that farmers who are exposed to such programs are likely to acquire new knowledge on a given technology.

5.3 Results and discussion

5.3.1 Generating IPM Knowledge index from IPM practices

The descriptive results in Table 5.2 indicated that knowledge of pesticide application,crop rotation, timely planting and ash application are the most widely known practices.

Table 5.2: Knowledge of IPM practices among FFS, CIG and control based (% of farmers who know about practices measured as 1 = yes, 0 = no)

Knowledge of IPM practices	FFS (157)	CIG (159)	Control (171)	χ^2	P-value
Pesticide application	69.430	71.070	72.510	0.379	0.827
Mass trapping	21.020	17.610	8.770	10.042***	0.007
Hand picking	57.960	38.990	35.090	19.562***	0.000
Deep ploughing	58.600	50.940	50.290	2.744	0.254
Plant resistance	42.040	34.590	29.240	5.913	0.052
Mixed cropping	82.800	54.090	52.630	39.637***	0.000
Timely planting	61.150	59.120	41.520	15.575***	0.000
Sanitation	52.870	52.200	40.350	6.607**	0.037
Crop rotation	89.810	71.700	71.350	20.367***	0.000
Solarization	9.550	6.290	4.680	3.169	0.205
Applying ash	73.890	62.260	50.880	18.399***	0.000
Plant extract	37.580	28.930	22.220	9.329***	0.009

*** and ** indicate statistically significant at 1% and 5% probability level

Source: *Computed from own survey data, 2008*

Knowledge of hand picking, mixed cropping, timely planting, crop rotation, ash application, mass trapping, planting resistant variety and use of plant extract differs significantly at 0.01 probabilities.

The result of the principal component analysis in (Table 5.3) indicated that the first component explained 30.5% of the variance in knowledge of IPM practices while the second component explained 11% of the variation. Thus both explained overall 42% of the total variation in group variables. This means that the first two components would be correlated with at least some of the observed variables. Following Kaiser (1960) eigenvalues greater than 1 were retained for further analysis. Further, components were rotated using varimax rotation with Kaiser Normalization procedure for interpretation.

Table 5.3: Principal component analysis of knowledge of IPM practices among farmers

Variable	Principal Component	
	1	2
Pesticide application	-0.002	0.333
Mass trapping	0.017	0.414
Handpicking	0.259	0.191
Deep ploughing	0.460	-0.041
Plant resistance variety	0.027	0.399
Mixed cropping	0.484	-0.066
Timely planting	0.320	0.152
Sanitation	0.074	0.309
Crop rotation	0.514	-0.140
Solarization	-0.119	0.453
Ash application	0.310	0.063
Plant extract	0.047	0.408
Eigenvalue (4.97)	3.650	1.320
Percentage of variance explained (41.49)	30.480	11.010

Source: *Computed from own survey data, 2008*

The results indicated that four of the IPM practices loaded heavily on the first component while five of the IPM practices loaded heavily on the second component.

The first component had the following IPM practices loading heavily on it: crop rotation, mixed cropping, deep ploughing, and timely planting. On the other hand, ash application, mass trapping, plant extract, plant resistance variety and sanitation heavily loaded on the second component. This suggests that the above mentioned variables are major contributors to component one and component two.

5.3.2 Factors affecting knowledge acquisition and sharing

This particular sub-section demonstrates the results of the factors hypothesized to influence IPM knowledge acquisition and sharing. The model specification results show that the model fit with Prob > χ^2 = 0.0000 leads us to reject the null hypothesis and hence that all the entire model is significant indicating the significance power of the explanatory variable used in the model. The Pseudo R^2 was also 21 and 35 for IPM knowledge acquisition and IPM knowledge sharing respectively (Table 5.4). The Pseudo R^2 figures are higher than the cut -off point of 20%, implying that a high percentage of the changes in the dependant were associated with the variable in question. The covariates show marginal changes in the predicted probabilities of IPM knowledge acquisition and IPM knowledge sharing. The marginal probabilities enable ease in the interpretation of the covariates, and reflect marginal changes of the dependant variable due to a unit change in the covariates.

Table 5.4: Marginal effect results on determinants of IPM knowledge acquisition and sharing by horticulture farmers

Variable	Knowledge acquisition	*P*-value	Knowledge Sharing	*P*-value
Dependent Acquisition of IPM knowledge (index) (1=yes, 0=no) IPM knowledge sharing (yes=1 and 0 otherwise)				
FFS	0.278***	0.000	-0.229***	0.003
CIG	0.198***	0.001	0.078	0.200
Other groups	0.068***	0.001	-0.034	0.181
Household literacy	0.025**	0.027	0.016	0.177
Age	0.002	0.313	0.003	0.226
Gender	-0.041	0.375	-0.155**	0.006
Household size	-0.022**	0.030	0.001	0.988
Land under horticulture farming (log ha)	-0.058**	0.040	-0.011	0.764
Permanent labourers employed	-0.060**	0.038	-0.020	0.581
Casual labourers employed	-0.001	0.862	0.016	0.096
Access horticulture production information	-0.206***	0.000		
IPM Knowledge acquisition			0.864***	0.000
Distance to extension services	-0.012***	0.001		
Farmers visitors			0.573***	0.000
Frequency of listening to radio on horticulture production and pest management information	-0.041**	0.021		
Maragua	0.205**	0.024	-0.254***	0.007
Makueni	0.206**	0.029	-0.231**	0.033
Thika	0.043	0.667	0.175**	0.005

Muranga	0.107	0.227	-0.135	0.126
Log pseudo likelihood	-225.155		-208.373	
Number of observations	487		487	
Wald	97.92		166.17	
Prob > χ^2	0.0000		0.0000	
Pseudo R2	0.2194		0.3526	

*** and ** indicate statistically significant at 1%, and 5% probability levels

Source: *Computed from own survey data, 2008*

Further, the marginal effect results on factors affecting IPM knowledge acquisition and sharing of the acquired knowledge are presented in Table 5.4. Results showed that participation in FFS increased the marginal probability of IPM knowledge acquisition by 0.278. The results were significant at 1% proving the importance of FFS membership in obtaining IPM knowledge. This finding corroborates those of Pontius *et al.* (2002), Godtland *et al.,* (2004) and Yang *et al.*, (2008) who reported that FFS play a major role in extending IPM knowledge to farmers emphasizing the importance of FFS participation in increasing farmer's knowledge. The findings of this study also demonstrated the important role that of FFS played in acquiring IPM knowledge.

For example, the strategy of FFS approach was not to train all farmers in the community, but rather to catalyze the spread of knowledge about technologies and practices through farmer-to-farmer diffusion (Feder *et.al,* 2004). Our results also indicate that participation in CIG significantly ($p<.05$) increased the marginal probability of IPM knowledge acquisition by 0.198, which is less than FFS membership. The acquisition of IPM knowledge among FFS and CIG group based farmers is probably because farmers are organized in groups, trained in IPM and crop production techniques.

The probability of IPM knowledge sharing among FFS farmers was significantly ($p<.05$) negative with marginal probability of 0.229. The significant and negative influence of FFS participation in knowledge sharing might have reflected the lack of motivation among FFS farmers to disseminate knowledge of IPM to other farmers. The lack of information sharing among the FFS could also explain why the majority of control farmers lacked information on IPM. The result of this study agrees with Feder *et al.,* (2004) who reported the lack of significant diffusion of knowledge from FFS participants to farmers who resided in the same village. Similarly, being a member of a CIG group did not increase the marginal probability of sharing IPM knowledge since CIG farmers rather are interested in market and marketing information.

According to the marginal effect result, FFS and CIG membership, the number of groups farmers belonged to excluding FFS and CIG, farmer household members' literacy (number of literate persons in the farmers' household) and locality positively and significantly affected IPM knowledge acquisition while household size, land size, permanent labour, casual labour, access to horticulture production information, distance to extension services, farmer visitors, frequency of listening to radio on horticulture production information and frequency of reading news paper on horticulture production negatively and significantly affected IPM knowledge acquisition. Knowledge sharing is significantly and positively linked with the number of casual labours employed, IPM knowledge acquisition and the number of visitors received while membership in FFS, gender, and locality also significantly and negatively affect IPM knowledge sharing.

From our results, farmers belonging to more than one association appeared to have a positive effect in acquiring IPM knowledge with the marginal probability of 0.068. The significant and positive influence of group membership plays a role in enhancing farmer interaction, which in turn enhances IPM knowledge acquisition. Katungi *et al*., (2008) reported that belonging to more associations in rural Uganda appeared to have a strong effect on two-way informal information exchange, increasing the likelihood that both men and women will engage in information pooling with others.

Literacy among members of a household increased the probability of acquiring IPM knowledge by 0.025. Households with literate members are more likely to acquire IPM information that could subsequently benefit the farmer. Basu *et al*., (2000) reported that an educated member of the household confers a positive externality on the illiterate agents in the household by sharing the benefits of his or her literacy.

Results on gender indicated that IPM knowledge sharing among female farmers decreased by 0.155. This is possibly because female farmers are likely to be engaged in household responsibilities, which could limit their interaction with other farmers.

Results on household size showed that the increase in number of members negatively influenced the marginal probability of acquiring IPM knowledge by 0.022. Farmers with larger households might have more responsibilities that could affect the time left for interaction as well as for attending to agricultural practices enrichment programs.

Larger land size under horticulture crop decreases the probability of acquiring IPM information by 0.058. The results were significant at 5% but with the negative influence on the marginal probability of acquiring IPM knowledge. This finding could imply that farmers with large land size could be less risk averse to new technologies. This result is not in line with finding of Feder *et al*., (1985) in their adoption studies where they demonstrated that smaller land sizes were a constraint to rapid adoption of new technologies.

Results on permanent labour showed that there is a negative correlation between permanent labour and IPM knowledge acquisition. The results were significant at 5% but with the negative influence on the marginal probability of acquiring IPM knowledge.

On access to horticulture production and pest management information, results showed that farmers with insufficient access were more likely to acquire knowledge of IPM compared to those who had adequate access. The results were significant at 1% but with a negative influence on the marginal probability of 0.206, suggesting that acquisition of information is influenced by accessibility. This means that for better acquisition of knowledge there is need for ensuring that sources of information to farmers are easily available and accessible.

Distance to extension service decreases the marginal probability of IPM knowledge acquisition by 0.012. The results were significant at 1%. This negative influence of distance to the extension service confirms the importance of accessibility of the public extension services as earlier indicated by the descriptive results. This finding is in agreement with Chilot (1994) who reported that increase in distance to extension services negatively affects agricultural information reception among farmers. This may be due to an increase in transaction costs associated with distance.

Results on farmers who received visitors and shared IPM information with them increased the marginal probability of IPM knowledge acquisition by 0.573. The results were significant at 1%. The significance and positive influence of visitors illustrates the importance of farmer to farmer interaction in exchanging ideas on new technologies such as IPM. As expected, results also showed that farmers who had acquired IPM knowledge were likely to share it. The magnitude of the marginal influence was 0.864 percentage points emphasizing the need for training and encouraging farmer to farmer extension.

Locality was also found to be one of the factors that influenced IPM knowledge acquisition and sharing. In this study, Embu district was taken as a base district for the purposes of comparison. It has a diversity of agroecological conditions ranging from high altitude or temperate vegetable zone (UM1) to very dry low land (Ouma *et al*., 2002), which serve as a representative for each district. The results showed that farmers in Maragua district were more likely to acquire IPM knowledge compared to farmers in Embu. The results were significant at 1% with the marginal probability of 0.205. The significant and positive influence of locality reflected the important role played by proximity to the capital city and good infrastructure. Maragua district has a high farmer density, is nearer to Nairobi city, has good infrastructure, has available extension staff, and has many farmer groups such as FFS and CIG. These factors make access to information sources easier in addition to providing it with a large market. The result also showed that farmer's residence in Makueni district is statistically significant in terms of IPM knowledge acquisition at 5%. Farmers' residence in Makueni compared to residence in Embu was more to be associated with IPM acquisition. This suggests that there could be more information receiving and sharing networks in Makueni than Embu. This is possibly because being makueni is a dry and a major horticultural producing area, the government and other stakeholders might have paid a lot of attention in terms of information access.

The marginal probability of sharing IPM knowledge among farmers who resided in Maragua and Makueni as compared to Embu decreased by 0.254 and 0.231 units. On the other hand, the probability of sharing IPM knowledge among farmers who reside in Thika as compared to Embu increased by 0.175. The results were significant at 5%. Suggesting the proximity of Thika district on the outskirts of Nairobi city and availability information sharing networks could be instrumental here.

The marginal effect results also showed that the increase in frequency of listening to radio and reading newspaper among farmers decreased the probability of acquiring IPM knowledge. The magnitude of the marginal influence was 0.041 and 0.037. This is possibly because farmers who spend few times in listening to radio and reading news paper on horticulture production were less likely to acquire IPM knowledge.

5.4 Summary and conclusions

Horticulture is an important sector of the Kenyan economy with a range of pest and disease problems that are mostly dealt with by chemical control. Recently, group-based training approaches have been promoted in Kenya to accelerate dissemination of new technologies and practices among farmers through various learning and communication networks. Among the most popular ones are the farmer field school (FFS) approach and common interest groups (CIGs). The former approach concentrates more on production and management whereas the latter centers on commercial opportunities. The aim of this study was to assess to what extent FFS and CIGs contributed to increasing knowledge and dissemination of information on integrated pest management. The analysis was based on a random sample of 495 active horticulture farmers in five districts of Kenya. The horticulture farmers were sampled from FFS, CIGs as well as control farmers who did not belong to any of these two groups. Principal component analysis was used to generate a binary variable (knowledge index) and a recursive regression model used to analyze the acquisition and sharing of IPM knowledge.

The principal component analysis result showed that the first and the second component explained 42% of the total variation in group variable. Further, the result showed that the first component represented latent knowledge gained from crop rotation, mixed cropping, deep ploughing, and timely planting while the second component were driven by ash application, mass trapping, plant extract, plant resistance variety and sanitation.

On the other hand, the results of the marginal effect indicated that farmer participation in FFS and CIG was more likely to enable acquisition of knowledge of IPM but they could not enable sharing of the acquired knowledge with other farmers. The study also found out that distance to extension services was a major constraint to information flow. Therefore, this study recommends that distance to extension services to be reduced by organizing farmers in groups as well as by increasing well trained extension staff with adequate provision of transport facilities to reach out farmer who are far from the extension service. It is also important to consider a large coverage and good road network with efficient public transport system. The marginal effect result revealed that group membership mattered in the decision to acquire IPM knowledge since group interaction enhanced the ability of farmers acquiring information. The study also showed that some districts (Maragua and Makueni) facilitated knowledge acquisition. This implies that proximity to Nairobi town and IPM information networks play a major role in knowledge acquisition. In addition, formation of farmer groups were also found to be an important factor in the area of promoting improved horticulture production and IPM, since farmer groups were mentioned as one of the most important sources of IPM information among FFS and CIG groups. Farmers' membership in more than one association plays a major role in acquiring IPM knowledge. This is possibly because group membership enhances farmer interaction that can be a prerequisite of knowledge acquisition. In addition group membership has some important characteristics that include better handling of risks. Further, it also considered as sources of resources and inputs.

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CHAPTER SIX

ASSESSING THE ROLE OF SOCIAL CAPITAL AND OTHER FACTORS IN ADOPTION OF IPM TECHNOLOGIES

6.1 Introduction

Social capital is a term that has been used in agricultural development to refer to the features of social life such as human networks, norms, and trust that enable participants to act more effectively in order to achieve shared objectives (Putnam, 1996). According to the World Bank (1999), the social capital concept embraces the relationships and norms that shape the quality and quantity of a society's social interactions. It is also known to ease transaction by reducing costs associated with acquiring information (Coleman, 1990). Recently, the social capital concept has gained popularity for its contribution in explaining information diffusion and in reducing the cost of information acquisition (Amudavi, 2007; Katungi *et al.,* 2008). However, the contribution of social capital to agricultural transformation through contributing to successful adoption and diffusion of agricultural technologies depends on the social structures that are in place in a society and farmers' individual attributes (Isahm, 2000; Palis *et al*, 2002).

In Kenya the horticulture sector is the biggest foreign exchange earner (HCDA, 2005). Horticultural commodities are predominantly produced by small (<1 acre) to medium (<10 acres) scale farmers. Smallholder farmers in Kenya generate 40 to 50% of total horticultural exports and 90% of the commodities consumed locally (Wasilwa, 2008). However, the sector faces serious challenges due to pests and diseases, which result in yield losses (Oerke, 2006).

In Kenya, various approaches are used in disseminating agricultural information to farmers on issues such as disease and pest management and good production skills. These approaches include Integrated Rural Development Program (IRDP), modified Training and Visit (T&V) and group based information approaches like Farmer Field Schools (FFS) and Common Interest Groups (CIG). The use of the T&V approach, which involves farmer contact on a one-to-one basis extension system, was found to be expensive and unsustainable in facilitating farmers' access to agricultural technology (Gautam, 2002). This prompted a switch to the use of farmer groups for agricultural technology transfer.

Farmer groups are believed to promote sharing of experiences, knowledge and pooling of resources. They also facilitate farmer to farmer interaction which is crucial for agricultural information exchange. Two group approaches namely the FFS and CIG are currently in use in Kenya. In these approaches, farmers interact and support each other to learn and adopt a given technology and promote farmer-to-farmer extension.

The group based approaches are considered to embrace social interaction, which is a prerequisite for social capital generation (Palis, 2005; Gallagher, 2000; Bingen *et al*., 2003). Adesina *et al*., (2000) reported that group membership played an important role in the adoption of alley farming practices by farmers on the forest zone of South West Cameroon. In yet another study, Rogers (1995) reported that decisions on adoption are also affected by the existing social structure. In a recent study, Bukenya *et al*., (2008) demonstrated group method as an effective tool in disseminating agroforestry technologies. Davis (2004) in their previous study showed the government of Kenya and donors considered farmer groups to be a vehicle and an entry point for new technologies. In recent study Bekele *et al*., (2010) demonstrated that group membership catalyzed farmers' uptake of IPM knowledge and knowledge sharing.

In this chapter we postulate that farmers' group membership and the associated social capital for search of agricultural information is a crucial component of the diffusion process. This implies that farmers are likely to be influenced by information acquired through membership in farmer groups and through their interaction with other individuals to adopt a given technology. In spite of the increasing currency on the use of group-based approaches in dissemination of agricultural technologies, information on the contribution of social capital generated through FFS and CIG on technology uptake such as adoption of IPM is scanty. The objective of this study was therefore to assess the extent to which group based training approaches foster generation of social capital and stimulate adoption of IPM technology.

6.2 Methodology

6.2.1 Construction of adoption of IPM index using principal component analysis

Principal component analysis (PCA) is a variable reduction procedure for data sets with a large number of variables which may be correlated. PCA helps to reduce the observed variables into a smaller number of principal components that account for most of the variance in the observed variables. PCA can be applied in deriving a knowledge index of the integrated pest management (IPM) practices adopted by an individual farmer. This is largely because measuring the adoption of each practice would be very difficult since all the practices simultaneously contribute to the integrated adoption. This study therefore, chose to use the PCA to derive weights for IPM adoption index that would proxy for adoption of IPM practices for further analysis.

The PCA method has been used in several studies. For example, Amudavi (2005) used the PCA to investigate the propensity of farmers to adopt integrated natural resource management practices in Vihiga, Baringo and Embu districts of Kenya. In a recent study (Bekele *et al*., 2010) used the PCA procedure to generate IPM knowledge index that would proxy for IPM knowledge for assessing factors affecting IPM information flow among smallholder horticulture farmers in Kenya. Following Kaiser (1960) components with an Eigen value greater than 1 are usually retained for further analysis.

6.2.2 Construction of social capital index using principal component analysis

PCA procedure was used to generate the social capital index that would proxy for social capital for further analysis. Following Grootaert (1999) and Narayan and Pritchett (1999) the social capital index for this study was constructed using the indicators shown in Table 6.1 ,memberships in FFS and CIG, number of groups that a farmer belonged to other than FFS and CIG, frequency of being visited by people, frequency of meeting people in public places in the last one month, frequency of meetings in social affairs (e.g., religious festivals, funerals, village affairs, and family affairs) in the last one month, number of close friends that a farmer had at the time of the study, and number of people beyond family members who could give assistance.

The indicators were analyzed using the principal component analysis with Varimax rotation.

Varimax rotation demonstrates a "simple structure". Simple structure means that the pattern possesses two characteristics: (a) most of the variables have relatively high factor loadings on only one component, and near zero loadings on the other components, and (b) most components have relatively high factor loadings for some variables, and near-zero loadings for the remaining variables. Components with Eigen values greater than 1 were retained for further analysis because they accounted for a greater proportion of the variance than the original variable and hence provided better interpretation.

Table 6.1: Social capital indicators and their measurements

Variable	Measurements
Membership in FFS	(1=yes, 0=no)
Membership in CIG	(1=yes, 0=no)
Number of groups farmers belongs to	Number
Number of meetings	Number
Number of farmer close friends	Number
Are there people beyond family who can give assistance	(1=yes, 0=no)
Frequency of visiting people	Number
Frequency of being visited by other people	Number
Frequency of meeting people in public places to talk	Number
Number of village affair meetings in the last one month	Number
Number of religious meetings in the last one month	Number
Number of family affairs meetings in the last one month	Number
Frequency of participation in funerals in the last one month	Number

Source: *Computed from own survey data, 2008*

6.2.3 The Binomial logit model

This study estimated farmers adoption decision of IPM practices by using the logit model. Logistic regression or logit model involves binary response variables and investigates the relationship between independent variables and the log odds of the binary outcome variable. Several studies used logit model to assess adoption of a given technology. For example, Firouzjaie *et al*., (2007) used logit model to assess the influence of social capital on adoption of rural development programs among farmers in the Caspian Sea region of Iran. Cramb (2004) also used logit model to assess the role of social capital on promotion of soil conservation farming in the southern Philippines. Zegeye *et al*., (2001) used logit model to assess the adoption of wheat variety and in organic fertilizer among small scale farmers in Yelmana Densa and Farta districts of northwestern Ethiopia. Nyende and Delve (2004) used logit model for legume cover crops and biomass transfer technologies for soil fertility improvement in Tororo District, Eastern Uganda. The logit model for our analysis is expressed as:

$$AIPM = \beta_{0i} + \beta_{1i} socialcapital + \beta_{2i} passifo + \beta_{3i} access + \beta \sum_{i}^{n} \beta_{ji} D_i + \mu \qquad (6:1)$$

where *AIPM* is the adoption index, a binary variable equaling 1 if farmers adopted IPM and 0 otherwise. The social capital index (*socialcapital*) is also a dichotomous variable that equals 1 if farmer has social capital and 0 otherwise: (*passinfo*) is 1 if a farmer shared IPM knowledge and 0 if otherwise. Access is if a farmer has access to agricultural information =1 and 0 otherwise. D_i are demographic attributes such as gender (1 = male, 0 = female), age (number), total number of school years (number) , farming experience (number), distance to extension services in kilometers (number), household size (number) , land size(number) , wealth if a farmer owns a car, vehicle, radio and bicycle and television = 1 otherwise 0, labour (number of workers in the farm) , household literacy (number) and μ is the disturbance term. $ß_{ji}$ (j = 0, 1, …, 3) are parameters to be estimated.

In this study social capital was hypothesized to have a positive influence on adoption of IPM technologies through individual interaction. In addition, farmers with strong social capital are likely to exchange agricultural information through interpersonal communication that eventually influences adoption of IPM technologies.

Gender**:** It is also expected to have an impact on technology adoption. Female farmers are hypothesized to adopt less due to family responsibilities as compared to male farmers and hence a negative sign is expected.

Age**:** age is known as an important determinant of technology adoption (Burton *et al*., 1999). Older farmers are more likely to adopt IPM technologies due to more experience in farming and better decision making abilities Therefore, we expected a positive coefficient. However, younger farmers may be more innovative and less risk averse. The coefficient on age may therefore be negative or positive.

IPM knowledge sharing: It is hypothesized to have a positive influence on the adoption of IPM technology and it is measured as 1 if farmer share IPM knowledge 0 otherwise. Knowledge about a given technology plays a major role in the adoption process. Farmers who acquire IPM knowledge have a greater chance to adopt this technology. A study by Valancy and Lawrence (1994) demonstrated that lack of knowledge about a new technology to be the main barriers to adoption

Distance to extension services**:** This is a continuous variable and is expected to have a negative impact on adoption because the farther farmers are from the extension services the less likely they have access to information. Better access to extension services is expected to positively impact the adoption of IPM technologies since extension staff are the main sources of IPM information. According to Mauceri *et al.*, (2007), access to information is one of the main drivers of IPM adoption by potato growers in Ecuador. And this implies that proximity to extension service play a major role in the technology adoption process.

Education**:** It is also expected to influence farmer's adoption decision. Educated farmers are likely to take up new innovation such as IPM. Former studies have shown that education is a variable that positively affects farmer's adoption decision (Asfaw *et al.,* 1997; Tadesse, 2000).

Household education: *It* is a continuous variable and hypothesized to influence farmers' adoption decision positively. Study by Asfaw and Admassie (2004) confirms that the presence of an adult literate person in the family plays a significant role in increasing the probability of the household to adopt chemical fertilizer. Hence, we expect a positive sign.

Farm size**:** It is the total land holding under horticulture crops for the reference year which is a proxy for wealth. It is expected that farmers with larger pieces of land are expected to adopt IPM technology. A positive sign is therefore expected.

Farming experience**:** It is measured in (years) is expected to positively contribute to adoption of IPM. Farmers with higher experience in farming appear to have often full information and better knowledge and supposed to evaluate the advantage of the technology. Hence it was hypothesized to affect adoption positively.

Household size**:** Another important determinant factor affecting technology adoption is the household size. Farmers with larger households are expected to have wider social networks that influence adoption of technology positively.

Access to information**:** It is a dummy variable (1=yes) to indicate a farmer that had access to agricultural information. Farmers who have access to information can get better information on horticultural farming and intensify IPM technology. A positive coefficient is therefore expected for IPM adoption.

6.3. Results and discussion

6.3.1 Descriptive results

Results of Table 6.2 indicated that farmer membership in economically oriented organizations such as saving groups (21.66%) and social organizations such as cultural group (9.55%) were the most popular among FFS farmers. This is also true for farmer membership in economically oriented organizations (17.61%) and social organizations (5.03%) the case of CIG farmers. On the other hand, saving groups (14.62%) and social organizations such as youth groups (6.43 %) were found to be the most popular among the control farmers.

Table 6.2: Farmers' belonging to other groups or associations in the study area (% response)

Group membership	FFS(N=157)	CIG(159)	Control (N=171)		
	%	%	%	P-value	Chi Square
Sports group	1.91	0.00	4.09	6.8881	0.032
Saving group	21.66	17.61	14.62	2.7721	0.250
Youth group	3.18	3.77	6.43	2.3048	0.316
Cultural group or association (art, music)	9.55	5.03	5.26	3.3662	0.186

Source: *computed from own survey data, 2008*

6.3.2 Generating adoption of IPM index from IPM practices

The results show that the total variation of the principal component is related to the first three components (Table 6.3). The cumulative proportion for the first three principal components was 49.35. Following Afifi *et al*., (2004) variables with correlations >=0.5 with the principal components were selected, therefore the coefficient of the variables (pis ractices) highlighted if it exceeds 0.5/SQRT(Var C_i) as explained in Afifi *et al*., (*ibid*). Then only, variables with factor loadings greater than 0.3 on the components were considered. The varimax rotation showed that five of the IPM practices loaded heavily on the first component: mixed cropping, crop rotation, plant resistant variety, deep ploughing and ash application.

The second component had heavy loadings from the following IPM practices: selected pesticide application, hand picking, plant resistance variety, timely planting and sanitation. Component three on the other hand had heavy loadings from solarization, mass trapping, and plant extract. However, the major practices that contributed to IPM adoption (chapter 6) and knowledge of IPM (chapter 5) are deep ploughing, mixed cropping and crop rotation. These IPM practices seem to be common and are easily implemented.

Table 6.3: Principal component analysis of adoption of IPM following varimax rotation

Variable	Principal component		
	1	2	3
Pesticide application	0.149	**0.552**	0.002
Mass trapping	0.050	0.017	**0.499**
Hand picking	0.186	**0.376**	0.051
Deep ploughing	**0.467**	0.021	0.049
Plant resistance variety	0.087	**0.354**	0.250
Mixed cropping	**0.514**	0.021	0.018
Timely planting	0.259	**0.321**	0.036
Sanitation	0.068	**0.550**	0.019
Crop rotation	**0.499**	0.021	0.079
Solarization	0.067	0.123	**0.655**
Ash application	**0.344**	0.016	0.140
Plant extract	0.076	0.060	**0.474**
Eigenvalue	3.57	1.30	1.05
% of variance explained (49.35)	29.81	11.00	8.75

Source: *Computed from own survey data, 2008*

6.3.3 Generating social capital index from social capital indicators

By accepting principal components with eigenvalues greater than 1 our data set was narrowed down from 11 original variables to 4 (Table 6.4) that still explained nearly 55 percent of the total variance in the observed variables. The four principal components with eigenvalue greater than one were extracted and considered as proxy indices for social capital. The components were aggregated and a new variable called socialcapital that involves integer numbers, ranging from (– to +) value were generated. Then from the new variable the social capital index called soialcapital1 (dependent variable) was generated using the STATA command (gen socialcaptal = 1 if socialcapital >=1 and replace socialcaptal =0 if socialcapital <1). The dependent variable in the binomial logit model was used to assess the role of social capital in adoption of IPM technologies.

Table 6.4: Principal component analysis of social capital following varimaxrotation

Variables	Principal components			
	1	2	3	4
FFS	0.042	0.001	**0.690**	0.090
CIG	0.014	0.018	**0.676**	0.092
Number of groups farmer belongs to excluding FFS and CIG	0.007	**0.475**	0.098	0.263
Frequency of being visited by people in the last one month	0.038	**0.602**	0.020	0.037
Number of meetings with people in public places in the last one month	0.082	**0.541**	0.026	0.093
Number of village affair meetings in the last one month	**0.517**	0.011	0.167	0.218
Number of religious meetings in the last one month	**0.598**	0.005	0.010	0.200
Number of family affairs meetings in the last one month	0.161	0.001	0.051	**0.590**
Frequency of participation in funerals in the last one month	**0.555**	0.023	0.133	0.025
Number of close friends	0.172	0.076	0.038	**0.667**
Number people beyond family member who could give assistance	0.025	**0.333**	0.073	0.148
Eigenvalue (6.01)	1.93	1.51	1.44	1.13
% of variance explained (54.68)	17.56	13.76	13.09	10.27

Source: *Computed from own survey data, 2008*

The results of the PCA indicated that the following variables loaded heavily on the first component: Number of religious meetings that the farmer attended frequency of attending funeral meetings and frequency of village affair meetings. For component one the frequency of attending religious meetings loaded the highest. Frequency of being visited by people, number of meetings with people in public places, number groups farmer belongs to and number of people who could give assistance load highly on component two.

The third component in addition has heavy loadings from Farmer Field School (FFS) and Common Interest Group (CIG). The highest loading for component two was from FFS. Number of family meetings and number of close friends contributed the highest for component four. However, the high loadings of FFS and CIG in component 3 does not necessarily make the group based approaches less important in contributing to social capital but it only indicates the different contribution of FFS and CIG.

6.4 Adoption of IMP technologies

The model specification results in Table 6.5 show that the model fit with Prob $> \chi^2 = 0.0000$ leads us to reject the null hypothesis and hence that the entire model is significant indicating the significance power of the explanatory variables used in the model. The result for the Pseudo R^2 however showed 16 % which is far much less than the 20 % cut off point. However, in order to increase the Pseudo R^2, we used various socio-economic variables together with social capital variable (social capital index) to raise the Pseudo above the average 20% cut-off point. Continuous variable (e.g. age) was also squared and used in the analysis. However, the figure still remained below the cut-off point. This may be that there are certain important variables that this study didn’t capture. However, the major objective of this chapter was to investigate the role of social capital in adoption of IPM technology and the result showed the significant and positive influence of social capital (Table 6.5) in the adoption of IPM technology.

The logit model result in further showed that the odds in favour of adopting IPM technology increased by 0.774 ($P<0.05$) for farmers who had a social capital than those with none. Social capital is known to facilitate individual interaction which is a prerequisite for agricultural information diffusion which subsequently influences technology adoption (Sanginga *et al.*, 2004; Collier, 2002). Farmer groups facilitate social interaction and play a major role in affecting the adoption of a given technology through exchange of new ideas (Amudavi, 2007). Interactions among individuals offer opportunities for networking and, therefore enhance the chance to learn about new ideas (Rogers, 1995; Bentley et *al*., 2004).

Table 6.5: Logit estimation for the adoption of IPM technology (dependent variable: adoption of IPM (index) (1=yes, 0=no)

Variable	Coefficient	Std.error	Marginal effect
Dependent adoption of IPM (index) (1=yes, 0=no)			
Social capital	0.774**	0.272	0.134
Total number of school years	-0.006	0.038	-0.001
Household literacy	0.659**	0.261	0.102
Age	0.009	0.061	0.001
Gender	0.387	0.265	0.061
Household size	-0.092	0.050	-0.014
Land under horticulture farming (log ha)	-0.162	0.166	-0.025
Farming experience	0.199	0.180	0.031
Access to horticulture production information	-1. 249***	0.380	-0.150
Income	-0.034	0.032	-0.005
Radio	0.709	0.712	0.088
Television	-0.442	0.583	-0.060
Vehicle	-0.528	0.273	-0.080
Bicycle	0.100	0.284	0.015
Family labour	0.284	0.221	0.044
Casual labour	-0.049	0.175	-0.007
Permanent labour	-0.350	0.188	-0.054
IPM Knowledge sharing	1.412***	0.309	0.198
Distance to extension services	-0.059**	0.024	-0.008
Log pseudo likelihood			-225.97306
Wald χ^2(21)			78.09
Prob > χ^2			0.0000
Pseudo R^2			0.1690

*** and ** indicates statistically significant at 1% and 5% probability level, respectively

Source: *Computed from own survey data, 2008*

The odds in favor of IPM technology adoption among farmers with large households decreased by 0.092. This is possibly because large households are asset constrained such that investments in IPM are costly for such households to afford. In Addition, farmer with large household size may also have limited network and fewer interactions among individuals which may lead to less access to information negatively and therefore affecting information exchange and technology adoption.

The logit model result also showed that the odds in favour of adopting IPM technology among farmers who resided far from point of extension service decreased by 0.051. This is possibly because constrained spatial access to information discourages IPM uptake. Furthermore, adoption of technology has been linked to access to agricultural information and farmers are known to gain access to new information through extension services (Ransom *et al*., 2003).

Houesholds with literate household members increases the odds in favour of adopting IPM among by 0.659. This is possibly because an educated member of the household is likely to share new ideas about a certain technology. Because these group of people are likely to have exposure and a wider social network. The information obtained from the literate members of the household was perceived as important and trusted and so was easily adopted.This finding is in agreement with the findings of Basu *et al*. (2000), who reported that an educated member of the household confers a positive externality on the illiterate agents in the household by sharing the benefits of his or her literacy.

On the other hand wealth related variable such as vehicle ownership, which was used as a proxy for the wealth status of the farmer showed that the odds in favour of adopting IPM technology among farmers who have vehicle reduced by 0.528. A possible explanation to this is that, having a vehicle among smallholder farm households might be a sign of wealth. The chances of looking for Agricultural information among welloff frarmers from the comunity and farmer group might be very low. Welloff farmers might also have other sources of income and better sources of information.

Access to agricultural information in this study was also measured as 1 if farmer had adequate (sufficient) access to horticulture production information and 0 otherwise, to assess the contribution of adequate agricultural information on adoption of IPM technology. The correlation test between vehicle and access were first carried out and the correlation result showe -0.1840. Following the correlation test result the variables were considered and included in the model for further analysis. The logit model resulst showed that the odds in favour of adopting IPM technology among farmers who have limited access to agricultural information increased by 1.249 ($p<0.01$). The significant and negative result on access to information indicates that farmers may have been exposed to specialized sources of IPM information as it has been demonstrated from the PCA results the practices. Farmers may have been getting IPM information from generalized sources such as mass media, newspapers that can give provide them with generalized inforamtion. The high loadings of the PCA results on some of the IPM practices may suggest the role that IPM group based training approaches played in enhancing farmers IPM knowledge.

On the other hand, the odds in favour of adopting IPM technology increased by 1.412 for farmer who had the knowledge of IPM as compared to those without. This is likely because farmers make a decision to adopt or reject a technology only if they have the knowledge. This finding is in agreement with that of Rogers (1983) who indicated that the innovation decision is the process through which an individual or other decision making unit, extension organization passes from first knowledge of an innovation to forming an attitude towards the innovation, to decision to adopt or reject, to implementation of the new idea, and to the confirmation of the decision. Lionberger (1968), and Rogers and Shoemaker (1971) described the innovation decision process as the mental process through which an individual passes from knowledge of innovation to a decision to adopt or reject and to confirmation of this decision.

6.5 Summary and conclusions

The social capital concept has gained popularity for its contribution to agricultural information diffusion and technology adoption. Descriptive statistics and principle component analysis were used to assess farmers' characteristics and to reduce the data into smaller components respectively. Binomial logit model was used to assess the role of social capital in the adoption of IPM technologies.

The descriptive results indicate that FFS and CIG farmers participated in economically oriented organizations such as saving groups as well as cultural groups. Participation in saving groups found to be the most popular among the control farmers. Social capital and adoption of IPM technologies positively correlated indicating the importance social interaction that exists in the FFS and CIG group membership. Other factors such as socio-economic characteristics of the farmer found to influence adoption of IPM technologies. Furthermore, the Binomial logit model results show that social capital, IPM knowledge sharing and household literacy positively and significantly influenced adoption of IPM technology. Distance to extension services, household size, access to information and wealth status of the farmer negatively influenced adoption of IPM technology. The aim of this study was to assess the role of social capital generated through FFS and CIG in contributing to IPM technology adoption

The results also confirm that the existence of social capital through networking and interaction in group membership plays a role in farmers' adoption decisions. It was also revealed that farmers who have knowledge on IPM are likely to adopt the technology because knowledge about a technology is important in farmers' decision making process. This suggests that knowledge sharing about IPM is crucial in farmers' adoption decision. Our findings also showed that the social capital generated through group membership and individual interactions play a major role in farmers' adoption decision.

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CHAPTER SEVEN
THE IMPACT OF GROUP BASED TRAINING APPROACHES ON CROP YIELD, HOUSEHOLD INCOME AND ADOPTION OF PEST MANAGEMENT PRACTICES IN THE SMALLHOLDER HORTICULTURAL SUBSECTOR OF KENYA

7.1 Introduction

Agricultural extension services provide farmers with information and training new technologies and management practices. It is the process of introducing farmers to knowledge, information and technologies that can improve their productivity, income and welfare (Purcell and Anderson, 1997). The knowledge is introduced through various channels including trainings and demonstrations. The service provides a mechanism for important feed back as well. In addition, agricultural training and education indirectly impacts agricultural productivity since the ultimate goal of any farmer training is to help farmers acquire knowledge of the technology thus enable the farmer to make informed decisions on what technology to adopt. In sub-Saharan Africa 60-80% of the population is employed in agriculture, producing 30-40% of GDP (Staatz & Dembele, 2008; World Bank, 2007a). Out of this proportion smallholder’s account for the majority of these agricultural workers (World Bank, 2007b). In Kenya, smallholder horticulture farmers generate 40 to 50% of total exports and 90% of the commodities consumed locally (Wasilwa, 2008). Nonetheless, the horticulture industry is the major consumer of pesticides (Rhoda *et al.*, 2006).

Farmers in developing countries heavily rely on the use of pesticides to control insects and diseases (Thrupp *et al.*, 1995). Cooper (1999) has shown that half of the smallholder producers in Kenya used more than three times the recommended volume of pesticides. Tomato producers in Nakuru district also used 3-7 times the recommended amount of pesticides (Lagat *et a*l., 2007). The use of excessive pesticide is perceived as a loss aversion factor by farmers (Antle, 1988) and caused serious environmental problems in Indonesia (Oka, 1991). Besides, the negative impact of pesticides on health and environment, call for an intervention. Previous studies have shown that agricultural extension programs such as farmer training are considered an investment to the agriculture sector and farmers at large (Feder *et al.*, 2003). Recent study by Yan (2006) demonstrated that farmers in China witnessed the highest annual income increase in 2005 due to training of young farmers.

However, despite the importance that farmer training holds, the previous extension systems in Kenya failed to deliver effective extension services to farmers. In early 1980s the government of Kenya adopted the training and visit (T&V) system of extension. In this method of extension the contact farmer approach was used. The approach was supported by the World Bank through the First and Second National Extension Projects (NEP-I and II). The training and visit extension approach was financially costly yet the resultant impact on agricultural production was limited (Gautam, 1999). Due to the weaknesses in the previous extension systems the government of Kenya through the Ministry of agriculture and other stakeholders embraced participatory and demand driven extension systems (ROK, 2005). These extension approaches focus on the group based training approaches such as FFS and CIG. These approaches promote participatory method of training and farmers in these groups are trained collectively in order to share their experiences, learn and understand different technologies. According to van de Fliert *et al.*, (2007) experiences gained by farmers through FFS training are more effective; it is more attractive to farmers since they are able to benefit from learning how to gather information and how to better manage their farms within the context of rapid changes in a liberalizing and development climate.

Recently one strategy that has led to improved crop production and pest management knowledge while protecting the environment is the integrated pest management technology. This technology has been found one suitable for smallholder production in export and domestic market crops (Nyambo and Nyagah, 2006) since it keeps pests below the economic damaging level and subsequently improve horticultural production. The integrated pest management was perceived by the Indonesian government as an alternative national pest control strategy to sustain environmentally friendly agricultural production while minimizing the risks associated with pesticide use (Röling *et al.*, 1994; van den Berg, 2004).

Nevertheless, the IPM technology is a complex technology, it requires farmers to integrate different pest control methods including varietal resistances, cultivation, mechanical control, biological control and chemical control according to their specific field conditions" (Yang *et al.*, 2008). Furthermore, the technology requires sufficient knowledge acquisition for successful implementation to occur (Mauceri, 2004). The group based training approaches have been considered as the most effective way to learn a certain technology. The implementation of integrated pest management practices through group based farmer training approach is the best way for achieving good agricultural practices while protecting the environment. Thus farmers need skills in pest monitoring and knowledge of pest ecology (Lewis *et al.,* 1997; Matthew, 1999; Ruttan, 1999; Atkinson *et al*., 2004). In this respect various stakeholders, including NGOs' and government of Kenya through ministry of agriculture, offer training opportunities to farmers in agricultural production and integrated pest management practices (IPM). However, the impact of IPM training among smallholder horticulture farmers in Kenya is partially unknown and if known, it is inconclusive. This study aims to fill this knowledge gap**.**

7.2 Empirical assessment of training

Agricultural extension services provide farmers with important information such as training in new technologies, management practices with respect to production and marketing, and market information. Generally extension services improve the knowledge base of farmers, through various means, which include trainings and demonstrations, and provide a mechanism for important feedback. Given that the extension services cannot reach all farmers, the working of the system is largely dependent on the assumption that messages will spread through the farming community through a diffusion process (Feder *et al*., 2003).

In addition, agricultural training and education indirectly impacts agricultural productivity. A number of papers have examined the effect of training on productivity by using econometric measures on farm-level data, focusing largely on contributions of training to harvested yield. Barrett and O'Connell (2001) regressed the level of training intensity on the change in productivity and found out that the effect of training, days/total employment, was positive and significant on changes in labor productivity. Black and Lynch (1996) estimated a standard Cobb–Douglas production function including training intensity, three specific types of training activities, and several controls for other workplace practices. However, estimating productivity of training using econometric models such as the Cobb-Douglas production function is likely to be biased because of the endogeneity of the training variable.

Establishing the impact of training is difficult using observed data from the survey because of the observed and the unobserved farmers' attributes that are likely to be correlated with training frequency and content and the farmers' characteristics influence on the training approach. Farmers who are trained are likely to be more productive, apply inputs nearer to the economic optimal levels thereby causing a problem in separating the impact of training in production from that of use of more productive inputs. The decision to attend training may also be influenced by some intrinsic farmer characteristics that are not obviously observable. An appropriate methodology for such analysis should consider the selection bias by controlling for farmers' differences when examining the impact of training on productivity.

7.3 Methodology

7.3.1 Empirical specification of propensity score

In this study the estimation of propensity score is analyzed using the logit model. Due to its computational simplicity, the logit model is used when there is a non-normal distribution. The logit model for our analysis is expressed as:

$$P(X) = \Pr(D = 1 \mid X) = F(\beta_1 X_1 + ... + \beta_i X_i) \qquad (7:1)$$

Where D is the indicator of participation, $D = 1$ if a farmer is a participant in FFS and 0 otherwise. X_i represents a set of covariates of the observed farmer characteristics which are same across all FFS farmers.

$$P(X) = \Pr(Z = 1 \mid X) = F(\beta_1 X_1 + ... + \beta_i X_i) \qquad (7:2)$$

where Z is the set of indicators of participation with $Z = 1$ is if a farmer is a participant in CIG and 0 otherwise. X_i represents covariates of the farmer characteristics which are same across all CIG farmers'. Then, followed by options that commands for generation of propensity score index '*mypscore*', generation of variable '*myblock'* for the identification of blocks of propensity score , and *'comsup'* option that generates a dummy variable, which identifies household that meet the matching condition. The common support variable attaches numerical '1' corresponding to the subjects that meet the matching condition and '0' to those that do not meet the condition.

In estimating the average treatment effect of FFS and CIG participation commands in STATA, such as *attnd* for nearest neighbor, *attr* for radius matching, *attk* for kernel matching and *atts* for stratified matching methods were used. The general formula of the empirical model is as follows:

Command: $y = \beta_0 + \beta D + \beta_i X_i + \varepsilon, pscore(mypscore), com\sup, \log it$ (7:3)

where *command* denote the matching estimators such as *attnd, attr, attk and atts. While y* is the outcome of interest, X_i is a vector of participation covariates followed by the propensity score option, then the common support option. The two options are important .in the sense that the average effect of participation (AEP) is computed from propensity score index (eg. the difference in outcomes for participants and non-participants who are similar in personal characteristics as possible). Common support also mandatory option to ensure matching is done only on controls that are similar to participants.

7.4 Results and Discussion

7.4.1 Descriptive results

The status of general agricultural training among FFS, CIG and control farmers is presented in Table 7.1. Nearly 87%, 63% and 49% the majority of FFS, CIG and control farmers received agriculture training. The results also showed that nearly 85%, 62% and 48% of FFS, CIG and Control farmers applied the technique that they have learnt. The findings also indicated that farmers who undergo training are aware about the benefit of training. Nearly 87%, 62% and 48% of FFS, CIG and control farmers respectively cited the benefit of Agricultural training.

Table 7.1: Status of agricultural training among FFS, CIG and control farmers

Variable	FFS (N=157)	CIG (N=159)	Control (N=171)	χ^2	P-value
	%	%	%		
Agricultural training					
Yes	86.84	62.42	48.73	51.11	0.000***
No	13.16	37.58	52.43		
Application of technique learnt					
Yes	84.87	61.74	48.73	45.397 0	0.000***
No	15.13	38.26	51.27		
Benefit of agricultural training					
Yes	86.84	61.74	47.47	54.01	0.000***
No	13.16	38.26	52.53		
Family members training					
Yes	23.03	14.77	15.19	5.53	0.104
No	76.97	85.23	84.81		
Do you advice farmer to go for training					
Yes	92.76	85.23	81.01	9.24	0.010**
No	7.24	14.77	18.99		
Are you willing to train others					
Yes	88.82	78.52	74.05	11.20	0.004***
No	11.18	21.48	25.95		

*** and ** indicate statistically significant at 1% and 5% probability level

Source: *Computed from own survey data, 2008*

Furthermore, these trained farmers are in a better position to apply the techniques they have learnt as it is demonstrated in this chapter as well as in the preceding chapters (5 and 6). This suggests the important role that farmer group-based IPM training plays in improving the knowledge base of farmers and subsequently enhances adoption of IPM technology.

7.4.2 Propensity score of FFS and CIG participation using the logit model

The logit model results on participation of FFS and CIG are presented in Table 7.2. The results showed that memberships to other groups, age, gender and distance to extension services influenced participation in FFS. On the other hand, total number of school years, memberships to other groups, age, gender and household size influenced participation in CIG. This suggests that farmers' socio economic characteristics are important in determining farmers' participation in extension programs.

Table 7.2: Logit model to predict the probability of FFS and CIG participation conditional on selected observables

Variable	FFS participation		CIG participation	
	Odds ratio	Marginal effect	Odds ratio	Marginal effect
Other groups	-0.509***	-0.126***	-0.330**	-0.082**
Total number of school years	-0.049	0.012	0.111**	0.027**
Age	0.040***	0.010***	0.027**	0.006**
Gender	2.517***	0.536***	0.901***	0.224***
Household size	0.067	0.016	0.462*	0.115*
Land under horticulture farming (log ha)	0.049	0.012	-0.043	-0.020
Casual labourers employed	-0.296	-0.073	-0.149	-0.037
Number of meetings for different social gatherings	0.172	0.042	-0.068	0.017
Distance to extension services	0.311	0.007	0.115	0.028
Frequency of listening to radio on horticulture production and pest management information	-0.117	-0.029	-0.128	-0.032

*** and ** indicate statistically significant at 1% and 5% probability level

Source: *Computed from own survey data, 2008*

Table 7.2: Logit model to predict the probability of FFs and CIG participation conditional on selected observables continued

Variable	FFS participation		CIG participation	
	Odds ratio	Marginal effect	Odds ratio	Marginal effect
Frequency of reading newspaper on horticulture production and pest management information	-0.056	-0.014	-0.102	-0.025
District	-0.006	-0.001	-0.015	0.003
Number of observations	328		330	
Log likelihood	-179.50368		-209.61033	
LR chi2(12)	95.10		37.82	
Prob > chi2	0.0000		0.0002	
Pseudo R2	0.2094		0.0827	

*** and ** indicate statistically significant at 1% and 5% probability level

Source: *Computed from own survey data, 2008*

The odds in favor of FFS and CIG participation among farmers belongs to other groups decreased by 0.509 and 0.330 percentage points respectively. The significant and negative results of other groups not participating in FFS and CIG could be that farmers join any group if they gain economic benefit rather than to learn new farming skills.

7.4.3 Average treatment effect of FFS and CIG participation on yield, income and pest management practices

7.4.3.1 Average treatment effect of FFS

We evaluated the treatment effect of FFS and CIG participation on horticultural crop yield, income and pest management practices. Income in this study is defined as (income from sale of fruits and vegetables). Average treatment effect result for FFS participation is presented in Table 7.3 using different matching techniques. The Nearest Neighbor Matching (NNM) shows that 157 participants matched with 71 non-participants with average effect of program participation. However, contrary to studies of Davis et al., (2010) and Van de Flirt (1993) on the impact of FFS on yield in East Africa and Central Java, our results on yield as measured by kilogram per hectare (kg/ha) showed no significant impact. This finding is however consistent with Bentley (2009) and Feder *et al.,* (2003), who reported the non-significant impact of FFS participation on yield in Indonesia and in the tropics respectively. According to Bentley (2009) “FFS may be better suited to stimulating collaborative research with farmers than for extension itself”

In addition, Praneetvatakul and Waibel (2006) did not find any impact of FFS programs on rice production in Thailand. However, the authors found a significant impact on reduction of pecticide use and environment. The lack of FFS impact on horticultural yield in the study area might be attributed to lack of effective training methodology combined with lack of proper understanding of IPM implementation processes among horticulture farmers. The lack of FFS and CIG impact on crop yield might be attributed to the IPM substitutes for chemical inputs that may also cause the yield to remain constant for some time. Furthermore, the system may also take sometime to show effects which the study could not yet trace. The impact of the program on crop yield may also fluctuate between years and not be traceable with cross sectional data. In addition, farmers’ lack of confidence on the IPM concept as well as the training methodology used might also be instrumental here.

Thus, this study recommends the need to review aspects of the FFS training methodology and boost farmers’ confidence through encouragement of use of IPM technology. This may help farmers overcome the risk that is associated with trying out new technologies. On the other hand, the negative impact of FFS participation on income might be attributed to lack of product and price differentiation among horticultural crops that are available in the market. Because, horticultural crops that are grown using IPM practices are not identified in the marketplace like organic horticulture crops. Therefore, farmers who use IPM or conventional methods sell their products at the same price. This calls for an intervention.

Table 7.3: Average effect of FFS program participation on yield, income and pest management practices

Horticulture yield

Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	157	71	-0.377	0.234	-1.614
Radius	157	151	-0.388	0.159	-2.438
Kernel matching	157	151	-0.408	0.183	-2.231
Stratified matching	157	297	-0.336	0.172	-1.952

Income

Matching Method	Participant	Non-participants	ATT	Std.Err	t-value
Nearest neighbor	157	30	0.113	0.230	0.492
Radius matching					
Kernel matching	157	151	0.267	0.199	1.345
Stratified marching	157	297	0.149	0.119	1.251

Adoption of pest management practices

Matching Method	Participants	Non-participants	ATT	Std.Err	t-value
Nearest neighbor	157	71	2.051	0.562	3.647
Radius matching	157	151	1.764	0.315	5.610
Kernel matching	157	151	1.903	0.330	5.766
Stratified marching	157	297	1.805	0.353	5.113

Source: *Computed from own survey data, 2008.*

The results in Table 7.3 show a significant and positive impact on adoption of pest management practices. This finding is in agreement with Praneetvatakul and Waibel (2006) who found a positive impact of FFS participation on pesticide reduction and environment and farmers' pest management practices in Thailand. Godtland *et al*., (2004) also estimated the effect of a farmer field school program on farmers' knowledge of integrated pest management practices, and found significant and positive effect. This means that farmers who are members of FFS are likely to gain more knowledge and adopt IPM practices. Similarly, CIG participation also has a positive effect on adoption of pest management practices. This suggests that the important role that group based training approaches play in facilitating adoption of IPM practices.

7.4.3.2 Average treatment effect of CIG

The average treatment effect results of CIG participation on horticulture yield and farmers' income are presented in Table 7.4. The results show a non-significant impact of CIG participation on horticultural crop yield. They are in contrast to those by Cuellarl *et al*., (2006) and Githaiga (2007) findings on the impact of CIG participation on yield. Similarly, CIG participation also did not show any significant impact on farmers' income. The lack of impact on yield might be attributed to farmers' lack of confidence in using the IPM strategy and lack of understanding on the IPM implementation process. In addition, the lack of impact of a CIG program on income might be attributed to lack of information on price for the different horticulture products that are grown using the IPM and conventional methods.

Table 7.4: Average effect of CIG participation on yield, income and pest management practices

Horticultural yield					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	159	83	0.026	0.197	0.130
Radius	159	171	-0.047	0.161	-0.294
Kernel matching	159	171	-0.125	0.172	-0.724
Stratified matching	156	315	-0.098	0.151	-0.650
Income					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	159	39	0.241	0.268	0.898
Radius matching					
Kernel matching	159	171	0.054	0.167	0.322
Stratified marching	156	315	-0.017	0.104	-0.161

***Source**: Computed from own survey data, 2008*

Table 7.4: Average effect of CIG participation on yield, income and pest management practices continued

Pest management practices					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	159	83	0.839	0.376	2.228
Radius matching					
Kernel matching	157	151	0.677	0.277	2.449
Stratified marching	156	315	0.596	0.299	1.996

***Source**: Computed from own survey data, 2008*

7.5 Summary and conclusions

This chapter has evaluated the impact of group based training approaches such as FFS and CIG on horticultural yield, income and adoption of pest management practices. Our descriptive results show that the majority of farmers in FFS and CIG had gone for agricultural training. On the other hand, our results on horticultural yields show that the impact of FFS and CIG participation on horticultural yield was not significant. The lack of FFS and CIG impact on horticultural yield in the study area might be attributed to lack of effective training methodology combined with lack of proper understanding of IPM implementation process among horticulture farmers. Integrated Pest Management (IPM) substitutes for chemical inputs may also cause the yield to remain constant for some time. And the system may also take sometime to show effects which the study could not yet trace. The impact may also fluctuate between years and not be traceable with cross sectional data. Furthermore, farmers' lack of confidence in the IPM strategy might also be instrumental here. Correspondingly, the non significant impact of FFS and CIG on income might be attributed to lack of market access among smallholder horticulture farmers.

Conversely, the results on the impact of FFS and CIG participation on adoption of pest management practices show a significant impact suggesting, the important role of

FFS and CIG participation in facilitating pest management training. However, this study recommends, the training curriculum of the FFS and CIG approach to be reviewed, and also boost farmers confidence of adopting IPM technology while helping farmers overcome the risk associated with trying out new technologies. The study also suggests that the relevant bodies in the government should come up with price differentiation between the two different products that are grown using IPM method and conventional method. There should also be awareness through mass media on the danger of pesticides that arise through consuming horticulture crops that are not grown using the IPM method.

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CHAPTER EIGHT
GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

8.1 General discussion

The horticultural sub-sector in Kenya is a key source of foreign exchange earnings, employment and plays a major role in ensuring food security. The sector generates 40 to 50% of the total exports and 90% of the commodities consumed locally (Wasilwa, 2008). Although the Kenya horticulture sector is a success story, the sector faces serious constraints due to pests and diseases. The agricultural extension service in Kenya is one of the priority functions of the agriculture and rural development sector whose mandate includes training farmers on good agricultural practices including pest and disease management (ROK, 2005). The role of the extension service is outlined in the Governments' Strategy for Revitalizing Agriculture (SRA) report (ROK, 2004). From the SRA, a well functioning extension service can contribute to economic growth and poverty reduction (ROK, 2005). The SRA embraces a pluralistic and demand driven extension system where group based participatory approaches are promoted. The main objective of this study was therefore to evaluate the impact of group training approaches, the Farmer Field Schools (FFS) and Common Interest Group (CIG), on smallholder horticulture farmers in two major horticultural provinces of Kenya.

Results showed that the Ministry of Agriculture extension staffs in the study area were cited as the most important source of IPM and horticulture farming information (chapter 4). The result also indicated that the majority of FFS participants were female farmers as compared to CIG and control farmers who had more males. Farmer Field Schools were better in reaching out to female farmers as shown by the high share of female participants in contrast to CIG and control farmers. In this study FFS and CIG groups are likely to acquire IPM knowledge as compared to control farmers (chapter 5). Feder *et al*., (2004) reported that farmer groups such as FFS were critical in extending IPM knowledge. However, they did not find any evidence of diffusion effects from trained to non trained farmers. The results in the present study also indicated that FFS and CIG are not likely to share IPM knowledge.

This study further demonstrated that the social capital generated through group membership influenced the adoption of IPM technologies (chapter 6). This result indicates the importance of farmer to farmer interaction in the adoption process. The role of social capital in adoption of improved agricultural technologies has been demonstrated by other scholars (for example; Sanginga, *et al*., 2007a; Nayaran, 2007).

Participating in Farmer Field School and CIG membership had no significant impact on yield (chapter 7). This could be attributed to the lack of effective training methodology combined with lack of a proper implementation process of the IPM practices. The lack of FFS impact on crop yield again might also be attributed to the IPM substitutes for chemical inputs that may also cause the yield to remain constant for some time. Furthermore, the system may also take sometime to show effects which the study could not yet trace. The impact of the program on crop yield may also fluctuate between years and not be traceable with cross sectional data. This result seems to be similar to that found by Feder *et al*., (*ibid*) that group extension did not lead to any significant increase in agricultural productivity. Contrary to our results, Githaiga (2007) found that CIG membership had a significant impact on farm productivity. The lack of the programs impact on income might be attributed to lack of market access. On the other hand, FFS and CIG membership had a significant impact on adoption of IPM practices. Our results also suggest that farmers exposed to FFS information are more technically efficient in terms of IPM knowledge than control farmers who have not been exposed to information from FFS. As for other natural resource management interventions, integrated pest management may provide environmental benefits (see e.g. CGIAR (2006) for natural resource management projects in general and van den Berg and Jiggins (2007) for the impact of integrated pest management projects), which were not quantified and valued in the current study. Thus even though this study could not show a positive yield and income effect, such potential further benefits would have to be considered for a holistic assessment of benefits leveraged through such training approaches.

8.2 Conclusions

The horticultural sub-sector is critical to foreign earnings, employment creation and food security. Without farmer training the sector will perform below its potential. To minimize the negative impact of pests and diseases and to improve the sector the Government of Kenya with other stake holders promoted pluralistic and demand driven extension system that embrace the group based approaches involving participatory methods of training. For adoption of IPM technology and sustainable horticulture production, farmer training is crucial. Therefore, understanding the factors that affect adoption of IPM practices that are capable of improving production and the effectiveness of new group based training approaches in contributing to this process is important in the design of successful policies and programs to improve horticultural training systems.

Farmers across the three groups used different sources for IPM and horticulture farming information. The descriptive results of this study showed that Ministry of Agricultural extension staffs are crucial in disseminating IPM as well as horticulture production information. Hence, encouraging extension staff to go for IPM training will have a substantial impact on adoption of IPM technology.

Farmers who participate in FFS and CIG groups are more likely to acquire IPM knowledge than non group members. This is because farmer groups are likely to serve as an entry point for agricultural information acquisition. Hence, it is very important for extension programs that farmers are organized in groups. However, it was observed that FFS and CIG members did not share acquired knowledge emphasizing the need for extension workers to encourage the group to share information.

The social capital generated through group membership significantly influenced adoption of IPM technology. Farmers organized in groups were in a better position to exploit agricultural information through farmer to farmer interaction, which has been shown to be crucial for adoption of technology.

Analyzing the impact of group based training approaches on yield, income and on adoption of pest management practices was one of the major parts of this dissertation. However the result did not show any significant impact on yield and income among farmers participating in FFS and CIG. However, significant impact was observed on adoption of IPM practices. The objective of the study was to investigate the influence of FFS and CIG on IPM technology adoption in Central and Eastern province were achieved in the study.

8.3 Recommendations

From the findings of this dissertation, some important policy implications of the study emerged. Agricultural extension service providers such as the Ministry of Agriculture and NGOs should consider improving the capacity of extension workers in terms of IPM training through seminars, short courses and agricultural workshops. From the study results, the majority of farmers received IPM and horticultural production information from the Ministry of Agriculture extension staff. Therefore, there is need for extension agents to have a set of particular methods and competencies that will enable them to deliver extension services successfully. Effort should also be made to use other information sources with wider coverage such as radio to reach out to farmers who reside in inaccessible areas. The findings of this study show the best information sources for researchers and extension providers on efficient dissemination of important agricultural information to farmers are Ministry of Agriculture extension staff and NGOs.

This study further shows that farmer groups such as FFS and CIG are the most effective for IPM knowledge acquisition and adoption. With respect to IPM knowledge sharing among the two FFS and CIG groups, emphasis should be given in the area of sharing IPM knowledge since it was observed that the FFS and CIG groups did not share acquired knowledge.

This study also highlights the positive and significant contribution of social capital generated through group membership in reference to IPM technology adoption. It is, therefore, important that development organizations encourage formation of farmer groups to facilitate individual interactions and consequently enhance social capital. This will create opportunities to get access to agricultural information and enable adoption. It is also necessary to motivate farmers to create a network with other farmers from whom they can learn.

This study recommends that extension providers need to boost farmers' confidence in adopting IPM technology while helping them to overcome the risk associated with trying out new technologies. There is also need for the relevant bodies in the Government to come up with price differentiation between the two different crops that are grown using IPM and conventional methods. It is recommended that market access should be improved since it affects most farmers in rural Kenya. This can be achieved through organizing farmer groups, and using mass media and other relevant information dissemination methods. There should also be awareness creation on the danger of chemical pesticides through consuming horticultural crops that are not grown using the IPM method.

Given the success of farmer groups, such FFS and CIG, with regard to IPM knowledge acquisition and adoption in the study area, the central priority for extension services providers should be on promoting group establishment and actively facilitate formation of farmer groups where there are none, to enhance social capital and consequently IPM technology adoption. In conclusion, this dissertation adds a plea for increased FFS and CIG group extension, so as to further improve extension services delivered to the farmers throughout the country.

8.4 Suggestions for further research

From the study, both FFS and CIG farmers had knowledge on the IPM concept and practices but it was not clear why they did not share the IPM knowledge. In the circumstances, further research is therefore recommended to clarify and identify the factors influencing sharing of information among farmers who participate in social networks of groups. In addition, further research is also needed to investigate the cost-effectiveness of the extension methods used in the FFS and CIG group based approaches in Kenya. It is also necessary to investigate why other sources of information are not as widely accessed as the Ministry of Agriculture extension staff in disseminating IPM information.

The study also demonstrated that social capital generated through group membership contributed to adoption of IPM technologies. However, further research in the area of other forms of social capital indicators such as kinship, family ties and ethnic relations, need to be evaluated if they could also influence adoption of IPM technologies among smallholder horticulture farmers in Kenya.

Further research should also be considered to analyze the cost benefit analysis in reference to horticultural production among FFS and CIG groups. Such research should incorporate quantification and valuation of environmental benefits associated with integrated pest management programs. Further, potential additional benefits associated with group based training approaches such as institutional change and empowerment of rural communities could also be addressed. It is also important to investigate the reason for lack of programs' (FFS and CIG) impact on yield and income and the training methodology and extension officer's skills used by FFS and CIG groups in Kenya. The role of FFS alumni in training of other farmers should also be investigated. Market access among these groups should also be improved.

Reaserch is also necessary to investigate on whether IPM practices private or public goods in nature.

8.5 Contribution of the study

Results of this study are the first of their kind comparing information access and transfer between FFS, CIG farmers as well as independent farmers. The effort to identify information sources accessed by FFS and CIG horticulture farmers unveil the most effective channels to technology designers and disseminators who strive to reach out to farmers who are not in a position to get important agricultural information such as IPM. The IPM technology is aimed at improving horticultural productivity while protecting human health and environment.

Secondly, the study contributes immensely to the body of knowledge on factors affecting IPM information flow particularly in reference to horticultural sub-sector. The horticultural sub-sector is key to foreign earnings, employment creation and food security. The results from the study are also sound and adequately supported by relevant conceptual models. In addition, the comparison between CIG, FFS and control farmers in information access and transfer is instrumental in guiding intervention entry points.

Thirdly, the study also demonstrates the importance of group membership particularly memberships in FFS and CIG in enhancing social capital and subsequently enhancing IPM technology adoption.

The study also shows a lack of program impact on yield and income suggesting the need for developing effective methodology and market access.

In conclusion, the study contributes to the existing body of knowledge on factors affecting information flow in reference to IPM technologies and particularly in the horticultural sub-sector with a view to suggesting possible ways for policy research, extension and development agencies. The study further contributes to evaluation of the new group based training approaches, which are promoted as more effective through the Government of Kenya.

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APPENDIX 1: QUESTIONNAIRE

1. Background information

1.1 Status of the respondent: /__/ (1 = Farmer- husband, 2= farmer-wife, 3 = farmer-son, 4=farmer- daughter, 5= other member precise. ________________,6 = farm worker)

1.2 Gender: /__/ (male = 1, female = 2)

1.3 Age of the farm-decision maker: ______ years
1.4 Total number of years of schooling ______________________ (Years)
1.5 How many household members know how to read and write? ______
1.6 How many people are permanent members of the household: ____adults, ___ children, _____ (Children are less than 15 years)
1.7 .For how long have you been a farmer? ____________________Years
1.8. Have you participated in ICIPE survey? /__/ (No = 0, yes = 1). ***If yes, Please tick the answer indicated in the table below and indicate the year for participating for each survey***

ICIPE survey	When did you participate in the survey? (year)
1.DBM Biological control	
2.Mango IPM	
3. Eurepgap	
4.LMF Bio-control	
5.Otherspecify	

1.9. Do you keep record of the activities you perform in the horticulture farm? /__/ (No = 0, yes = 1).
1.9.1.Where did you learn about record keeping?
____
1.10. How many family members work as full time labourer for the household:____ adults ___ children ____(children are less than 15 years)
1.11. How many non family members are permanently (paid monthly basis) employed by your household? ________

1.11.1. For which activities are they employed?

Farm worker	Activities (see below)	Wages/month
1		
2		
3		
4		

Activities: 1= Horticultural; 2 = Agricultural; 3 = Livestock; 4 =All; 5 = Other (specify)_________
1.12. How many casual workers do you employ throughout the year for horticulture activities? ***Fill the details in the table below***

Number of workers	Average days/month	Number of months /year	Daily wage rate

1.13. How much land do you own? _____ acre
1.14. How much land do you rent? _____acre
1.15. How much rent do you pay? ______Ksh per year
1.16. How much land are you given (borrow)? ________ acre
1.17. In the last one year what have been your main sources of cash income?(main sources of cash enable the household to obtain more money as compared to other sources for purchasing goods and services)

[NB. Read out all the options below to the respondent]

Income sources	Yes=1, no=0	Amount in each quarter in the year 2007				Total amount in 2007 (Ksh)
		Jan-March	Apri-June	July-Sept	Oct-Dec	
Sale of vegetables						
Sale of fruits						
Petty trade						
Employment as casual labor						
Permanent employment						
Sale of livestock/ livestock products						
Sale of Maize /staples in Bags/kg						
Business						
Other specify						

2. Assets /wealth

2.1. Please circle the farm assets that you have?
Panga and Jembe =1 , Wheelbarrow = 2, sprayer = 3, Cart =4 , Tractor =5
Food store =6, Plough =7, Sprinkler =8

2.2. Please circle the household assets that you have? ***Circle the answer***

Radio =1, TV =2, bicycle =3, Vehicle =4, all =5

2.3. Do you own any livestock? /__/ (No = 0, yes = 1)

2.4. If yes, please indicate the type, number and value of livestock per head in Ksh?

Livestock	**Number**	**Average value per head Ksh**
Cow		
Bull		
Heifer		
Calf		
Donkeys		
Goats		
Sheep		
Pigs		
Poultry		
Other specify		

3. Income sources

3.1.Indicate whether you receive income from any of the sources indicated in the table below

	Received money from sources (no=0; yes=1)	Amount in each quarter in the year 2007 (***codes below***)				Total amount in 2007 (***estimate in Ksh***)
		Jan-March	Apri-June	July-Sept	Oct-Dec	
Remittances from relatives						
Gifts from others (harambee)						
Gifts from projects						
Government pensions						
Private pensions						
Insurance receipts						
Bride wealth						
Dividend on shares						
Interest on savings						
Intereston money, which was lent out to						

others						
Renting out houses / land						

Remittances from relatives: money sent by relatives permanently living elsewhere. If received in kind estimate the value in Kshs.
Income Range: 1 = <5000, 2=5001-10000, 3 = 10,001 –20,000, 4= 20,001 – 50,000 5 = 50,001 – 100,000 6= >100,001

4. Horticulture

4.1. What vegetables and fruits did you grow in 2007? ***Fill in the table below*?**

Name of Vegetable and fruits planted	Variety	No. of planting seasons/year	Output per season		
			Season	Area (acre)	Output (kg)

4.2. What are the main crop pests affecting your horticulture crops in each of the cropping seasons (from 4.1) and what is the most frequently used pesticide for each of those pests? How much did you use of the most frequently used pesticide for each season, how often did you use it, and how much money did you spend on it for that season? Please then estimate overall pesticide expenditure for each season. ***Fill in answers in the table below***

Crop	Season	Main pest?	Apply pesticide? (no =0, yes=1)	Name of pesticide	Quantity (kg or l) of pesticides	Frequency of spraying	Total expenditure on most important pesticide	Total expenditure on *all* pesticides during that season

4.3 Did you apply fertilizers in 2007 for your horticulture crop during planting? What is your main organic and inorganic fertilizer and its costs for each of the seasons. Please then estimate total cost of all fertilizer (sum up for all fertilisers including foliar feed) for each season. ***Fill in answers in the table below***

Crop	Season	Name of fertilizer		Quantity of fertilizer (kg)		Cost of fertilizer (Ksh)		Total cost of fertilizer (Ksh)
		Inorganic	Organic	Inorganic	Organic	Inorganic	Organic	

5. Horticulture information access

5.1. What radio program do you listen in order to get horticulture production and pest management advice? ***Indicate the answer on the space provided***

____

5.2. How often you or anyone in your household read a newspaper or have one read to you on horticulture production and pest management? ***Circle the answer***

Every day=1,A few times a week =2, Once a week=3 ,Never =40

5.3. How often do you listen to the radio on horticulture production and pest management?

Circle the answer

Every day=1,A few times a week =2, Once a week=3 ,Never =40

5.4. How often do you watch television on horticulture production and pest management?

Circle the answer

Every day =1, A few times a week=2, once a week =3, Less, Never =0

5.5. Distance from homestead to the agrovet? (km)____________________

5.6. How long will it take you to reach the agrovet using matatu transport (hrs)? ***Circle the answer***

Less than 15 minutes =1, 15-30 minutes =2, 31-60 minutes =3, More than one hour =4

5.7. Distance from homestead to the extension services (km) ______________

5.8. How long will it take you from your homestead to the extension service station using matatu (hrs) ***Circle the answer***

Less than 15 minutes =1,15-30 minutes =2,31-60 minutes =3 , More than one hour =4

5.9. How long does it take you to get to the nearest working telephone using matatu? ***circle the answer*** . Telephone in the house =17, Mobile =15,Less than 15 minutes =3, 15-30 minutes =4, 31-60 minute =5, More than 1 hour =6, N/A=7

5.10.Distance from homestead to the nearest working telephone (km)_______________

5.11. What are the three most important sources of information about horticulture production and pest management? **(*pls indicate the first three ranks on the spaces provided*)**

Radio (=1) ___, Television (=2) ____, Pamphlet (=3) ____, MoA staff (=4)____, FFS Members (=5)____, CIG members (=6) ___,

Neighbours, relatives and friends (= 7) ____,NGOs (= 8) ___, Field days (=9) ____, news paper (=10)____ , Internet(=11)____ local market (=12)___,

Community leaders (=13)____, chemical companies =(14)___, Mobile (=15)___,

Agrovets (=16) ___, Telephone in the house (=17) _, Others specify (=18)____

5.12. What are the three most important sources of market information for prices of horticulture crop? **(*pls indicate the first three ranks on the spaces provided*)**

Radio (=1) ___, Television (=2) ____, Pamphlet (=3)____, MoA staff (=4)____,
FFS Members (=5)____, CIG members (=6) ___,
Neighbours, relatives and friends (= 7) ____,NGOs (= 8) ___, Field days (=9) ____,
news paper (=10) ____ , Internet(=11)____ local market (=12)___,
Community leaders (=13)____, chemical companies =(14)___, Mobile (=15)___,
Agrovets (=16)____, Telephone in the house (=17) ____Others specify (=18)____

5.13. What are the three most important sources of horticulture farming information? **(*pls indicate the first three ranks on the spaces provided*)**
Radio (=1) ___, Television (=2) ____, Pamphlet (=3)____, MoA staff (=4)____,
FFS Members (=5)____, CIG members (=6) ___,
Neighbours, relatives and friends (= 7) ____,NGOs (= 8) ___, Field days (=9) ____,
news paper (=10) ___, Internet(=11)____ local market (=12)___,
Community leaders (=13)____, chemical companies =(14)___, Mobile (=15)___,
Agrovets (=16)___, Telephone in the house (=17) ____Others specify (=18)____

5.14. In general, compared to five years ago what would you say about access to information on horticulture production and pest management? ***Circle the answer***
Improved =1, Deteriorated =2, Stayed about the same =3,

5.15. For your farming activities, do you rate agricultural information and technical assistance as: ***Circle the answer***
Very necessary =1, Necessary = 2, Unnecessary =3, don't know = 4

5.16. Do you think you have adequate access to horticultural information on production and pest management /__/ (No = 0, yes = 1)

5.17. What part of the year is your house easily accessible by road? ***Circle the answer***
All year long =1, Only during dry seasons =2, Never easily accessible =3

5.18. Please rank the following sources of information on IPM in order of importance? ***Indicate the answer on the space provided***
Radio (=1) ___, Television (=2) ____, Pamphlet (=3)____,
Ministry of agriculture staff (=4)____,FFS Members (=5)____,CIG members (=6) ___,
Neighbours, relatives and friends (= 7) ____, NGOs (= 8) ___ Field days (=9) ____, news paper (=10)___ , Internet(=11)__local market (=12)_,
Community leaders (=13)____, chemical companies =(14)___, Mobile (=15)___,
Agrovets (=16) _______,
Telephone in the house (= 17)____Others specify (=18)____

5.19. How often in the last one month did you get information on horticultural production and marketing? (or carry out meetings) for every source of information? ***Fill in the table below***

Information source	Frequency	Time length

6. Horticulture training

6.1. Has the farm decision maker gone for agricultural training? /__/ (No = 0, yes = 1)

6.2. If yes, when ________(year last attended)

6.3. In which field? ***Please circle the answer***. (Pest management =1, production=2, marketing = 3, record keeping=4, others, please specify ______________=4)

6.4. Who organized the training? _____________________________________

6.5. Do you apply the techniques you have learnt about agricultural training in your farm? /__/ (No = 0, yes = 1)

6.6. Was it beneficial?: /__/ (No = 0, yes = 1) ***If yes ,go to Q6.7***

6.7. In what way?

____
____
____

____
___

6.8. Have any of your family members have gone for agricultural training? /__/ (No = 0, yes = 1)

6.9. Do you advise your fellow farmers to go for agricultural training? /__/ (No = 0, yes = 1)

6.10. Are you willing to train other farmers on pest management and production practices?

/__/(yes = 1, no = 0) ***(If yes ask question 6.11 and if no, ask question 6.12)***

6.11. What would you need in order to train your fellow farmers effectively**?** ***Circle the answer***

Training materials = 1, seed for demonstration =2, plot for demonstration=3, other specify =4

6.12. Why would you not want to train other farmers? ***Fill in on the space provided***

i.____
____

ii.____
_____

iii.____
_____

iv.____
_____

7. Integrated Pest Management (IPM) knowledge and adoption

7.1. Do you know about the technology called IPM? : (***Explain briefly to the farmer what IPM is)***

/__/(yes = 1, no =0)

7.1.1. When did you first come to know about IPM? _______Year

7.1.2. From what source did you first come to know about IPM?__________________

7.1.3. Have you been trained in any of the following pest control practices?

(***Please describe each of the practices***)

Practice	Training (yes=1, no=0)	Knowledge about the pest control	Did framer practiced pest control?	What was your most important source of information when learning each of the practices (See codes below)
Pesticide application				
Mass trapping				
Hand picking				
Deep ploughing				
Plant resistance				
Mixed cropping				
Timely planting				
Sanitation				
Crop rotation				
Solarization				
Applying ash				
Plant extract				
Other specify				

Codes: Radio (=1) , Television (=2) , Pamphlet (=3), MoA staff (=4), FFS Members (=5), CIG members (=6) , Neighbours, relatives and friends (= 7) ,NGOs (= 8) , Field days (=9) , news paper (=10) , Internet(=11) local market (=12),Community leaders (=13), chemical companies =(14), Mobile (=15), Agrovets (=16), Telephone in the house (=17) Others specify (=18)

7.1.4 Do you think IPM techniques is helpful in controlling pests in your horticulture farm?

/__/ yes = 1, no = 0

7.1.5. Do you think use of chemical can be harmful to your horticulture crop/__/ yes = 1, no = 0 (if yes go to Q 7.1.10

7.1.6 .How is it harmful? ***Please provide the answer on the space provided***

____
____

7.1.7. Have you or anyone in your household ever experienced sickness due to pesticide?

/__/ (yes = 1, no = 0)

7.1.8. Which member of the household?

i.____

ii.____

iii.____

iv.____

7.1.9. What are the experiences?

i.____

ii.____

iii.____

iv.____

8. Group membership

8.1. Are you or any of your family members member(s) of any social groupings? ***Fill in the table***

Group	Farm decision maker (yes=1,no =0)	Family members Membership yes =1, no= 0	How did you join the group (1=free entry, 2= pay, 3 = other)	No. of family members including farmer in group	Age of the group (years)	How long been member	Freq of meeting (from June 2007-June 2008)	Rank groups in order of importance
FFS								
CIG								
Other farmer group, pls specify ________								
Sports								
Religious								
Ethnic-based Community group								

(clan)								
Self help group (please specify)								
Saving								
Youth								
Cultural group or associatio n (e.g. arts, music,								
Burial society								
Age group								

8.1.1. Of all the groups to which members of your household belong, which two are the most important to your household? ***Fill in the space provided below***

Group 1 ____

Group 2 ____

8.2. Farmer Field School (FFS)

8.2.1. Why did you decide to join FFS? Please ***rank the answers***

To get assistance (resources) (= 1) ___,to market products easily(=2)____, bargaining power (= 3)___, to learn good farming skills (= 4)___,Other (specify____ =5)_____

8.2.2. How was the FFS group formed? ***Circle the answer***

Government influenced = 1, NGO/CBO influenced = 2, Community's own initiative =3, FFS graduates initiative = 4, Other specify =5 (__________)

8.2.3. Since joining the FFS group have you benefited? : /__/ (yes = 1, no = 0)

8.2.4. What are the benefits***? please rank the answers***

Get assistance (resources) = 1, market products easily =2, bargaining power = 3, learn good farming skills = 4, get assitance from members in times of need (eg. wedding, sickness, burial.etc) = 5, other (***specify*** _____________) = 6

8.2.5. What production constraints were in your horticulture farm before joining the FFS group? Rank ***the answers***

Lack of farming knowledge = 1, lack of pest control information = 2, finances = 3, seed quality = 4, lack of bargaining power = 5, Other (***please specify***) ______________= 6

8.2.6 What marketing constraints were for your horticulture production before you join the FFS group? ***(Rank the answers)***

Lack of farming knowledge = 1, lack of pest control information = 2, finances = 3, seed quality = 4, lack of bargaining power = 5, Other (***please specify***) = 6, Middle men interference =7, Lack of market =8, Low prices of produce =9

8.2.7. Of the constraints listed above, which ones do you still experience in your farm?
Indicate the answer on the space provided

____

____

____

8.2.8. In your opinion, why do you still experience some of the constraints?
Fill in the space provided below

____

____

____

____

8.2.9 When there is a decision to be made in the group, how does this usually come about?
Circle the answer
Decision imposed from outside =1, Leader/ group management decides =2, Group leader/ management consults with members =3, Groups votes and majority decides =4,
Other (***specify*** ________) =5***. Please indicate for each group***
Group 1_________ Group 2_________ FFS_____________

8.2.10. How often do your groups meet? ***Please indicate for each group***
Group 1_________ Group 2_________ FFS_____________
once in a week =1, Once in two weeks=2, once in a month =3, once in two month = 4
(Other specify _________ =5)

8.2.11. How are leaders in this group selected? ***Circle the answer***
Decision imposed from outside =1, Leader/ group management decides =2, Group leader/ management consults with members =3, Groups votes and majority decides =4,
Other (***specify*** ________) =5***. Please indicate for each group***
Group 1_________ Group 2_________ FFS_____________

8.2.12.Do the groups interact with other groups in the area? /__/ (yes = 1, no = 0),
if yes, with which one? . ***Indicate the answer on the space provided***
Group 1_________ Group 2_________ FFS_____________

8.2.13. Does the group have a written constitution? /__/ (yes = 1, no = 0)
Group 1_________ Group 2_________ FFS_____________

8.2.14. How easy do you interact with members in higher hierarchy? ***Indicate the answer on the space provided***

Group 1____

Group 2____

FFS____

8.2.15. Do you hold any post in any of the group? /__/ (yes = 1, no = 0)

8.2.16. What Post? ***Circle the answer***

Chairman =1,Treasurer=2, secretary=3, discipline master =4, other (***specify*** _________)=5

Group 1_________ Group 2_________ FFS_____________

8.2.17. Compared to your situation before joining the FFS, how has access to information changed for you? ***Circle the answer*** Deteriorated=1, Stayed about the same =2, Improved =3

8.2.18. Since you joined the FFS has your relationship with other farmers in the area/ neighbourhood gotten better, worse, or stayed about the same? ***Circle the answer***

Gotten better =1, Gotten worse =2, Stayed about the same =3

8.2.19**.** What are the activities of the FFS group you belong to? (***activities related to horticulture farming)***

____

____

____

____

____

8.3.Common Interest Group (CIG)

835.1.Why did you decide to join CIG? ***Please rank the three main reasons***

To get assistance (resources) = 1, to market products easily (=2)___,bargaining power (= 3)__, to learn good farming skills (= 4)___,Other (specify____________) =5

8.3.2. How was the CIG group formed? ***Circle the answer***

Government influenced = 1, NGO/CBO influenced = 2, Community's own initiative =3, FFS graduates initiative = 4, Other specify =5 (__________)

8.3.3. Since joining the CIG group have you benefited? : /__/ (yes = 1, no = 0)

8.3.4. What are the benefits? ***Please rank in order of importance 1 being most important benefit***

Get assistance (resources) (= 1)____, market products easily (=2)____ bargaining power (= 3)__, learn good farming skills (= 4)___, get assistance from members in times of need (eg. wedding, sickness, burial.etc) (= 5)___, other (***specify*** ____________) = 6

8.3.5. What production constraints were in your horticulture farm before joining the CIG group? Please rank on the space provided ***Circle the answer***

Lack of farming knowledge = 1, lack of pest control information = 2, finances = 3, seed quality = 4, lack of bargaining power = 5, Other (***please specify***) __________= 6

8.3.5. What marketing constraints were for your horticulture production before joining the CIG group?

8.3.6. Of the constraints listed above, which ones do you still experience in your farm? ________

Indicate the answer on the space provided

8.3.7 In your opinion, why do you still experience some of the constraints? ***Fill in the space provided below***

____

8.3.8 When there is a decision to be made in the group, how does this usually come about?

Circle the answer

Decision imposed from outside =1, Leader/ group management decides =2, Group leader/ management consults with members =3, Groups votes and majority decides =4,

Other (***specify*** ________) =5**. *Please indicate for each group***

Group 1_________ Group 2_________ CIG_____________

8.3.9.How often do the following groups meet? ***Please indicate for each group***

Group 1_________ Group 2_________ CIG_____________

once in a week =1, Once in two weeks =2, once in a month =3, once in two month = 4

other (specify _________ =5)

8.3.10. How are leaders in this group selected? ***Circle the answer***

Decision imposed from outside =1, Leader/ group management decides =2, Group leader/ management consults with members =3, Groups votes and majority decides =4,

Other (***specify*** ________) =5**. *Please indicate for each group***

Group 1_________ Group 2_________ CIG_____________

8.3.11.Do the groups interact with other groups in the area? /__/ (yes = 1, no = 0),

if yes, with which one? . ***Indicate the answer on the space provided***

Group 1_________ Group 2_________ CIG_____________

8.3.12. Does the group have a written constitution? (yes = 1, no = 0),

Group 1_________ Group 2_________ CIG_____________

8.3.13. How easy do you interact with members in higher hierarchy?

Indicate the answer on the space provided below

Group 1____

Group 2____

CIG____

8.3.14 Do you hold any post in any of the group? /__/ (yes = 1, no = 0)

8.3.15 What Post? ***Indicate the answer in the space provided***

Chairman =1, Treasurer=2, secretary=3, discipline master =4, other (***specify*** ________)=5

Group 1_________ Group 2_________ CIG_____________

8.3.16 Compared to your situation before joining the CIG, how has access to information changed for you? ***Circle the answer*** Deteriorated=1, Stayed about the same =2, Improved =3

8.3.17. Since you joined the CIG has your relationship with other farmers in the area/ neighbourhood gotten better, worse, or stayed about the same? ***Circle the answer***
Gotten better =1, Gotten worse =2, Stayed about the same =3

8.3.18. What are the activities of the CIG group you belong to? (***activities related to horticulture farming)*** ____

9. Questionnaire for non FFS and non- CIG participants

9.1. Have you heard of a farmer field school?: /__/ (yes = 1, no = 0)
(If yes, ask question Q 9.2, if no go to Q 9.3)

9.2**.** Which farmer field school (FFS) have you heard of?
____

9.3.Would you like to be a member of FFS?: /__/ (yes = 1, no = 0)
(If yes, ask question 9.4 if no ask Q 9.5)

9.4.What do you expect to benefit from being a member of FFS? ***Please rank the three most important benefits. 1 being most important***
Get assistance (resources) = 1, market products easily =2, bargaining power = 3, learn good farming skills = 4, get assitance from members in times of need (eg. wedding, sickness, burial.etc) = 5, other (***specify*** _____________) = 6

9.5.Why would you not want to be a member of FFS? ***Please rank the three main reasons***
Groups disintegrate quickly (=1)___, Group not cohesive (=2)____, groups does not achieve market access=3, leadership problem = 4, money needed for registration =5, groups meetings and duties too time consuming Lack of interest =6

9.6.Please estimate the distance from your homestead to the nearest FFS group in your area (km)?

9.7.Have you heard of a Common Interest Group (CIG)? /__/ (yes = 1, no = 0)
(If yes, ask question Q 9.8)

9.8**.**Which Common Interest Group (CIG) have you heard of?
____

9.9.Would you like to be a member of CIG ? /__/ (yes = 1, no = 0**)** ***(If yes, ask question 9.10 if no go to Q 9.11)***

9.10.How do you expect to benefit from being a member of CIG? ***Circle the answer***
Get funds =1, bargaining power = 2, get assitance from members in times of need (eg. wedding, sickness, burial.etc)= 3, to get more skills in IPM – techniques =4,better horticulture information and skills=5, other specify = 6

9.11. Why would you not want to be a member of CIG? ***Circle the answer***

Groups doesn't stay together or disintegrate=1,Group not cohesive =2 ,lack of market =3,
leadership problem = 4, Lack of money for registration =5, Lack of interest =6

9.12. Please estimate the distance from your homestead to the nearest CIG in your area? (km)___________

9.13. Please estimate the distance from your homestead to the nearest CIG in your area? (km)___________

9.14 What changes, if any, have taken place in farming in this region since FFS was started in your village?***(If there are changes, ask Q 9.16) Circle the answer***

Production practices improved = 1, market access improved = 2, other (***specify*** ______) = 3

9.15 What changes, if any, have taken place in farming in this region since CIG was started in your village? ***(If there are changes, ask Q 9.16)***

Production practices improved = 1, market access improved = 2, other specify = 3

9.16. How has these changes been useful to your community? ***Circle the answer***

Production practices improved = 1, market access improved = 2, Interaction between farmers improved, communication and trust improved=3 other (***specify*** ___________) = 4

Since the FFS/ CIG started on your area, has your relationship with other farmers gotten better, worse, or stayed about the same? ***Circle the answer***

Gotten better =1, Gotten worse =2, Stayed about the same =3

9.17. What are the activities of the group you belong to? (***activities related to horticulture farming)***

Group	Activities

10. Social Capital (ALL FARMERS SHOULD ANSWER THIS SECTION)

10.1. In the last month, how many times have people visited you in your home?_________

10.2. In the last month, how many times have you met with people in a public place either to talk or to have food or drinks?___________________

10.3. In the last month, how many times have you visited people in their home?__________

10.4.What do you normally talk about***? Fill in the answers in the space provided below***

____

10.5. Were the people you met and visited with mostly of? ***Circle the answer***

Different ethnic or linguistic group/race/caste/tribe = 1,of different economic status =2,
of different social status = 3,of different religious group = 4, Other =5

10.6. What is your relationships to these people? ***Circle the answer***

Neighbours =1, Relatives =2, Friends =3, other (***specify*** ___________) = 4

10.7. How many times in the past 12 months from June 2007-June2008 did you participate in the following meetings? ***Fill in the table below***

Meetings	Frequency of meetings
Wedding	
Funeral	
Religious festival	
Family affairs	
Village affairs	

10.8. About how many close friends do you have? (These are people you feel at ease with, can talk to
about private matters, or call on for help) ___________________

10.9. Are there people beyond your immediate household and close relatives from whom you could
get assitance?)? /__/ (yes = 1, no = 0)

10.10. Do you think that over the last five years, the level of trust in this village/neighbourhood?
has gotten better, worse, or stayed about the same? ***Circle the answer***
Gotten better =1, Gotten worse =2, Stayed about the same =3

11. Diffusion of information

11.1. Do you receive visitors in your horticulture farm to share information about IPM?
/__/ (No = 0, yes = 1)

11.2. Do you share the new agricultural techniques that you have learnt with your visitors?
/__/ (No = 0, yes = 1)

11.3. Do you pass on horticultural production, marketing and IPM information to other farmers?
/__/ (yes = 1, no = 0) ***if yes, go to Q 11.3.1 and if no go to Q 11.5)***

11.3.1.Which kind of information **(see 11.1)** have you passed on***? Please indicate the answer on the space provided below.***

i.____
ii.____
iii.____
iv.____

11.4. How many times in a month do you pass IPM or pest control information? ***Circle the answer***
Once =1, twice =2, more than twice a month=3

11.5. If you have important information on new technology that you need to share with friends, neighbours and relatives estimate the number of your friends, neighbours and relatives you would have approached? Within the group you belong to and outside the group?
____

11.4.What are the challenges you face in sharing agricultural information and of IPM technologies in

Pest management practices? ***Please, list in order of importance. (1= most important, 5 = least important)*** .Lack of interest of the farmer (=1)___, Time (= 2)___,
training facilities (=3)___, Language barrier (=4)____, (other Specify (=5)____

12. General

12.1. Do you have DBM bio-control in your farm? /__/ (No = 0, yes = 1).

12.2. Did the post election violence affect your production? /__/ (No = 0, yes = 1).
If yes how? ***Please rank the three main reasons***
Prices of input has gone up(=1)___, lack of market access (=2)___,
psychologically affected (=3) ___,
produce consumed at home due to displaced relatives (=4) ___,
others (specify __________= 5) _______

APPENDIX 2: DISTRIBUTION OF CROPS

Distribution of crops among FFS, CIG and control farmers (% response)

Crops	FFS	CIG	Non-group-based
Kales	24	21	47
Cabbages	15	10	16
Passion fruit	5	15	2
Tomatoes	8	7.6	23
Bananas	9	15	1.8
Mangoes	11	7	5
French beans	6	1.2	8.3
Avocados	5	5.7	3.6
Butternuts	5	3.1	1.2
Onions	2.7	0.63	0.6
Cucumber	0.7	-	-
Capsicum	0.7	0.63	-
Amaranth	3.3	0.63	-
Brinjals	-	-	1.2
Courgette	-	1.27	0
Hot paper		0.63	0.6
Watermelon	3.3	0.63	0.6
Potatoes	2	1.9	-
Asian vegetable	-	0.63	1.2
Carrots	-	-	0.6
Spinach	-	0.6	-
Peas	-	0.63	1.2
pawpaw	-	1.9	0.6
Oranges	-	1.3	1.8