THE EFFECT OF SOCIAL CAPITAL ON INTEGRATED PEST MANAGEMENT TECHNOLOGY ADOPTION:
A CASE OF SMALL SCALE RURAL FARMERS IN KENYA

By

Tom Amek

THESIS

Submitted to
KDI School of Public Policy and Management
in partial fulfillment of the requirements for the degree of

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The committee in charge:

Professor Dongchul CHO, **Supervisor** ____________________

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Approval as of _________, 2011

ABSTRACT

THE EFFECT OF SOCIAL CAPITAL ON INTEGRATED PEST MANAGEMENT TECHNOLOGY ADOPTION: A CASE OF SMALL SCALE RURAL FARMERS IN KENYA

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Agriculture plays a pivotal role in Kenya's economic growth and development. As the sector becomes less productive, the entire economy suffers and poverty levels among the rural population worsen. Of serious concern is that pests largely contribute to the decline in agricultural productivity as they destroy up to half of all crops in the rural farms. Highly toxic chemical pesticides can reverse this loss but the cost and negative effects on health and on the environment are enormous. Integrated Pest Management (IPM) is recommended as it lowers the production cost, has no health and environmental hazards, and improves the long term sustainability of farming in the rural areas. A better understanding of IPM adoption process is therefore important. One element that is hypothesized to have a demeanor on IPM adoption is social capital which is interpreted as the degree of association, the level of trust and networks within a community. Using a Tobit model, the study sets out to verify the hypothesis that social capital influences IPM adoption.

The results of the Tobit estimates suggest that social capital variables significantly and positively influencing IPM adoption include a number of groups a household subscribes to; monetary contribution to groups; and informal chats with neighbors and group members.

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Thesis such as this does not come to fruition without many bumps. The process though rewarding was full of hesitations and missteps. Many individuals provided support and calm reassurance throughout the process. Their contributions were vital, energetic and full of patience. I sincerely express my gratitude to Professor Dongchul CHO for his supervision, guidance and intellectual support. He provided useful support, encouragement and constructive comments. I equally extend the same gratitude to Jung Hyun Choi whose comments and criticism were useful in shaping the final document. Special thanks to all farmers in Kishushe, Makandenyi and Mwakishimba communities of the Coastal Province of Kenya who during their busy schedules gave all the information I wanted.

Am indebted to the staff and management of the Korea Development Institute of Public Policy and Management for the Global Ambassador Scholarship award, excellent learning environment, and facilities. Special thanks goes to the Ministry of Youth Affairs and Sports, Kenya, for granting the study leave to pursue the course and funding data collection exercise for this thesis.

All 2008 students and the administrative staff, you deserve a special mention. You were full of happy faces. I will forever miss the many social activities. I will forever feel close to you. Finally, I dedicate this thesis to my family. They endured my absence during my one year stay in South Korea.

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KEY TO ABBREVIATIONS

CPA	Component Principle Analysis
CRF	Coffee Research Foundation
FAO	Food Agricultural Organization
FFS	Farmer Field School
IIBC	International Institute of Biological Control
IPMIntegrated Pest Management	
KARI	Kenya Agricultural Research Institute
KDI	Korea Development Institute
KIOF	Kenya Institute of Organic Farming
MM	Millimeters

CHAPTER 1

1.0 Background Information

1.1 Kenya

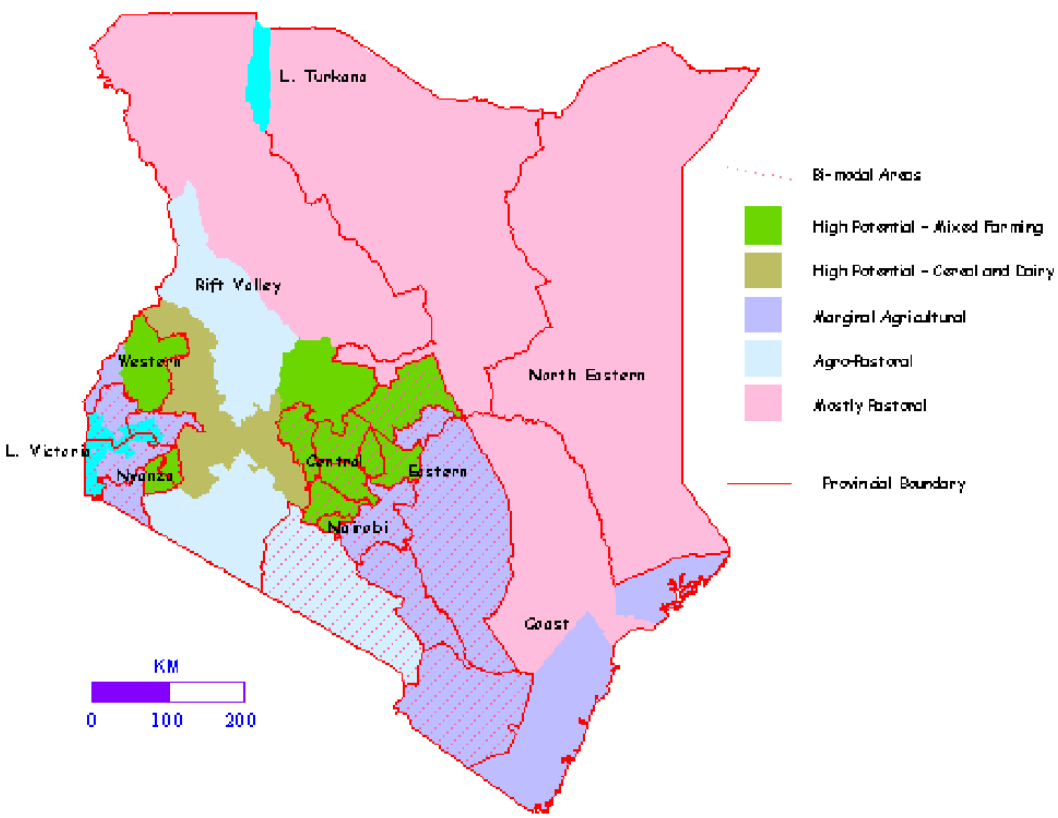
Kenya is one of the African countries, and it lies astride the equator to the east. It borders the Indian Ocean (to the east), Uganda (to the west), Tanzania (to the south), Sudan and Ethiopia (to the north), and Somalia (to the northeast). Kenya covers an estimated area of 582,646 km^2 of which about 98% is dry land and the rest is covered by water (Republic of Kenya, 1999). The altitude varies from sea level to 5199 meters above the sea level and this creates great climatic variations allowing for cultivations of a wide range of crops.

Figure 1: Map of Kenya

Source: http://geography.about.com/library/cia/blckenya.htm

The dry land is broadly classified according to the average annual rainfall received as shown in figure 1 below. High potential-mixed farming and high potential-cereals and dairy farming areas receive more than 857mm of rainfall annually and accounts for less than 13 percent of the total land area. The marginal agricultural land receives an average of 735 – 857mm of rainfall per year and covers about 10 percent of the land area. The low potential land, mostly agro-pastoral and pastoral land, covering more than 80 percent of the total land receive an average rainfall of less than of 612 mm. (Republic of Kenya, 2000).

Figure 2: Kenya's Production/Livelihood Systems



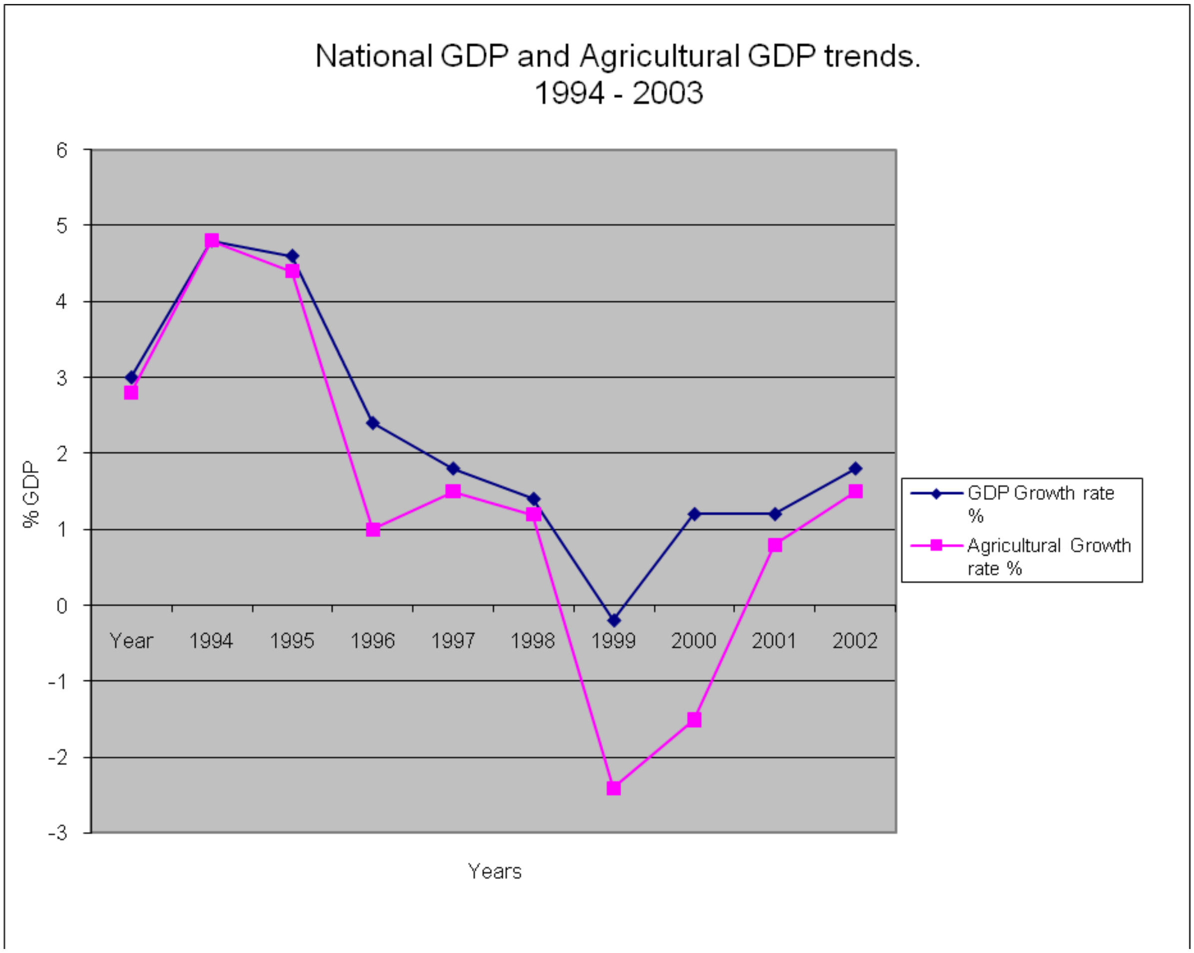
Source: **http://www.fas.usda.gov/pecad/highlights/2004/12/Kenya/images/AEZ_production_system.htm**

1.2 The Agricultural Sector in Kenya

Kenya like other sub-Saharan African countries relies heavily on agriculture for economic growth (see figure 3). The agricultural sector employs approximately over 70 percent of the Kenyan labor force, generates 60 percent of foreign exchange earnings, provides 75 percent of raw materials for industry, and account for 45 percent of total government revenue (Republic of Kenya 2001). Figure 3 shows a very close positive relationship between variations in the country's GDP and output in the agricultural sector. The agricultural sector and Kenyan economy almost grew at the same rate with both experiencing a downward trend with the worst performance of in 2000. This is evidence that the sector plays a pivotal role in economic growth and development of the Kenyan economy. As the sector becomes less productive, the entire economy suffers and the poverty level among the rural populations worsens (Odhiambo and Nyangito 2003).

Vast literatures in Kenya have discussions of the factors considered to be of importance in explaining this decline in the agricultural sector (see Kimenyi, 2002; Odhiambo and Nyangito, 2003; Omiti et al, 2006). These includes quantifiable factors such as low farm output prices, higher cost of farm inputs, lack of market access, poor physical infrastructure and lack of access to credit facilities. Non quantifiable factors such as bad weather, rapid land degradation, pests and diseases that are of outbreak type, poor agricultural policies and high population pressure have also been cited in explaining the decline.

Figure 3: Gross Domestic Product and Agricultural Output from 1994 – 2003



Source of data: 2003 Kenya Economic Survey

1.2.1 The Structure of the agricultural sector in Kenya

Agricultural sector in Kenya consists of large, medium and small scale farms. Large and medium farms exceed 10 hectares per single farm-plot and are mainly plantations growing market based perennial crops under mono-cultures (Gwyer 1973).

Currently these farms accounts for less than 33 percent of the total area under crop production, 50 percent of marketed output and generates 15 percent of on-farm jobs (Republic of Kenya 2001).

Small-scale farms with the average farm - plot size of less than 0.8 hectares per household represent 66 percent of the arable land. Most of the produce is for subsistence (home consumption) with little surplus sold in the domestic market (Odame, et al 2000). Small scale farms account for over 80 percent of on-farm jobs (Republic of Kenya 2001) but due to low farm productivity, these farmers are among the poorest in the country. Their farms are degraded with severe soil erosion, pest pressure and rodent invasion (Gitu, et al 1998).

Policy makers and researchers have always tried to seek appropriate, effective and sustainable technological interventions (pest, rodent and soil fertility management technologies) that can help reverse or in mitigating these problems. Many of these interventions have come in the form of government funded programs and projects. For the last 13 years, the government in collaboration with other development partners has been promoting Integrated Pest Management (IPM) Practices as potential and more effective approach to controlling pest pressure and increasing both land and labor productivity of rural farms.

IPM was believed to have dual direct benefits. First, it can increase the quality and the quantity farm output of which will make it possible to feed the growing population and improve nutritional status of the poor households. Secondly, any surplus output can be sold in both rural and urban markets commercially thus generating incomes that can boost other measures of wellbeing (Nyangena 2004).

CHAPTER 2

2.0 Pest Management and Social Capital

2.1 Introduction

Pest problem among the small scale rural farmers in Kenya as manifested by the potential farm output lost to the pest is widely seen as a major obstacle to agricultural growth and rural development. It is estimated that over 50 percent of potential farm output is lost to pest annually (FAO 2000). For example, maize yields in rural farms range between 0.4 tonnes to 0.8 tonnes per acre compared to an estimated potential of 4 tonnes (Gamba and Mghenyi, 2004).

Since 1995, the Kenyan government has been making efforts in collaboration with other research organizations in identifying and promoting sustainable pest management strategies that place a premium in the socioeconomic conditions of the rural farming households and environmental conservation. The pest problem has significant socio-economic consequences for poor farming households and this makes the promotion of IPM an important part of government strategy for reducing rural poverty.

IPM promotion and adoption by rural farmers are critical for a number of reasons. First, current modern pest management strategies (a pure use of chemical pesticides) are too costly. This has led to increasing large numbers of small scale rural farmers slowly abandoning the use of chemical pesticides which in effect has led to an increased amount of potential crops lost to pests. Secondly, several pests are increasingly becoming resistant to nearly all the available classes of pesticides. Farmers' reaction has been to resort to higher doses of chemical use leading not only to a higher proportion of farm income being used in pest control but also serious ecological and health related damages (Dasgupta et al. 2006).

The Kenyan government has used various strategies to speed adoption of agro-based technologies in rural areas. These strategies include high subsidies to new technologies, marketing incentives and coercion (Nyangena 2004). Despite these efforts, new technology adoptions are still very low and farm output in most rural areas continues to decline as evidenced by increased food shortages and chronic famine in most rural regions particularly among the rural farming communities . Most literature on agro-based technologies in rural areas in Kenya (Nyangena 2004, Gamba and Mghenyi 2004, and Oyuga 1999) places household characteristics, such as human capital, degree of risk aversion, farm size, and biophysical factors as key factors in adoption decisions.

The objective of this paper is to draw attention to the success story of some rural administrative divisions in the Taita district in adopting Integrated Pest Management (IPM) technology. The adoption intensity of IPM is remarkable and encouraging in Wundanyi division of the Taita district as opposed to other administrative divisions where the adoption rate is very low and disappointing yet the level of pest pressure is relatively the same. It was initially thought that given the "primitive" social, cultural and economic circumstances in the coastal region of Kenya, the whole Taita District would not give better adoption results compared to other relatively more advanced rural districts. This "Miracle" of IPM adoption in Wundanyi divisions of the Taita district has therefore generated a great amount of motivation for this paper.

Wundanyi division shows that farmers who adopted IPM managed to cope up with this pressure and drastically reduced to economically insignificant levels potential farm crops lost to pest. In this paper therefore I intend to explore whether the informal mechanism of information exchange and sharing, trust and communal learning could have significantly contributed to the adoption decision. Specifically, I intend to investigate the interaction between social capital and IPM adoption, and the effect of IPM adoption on farm productivity. For instance, in addition to the household, farm and institutional characteristics, decision behavior of one household can be influenced by the other households. The channel through which households may influence each other can include their membership in social, cultural or economic groups.

Group membership means trust among these households and that they can rely on each other in initiating and coordinating coping farm management strategies.

This knowledge is helpful when planning to promote other new agro based technologies among the rural farming households. I will attempt to examine the disparity in social capital among various administrative divisions within the Taita district. Several studies known to me have however only attempted to investigate the impact of social capital on rural household income in Kenya (Wafula 2003), and environmental conservation including soil conservation (Nyangena 2004).

In general, the broader goal of this paper is to develop and document the understanding of the economics of pest management in Kenya. Chemical pesticides dependent agriculture has proven no longer sustainable. IPM technologies offer an effective and realistic alternative path towards improving the quantity and quality of farm output. This will in turn improve food security and reduce poverty in rural areas. Policy makers in Kenya have always been concerned with the persistence disparity among most rural areas in terms of economic and social performance (Mbata 2001). Therefore it is of great interest that this study informs them on formulating policies that will be relevant in upgrading in agricultural output.

For sure Kenya relies heavily in agricultural sector as shown in figure 3 and any significant increase farm productivity will have much wider impact in household incomes and other social welfare measures.

2.2 Integrated Pest Management Practice (IPM)

The IPM practice has its origin in the United States of America where it was developed as an environmentally friendly way of controlling pests and diseases that caused economic damage in agriculture (Malena 1994). IPM has since then scored several striking successes, notably in Indonesia and India where its introduction allowed farmers to halve the cash spent on toxic pesticides (Alastair and Ritchie 2004).

Most rural farmers in Kenya for the last three decades have depended on the exclusive use of highly toxic chemical pesticides. This has over time raised serious economic, health and environmental concerns. Major health concern is the level of exposure to toxic wastes to human and wildlife. This is mainly through contamination of rural water sources and air pollution. Many scientists cite accumulation of toxic chemical residues in these water sources and agricultural produce as the major cause of cancer and other reproductive health problems in human beings (Ames, 1979).

Economic concerns results from the fact that several destructive pests are increasing becoming resistant to all available classes of pesticides and the farmers' reactions are always to resort to higher doses. This not only led to increased proportion of farm income spent pest management but has also increased medical costs associated with improper use of pesticides.

Alarmed by these threats from continued use of chemical pesticides, the Kenyan policy makers have sought to encourage the use of IPM in rural farms. In 1995, a pilot Integrated Pest Management (IPM) training project was initiated in most rural areas by the Kenyan government in partnership with the International Institute of Biological Control (IIBC), Kenya Institute of Organic Farming (KIOF), Coffee Research Foundation (CRF), and Kenya Agricultural Research Institute (KARI). The aim of the project was to introduce a sustainable pest management to farmers so that they could save massive crops lost to pests and avoid the hazards posed by chemical pesticides to their own health (Loevinsohn et. al 1998). The concerns about the contamination of the local environment and the proportion of the farmer's income spent on agro-chemical inputs were additional motives.

The project promoted IPM through Farmers Field Schools (FFS). This approach communicated IPM principles through discovery-based learning. The FFS training program has its origin in Andhra Pradesh, India where it emerged to be an effective educational approach for building the essential knowledge and decision-making skills among cotton farmers for IPM adoption (Francesca at al, 2008). It utilizes participatory methods to help farmers develop their analytical skills, critical thinking and creativity, and help them learn to make better decisions (Kenmore 2002).

A small group of contact farmers was taught how to identify relevant biological systems including the interrelations among crops, pests, natural controls, and use of pesticides.

They were further trained on how to develop pest control techniques or options that optimally manage pest pressure. This framework seeks to encourage farmers to self organize and innovate best farming practices. Unlike formal extension model that treats rural farmers as passive recipients of technologies, FFS recognizes that farmers actively gather information from fellow farmers to enhance their farming knowledge. This process of information gathering, also known as social learning is characterized by pooling of information or observing the behaviors of others and even imitating them (Katungi et al, 2008).

This approach was based on the understanding that most rural farmers often rely on informal mechanism of information exchange and knowledge sharing to address challenges they face. This may range from two or more neighboring farmers sharing labor and information on best farming practices. FFS strategy targets training few farmers on how to experiment and solve farming problems with the expectation that other farmers will also learn from the few, which will create a "snowball" effect promoting wider adoption of the new technology for specific environmental and cultural needs (Vasquez-Caicedo et al. 2000).

Informal information exchange and labor sharing process among the rural farmers comprises social capital and each farmer often participates in information exchange and labor sharing with a fixed level of social capital. Social capital stock within the farming community can influence the speed and scope of adoption of new farming technologies.

The increasing role of informal mechanism for information sharing (farmer to farmer models of agricultural development) is increasingly being recognized as more important in enhancing farmers' knowledge rapidly than the traditional extension model which treats farmers as passive recipients of information (Katungi et al. 2008).

IPM strategies that were diffused to the rural farming households in Kenya consisted of an array of pest control practices that included natural predators and parasites, pest resistant varieties, cultural practices, bio-control, physical techniques, and use of pesticides as a last resort. Rural farmers were expected to adopt as many as possible of these strategies in order to attain the maximum benefits of these IPM components.

All the IPM components gave due attention to socioeconomic and environmental concerns of the rural households and, any combinations of two or more components are designed to maintain the destructive crop agents, including insects at a tolerable level. Farmers using IPM components are expected to achieve same or higher crop yields as when they routinely use chemical pesticides. Farmers using IPM were expected to reduce chemical pesticide use by 70 percent lowering drastically the cost of crop production.

Table 1 below presents most of the various IPM components that were diffused in most rural areas in Kenya. Some of these components are independent, competitive or alternative approaches to pest management.

Table 1: A summary of IPM package

Component	Description
Cultural control	This includes push-pull strategy in which pest repellant and trap interim crops are intercropped with the major crops. E.g. Cow peas, Vetiger grass and Napier grass act as pest repellants and reduces the infestations of maize by pests; early planting to escape peak periods of seasonal pests, Crop rotation to break the pest life cycles, use of firewood ash in seed dressing etc.
Host plant resistant	The use of cultivars with disease and pest resistance. They are packaged in the seeds. The most commonly known to farmers include new cassava variety, new Irish potato variety, Orange fleshed sweet potatoes, and Bt maize
Bio-control	This involves the introduction of another enemy of the pest to reduce their levels to the extent that they cannot cause economic damage to the crops. The most effective is the barely visible parasitic wasp, Diadegma semiclausum that lays its eggs inside the bodies of caterpillars. When the wasp grubs hatch, they eat their host, and eventually emerge to infest more caterpillars. Most rural farmers in Kenya named the wasp “Friendly Pest”.
Behavioral manipulation	This involves the use of delta traps baited with odors naturally attractive to pests for monitoring pest populations. Based on the pest population the farmer decides whether to apply chemicals or not. It also involves pest scouting. An individual farmer scouts his/her farm and makes a decision on whether, when and which pesticide to use.
Botanical pesticides	These pesticides are prepared locally by farmers from extracts of locally available herbs. The commonly used in rural farms includes a mixture of extracts from pepper, onions, garlic and black jar.

2.3 Social Capital

Social capital is increasingly recognized as an intervening factor in the process of social learning and information exchange (Katungi et al. 2008). Social capital, as defined by Cohen and Prusak, refers to "networked ties of goodwill, mutual support, shared language, shared norms, social trust, and a sense of mutual obligation that people can derive value from". Katungi et al further states that, "Social capital is about values gained from being a member of a network and the membership guarantees one the access to resources and knowledge that non-members do not have".

Several studies (see Putman 1993; Coleman 1990, 1988) has pointed out that community social structure as an important determinant of economic welfare. Social capital is seen as an important asset that can be called upon in times of crisis, enjoyed for its own sake and used for material gain (Narayan 2000). It speeds resolution of disputes within the community (Schafft and Brown 2000) and according to Cohen and Prusak (2001), it is the "glue" that brings and holds communities together.

IPM strategy requires cooperation among neighboring farmers. Non cooperative action may lead to an inferior outcome being that pest problems cut across farm boundaries. Some of IPM components such as use of pest repellants are likely to transfer or increase pest pressure to neighboring farms.

This can lead to serious social conflicts. Collective action is therefore required to regulate the responsibilities and benefits of IPM pest management system. Collective action can be in the form of two or more neighboring farmers developed jointly a mechanism for identifying the level of pest pressure and then negotiating on the components of IPM to adopt and, sharing of labor in the case of components that are labor intensive.

Most of the agro-based empirical studies in Kenya have concentrated on investigating farm technology adoption by examining household ownership of various capitals, i.e. Physical capital (farming implements), financial capital (access to credit), human capital (level of education and training) and government policies. This attraction is obvious; however exclusive focus on the household and the government is highly incomplete.

Associational relationships and social norms in a community have the potential to influence household decisions and may be equally as important as households other form of capitals. For example, it is difficult to control population growth in most rural areas in Kenya through the use of contraceptives because such use is against the societal norms and punishable heavily by the society (Nyangena 2004). Social capital can therefore create a high level interaction and collective responsibility which can at times be a hindrance adoption of new techniques which are seen to be against or repugnant to the social norms.

Some empirical studies have however documented positive aspects of social networks in explaining adoption behavior. Nyangena (2004) used a learning model incorporating social capital as a fixed input to investigate the effect of social capital on adoption of soil and water conservation practices in Machakos District in Kenya. The results indicated that trust and group activities significantly influenced adoption behavior.

Vinon (1996) found that land degradation was worse in the more ethnically heterogeneous villages than in homogenous (same lineage) communities. This suggested that the level of social capital can explain the differences in the willingness and effectiveness of community controls. Wade (1988) had similar findings. He found that wide differences in the level of cooperation in South Indian villages attributed significantly to the differences in the physical characteristics of their irrigation network serving each village. Villages with higher social capital index had greater cooperation and irrigation network benefited nearly all members of the community.

Inspired by the concept of Social Capital, this study intends to draw out some important relationship between social capital and IPM adoption. This will give additional insight to the ongoing empirical discussions on the effect of social capital on the economic conditions of the rural households in Kenya in the context of sustainable development.

2.4 Research Problem and Implication of this Study

The government of Kenya estimates that pests destroy up to half of all crops produced in rural farms (Republic of Kenya 2005). Use of highly toxic chemical pesticides can reverse this loss because it kills large number of pests within short time. It is a very attractive strategy because farmers see pests dying on the spot soon after spraying.

But the negative effect of these toxic chemical pesticides on health and the environment is enormous. This fact coupled with the high cost has led to its negative publicity among the policy makers, environmental lobby group, researchers and rural farmers. This has made a large number of rural farmers slowly abandoning their use which in effect has led to more crop losses to pests.

The government and researchers are offering IPM as an alternative pest control strategy with several promises:

- That it is effective and sustainable measure for enhancing rural welfare
- That rural farmers will achieve the same or even better yields as when they were routinely applied chemical pesticides;
- That it would significantly increase soil fertility, reduce crop losses to pest and significantly improve household incomes;
- That it will help rural farmers reduce their cost of production by 70 percent; and
- That it will indirectly lead to other health and environmental benefits.

While the promises of an IPM program are laudable, there exist several debates whether or not the rural small-holder farms would decide and adopt it. Some researchers have argued that it is too theoretical, academic, and impractical that it cannot meet the rural farmers' preference. They insist that it is new and unproven, and just a return to traditional outdated practices and therefore cannot compete with the chemical pesticide control strategy. Most of the chemical pesticide manufacturers insist that IPM was a means to eliminate their business by the environmentalist lobby groups.

These groups opposing IPM as an alternative pest management strategies assume that the government and other lobby groups are taking advantage of the rural farmers' ignorance and illiteracy by imposing IPM on them. They ignore the fact that the final decision maker on IPM is the rural farmer who either independently or through the society influence judges its appropriateness and relevance before deciding on whether to take it or not.

Recent studies on IPM adoption in several rural districts of Kenya revealed that some regions had remarkable adoption rate while others had a dismal and disappointing adoption rate. The reason for this mixed success and failure are not well understood. For example, farmers in Wundanyi division had a remarkable adoption rate yet farmers in the other divisions within the same district had minimal adoption results despite them sharing same ecological characteristics with relatively same pest pressure.

Farmers in Wundanyi division who were found to have adopted IPM were also members of community based social and economic groups. This provides some lead that the disparity in social capital stock within the district may explain the difference in IPM adoption decision.

Resolving this divergent adoption outcome is very important for policy makers given the critical role agriculture plays in the rural economy. This paper therefore intends to look into the role of rural institutions such as social networks in IPM adoption.

The main task will be to isolate the features of these institutions that promote collaborative action when it comes to farming practices. IPM strategies require some minimal level of technical skills of which several rural farmers may not have due to low levels of formal education and partial access to formal extension services. Less informed farmers may be relying on their well informed neighboring farmers who in return get power, reputation and prestige (Lin, 2001).

2.5 Research objectives

The main objective of the study is to assess the effect of social capital on adoption of IPM strategies by the rural small-holder farmers in Kenya. Although it is recognized that the promotion of IPM will generate reasonable environmental and health benefits, an analysis of these benefits falls outside the scope of this study.

The research questions to be addressed by this study are as followed;

Does an increase in pest pressure motivate poor rural farmers to adopt IPM? (If yes, then social capital does not directly explain IPM adoption and therefore pest pressure can be counted as something positive.)

What are the differences in social capital stock among the three communities living in the Taita district?

How does the social capital variable affect IPM adoption?

What is the policy intervention needed to speed the adoption of the IPM strategy in rural farms in Kenya?

CHAPTER 3

3.0 Conceptual Framework

Literature provides several theoretical approaches of modeling technology adoption. Following Nyangena, (2004) and Adesina et al, (1993), two important issues will be addressed in a model describing households' IPM adoption behavior. First, households' IPM adoption and production decisions may be simultaneous. This simultaneous decision may arise from unobserved variables correlated with both adoption and production decisions. Second, the households do not make an adoption decision randomly but instead it is based on expectations on how their choice will affect farm productivity. The difference between adopters and non adopters may be reflected in the degree of variations in their respective expected farm productivity.

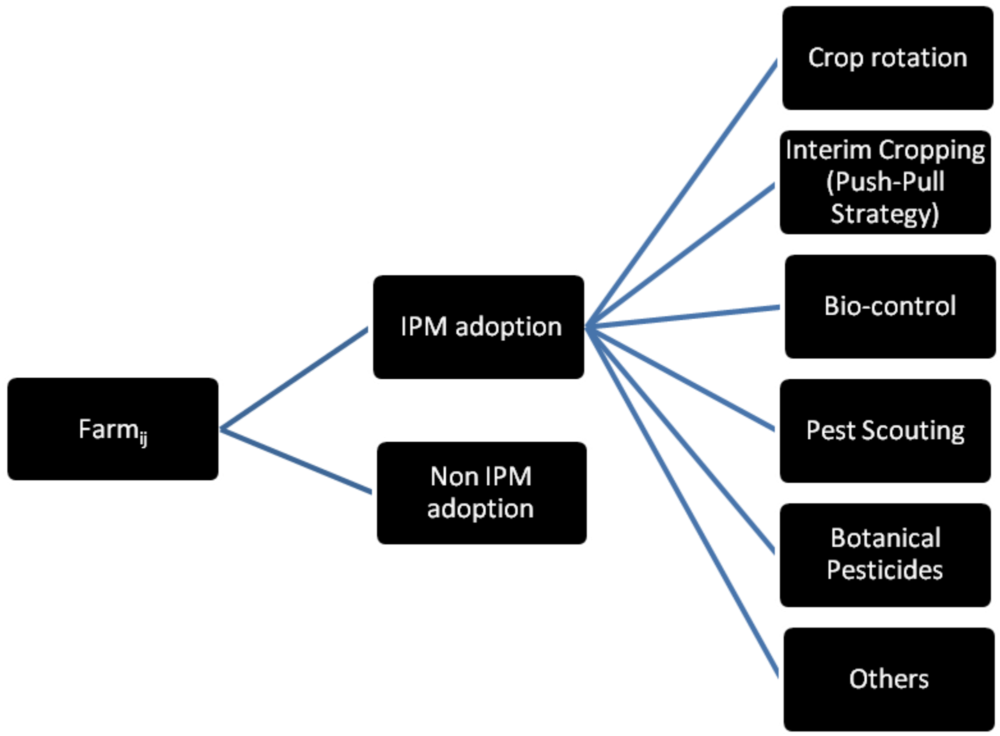
The IPM adoption decision may therefore depend on its expected profitability. But expected profitability rarely known with certainty to the households. Consequently prior to making the adoption decision, rational households will gather relevant information from various sources within his social network.

The trust of the information source may likely affect the reduction of the uncertainty associated with IPM. If we assume that households are rational, then after gathering and evaluating all the information, they will choose IPM only and only if it maximizes their utility.

We can neither quantify the reduction on uncertainty nor utility. We can only observe adoption, non adoption and quantify farm productivity. So when we observe IPM adoption then it means that the expected utility of its adoption is higher than that of incumbent pest management practices. Algebraically, IPM adoption will be observed if $E(U_{IPM(ij)}) > E(U_{Conv(ij)})$, otherwise non adoption will be observed. $E(U_{IPM(ij)})$ is the expected utility of IPM adoption in plot j by household *i, and* $E(U_{Conv(ij)})$ is the expected utility of incumbent pest control practices in plot *j* by household *i*.

For the purpose of this study, IPM adoption decisions can be diagrammatically illustrated as in figure 4. Sample separation will be observed and the distribution that will apply to the data will be a mixture of discrete and continuous distribution.

Figure 4: Diagrammatical illustration of an IPM choice model



From the above illustration, a given household (i) will decide whether or not to adopt IPM in farm (j) which in essence is a discrete choice. This decision is assumed to depend on the utility maximization behavior of the household. After comparing IPM strategy with other conventional practices (including non use of any pest control strategy), the household will adopt IPM if the expected utility is greater than other conventional practices.

Upon the household decision to adopt IPM, it will further decide on the number of IPM practices to use which makes IPM a continuous dependent variable. This is assumed to be based on the expected farm net output value.

After comparing the expected net output value of different combinations of independent IPM practices, the household will adopt the number of IPM practices that will maximize expected net outputs.

Using a Tobit censored model, IPM adoption decision can be defined as follows:

$IPM_{ij} = \beta X_{ij} + u_{ij}$ if IPM > 0

$IPM_{ij} = 0$ Otherwise. (1)

Where:

IPM_{ij} is the number of IPM practices (see table 1) adopted by household j in farm i;

X_{ij} is a k x 1 vector of explanatory variables including plot characteristics, human and social capital;

β is k x 1 vector of unknown parameters; and

U_{ij} is a vector of residuals that are independently and normally distributed with mean zero and a common variance of δ^2.

Tobin (1958) was the first to discuss this type of regression problem. For equation 1 (see Maddala 1983 pp 150 – 152), we define the following:

$$F_i = F(\beta' X_{ij}, \delta^2) = \int_{-\infty}^{\beta'' X_{ij}} \frac{1}{\delta(2\prod)^2} e^{-\frac{t^2}{2\delta^2}} dt \qquad (2)$$

$$\delta f_i = \delta f(\beta' X_{ij}, \delta^2) = \frac{1}{(2\prod)^{\frac{1}{2}}} e^{-(\frac{1}{2\delta^2})(\beta' X_{ij})^2} \qquad (3)$$

Where F_i and δf_i are the distribution function and density function of the standard normal evaluated at $\beta' X_{ij} / \sigma$ respectively.

For the observations $IPM = 0$, then:

$$\Pr ob(IPM = 0) = \Pr ob(U_{ij} \leq -\beta X_{ij}) = (1 - F_i) \qquad (4)$$

And for observations $ipm > 0$, we have:

$$\Pr ob(IPM > 0) * f(IPM / IPM > o) = F_i \frac{f(IPM - \beta' X_{ij}, \sigma^2)}{F_i}$$

$$= \frac{1}{(2\prod \delta^2)^{\frac{1}{2}}} e^{-(\frac{1}{2\delta^2})(IPM - \beta' X_{ij})^2} \qquad (5)$$

Hence the log likelihood function is:

$$\log L = \sum_{IPM=0} \log(1 - F_i) + \sum_{IPM=1} \log(\frac{1}{(2\Pi\sigma^2)^{\frac{1}{2}}} - \sum_{IPM=1} \frac{1}{2\sigma^2}(IPM - \beta' X_{ij})^2 \qquad (6)$$

The estimates of β and δ^2 will be obtained using STATA computer program.

The econometric model to be estimated is specified as:

$$IPM = \beta_0 + \beta_1 Assoc\,\text{var} + \beta_2 Trust\,\text{var} + \beta_3 Info\,\text{var} + \beta_4 Gender + \beta_5 Exp + \beta_6 Educ +$$
$$\beta_7 Labor + \beta_8 Fsize + \beta_9 FSecurity + \beta_{10} ExYield + \beta_{11} Cost + \beta_{12} Ext + \beta_{13} Credit + \mu_i$$

3.3 Variables Description

3.3.1 Dependent Variable

IPM

Rural farmers in Kenya have three exclusive options when it comes to pest management in their farms. The first option is to exclusively rely on toxic chemical pesticides. The second option is not to use of any pest management strategy and the last option which is to use the IPM strategy. IPM consists of an array of several of pest management strategies. These strategies include use of: natural predators and parasites; pest resistant seeds; cultural practices (e.g. crop rotation, fallowing, inter-cropping, early planting, etc.); Botanical pesticides; pest scouting and use of chemical pesticides as a last resort.

The dependent variable (IPM) will therefore be continuous over a restricted range. Question 31 of the questionnaire list all the possible IPM strategies that are used by the household in specific farm plots.

3.3.2 Independent Variables

Social Capital Variables

Assocvar (Association Variables)

Social capital in general is a property of a community (groups and associations) rather than of an individual household. The measure of social capital will therefore put emphasis on the membership in community groups and association.

Accordingly, we will consider four components of association variables and will be gathered using part B of the questionnaire in the appendix 1. Questions 13 to 19 in the questionnaire will aid in gathering data for association variables as they relate to participation in group and voluntary organizations.

Trustvar (Trust Variables)

The second bunch of variables is trust variables. The data on trust variables will be gathered from question 20 to 29. They capture household monetary contributions to groups, contacts and intimate interactions with personal friends and neighbors. The major aim is to explore the social capital dimension of both emotional and practical support from those within an individual's social network. They include community interactions.

Infovar (Information Variables)

Information variables as one of the social capital variables will be captured by various leading questions in the questionnaire. Free information flow is critical for pest management practices and other production decisions. Few rural farmers have access to media channels like television, radio and newspapers. Households are known to get information freely through social groups and other households within their social network in return for power and prestige.

Household Characteristics

Gender

Mbata (2001) found that women farmers have higher technology adoption rates than men. Men as the head of the families bear the responsibility of generating family income from off farm activities and hence spend limited time on farm activities.

Exp – Years of farming experience

Murithi (1996) found the farmers experience to be significant in influencing the adoption of improved varieties. A farmer's experience can generate or erode confidence. With more experience, a farmer can become more or less rigid to change. This variable can either have a positive or a negative effect on the farmer's decision to adopt IPM.

Educ - Education level of the farmer

Strauss et. al (1991), associated higher levels of education with increased adoption of technologies. Exposure to several years of education is likely to increase a farmer's ability to obtain process and use information on IPM. Hence, education is likely to be positively correlated with adoption.

Labor (Number of household members above 10 years and less than 60 years).

Bonana (1998) found the household size to be positively correlated with adoption of IPM practices. Most households in the study area do not hire labor and this age group specification is of interest because of the likelihood that they will participate in the on farm labor activities.

Farm Characteristics

Fsize - Farm size.

Adesina and Zinnah (1993) found farm size to have a positive correlation with adoption. Farm size is an indicator of wealth and always a proxy for social status within the rural farming communities. Larger farms are expected to be positively correlated with the decision to adopt IPM but it can also be negative where the farm size encourages intensification of agricultural production.

FSecurity- Farm security

Land titling in most rural areas in Kenya affects long term investments in farms and farmers with title deeds (security) for their farms have high chances of adopting new long term farm improvement practices than those without. Title deeds are also often used as collateral to secure farm loans and thus increase the farmer's chances of investing in the farm.

ExYield – Expected Yield (output)

This is the farmers' perception of the impact of the IPM on the crop yield. The adoption of IPM is likely to increase if the farmer perceives that IPM is likely to significantly improve farm yields.

Cost of pesticides– Monetary cost of pesticides.

Most of the farmers in the rural areas are resource poor and high costs of chemical pesticides are likely to accelerate the adoption of most less expensive components of the IPM package.

Institutional factors

Ext – Extension Services

Mazuze (2004) found that access to various forms and sources of information increases the adoption rate. The Ministry of Agriculture is the major source of formal information on agro-based activities in most rural areas in Kenya. The frequency of the contacts with government extension officers is likely to increase the farmer's decision on IPM adoption.

Credit – Accessibility to credit facilities

Byerlee (1996) found that farmers' easy access to credit significantly explains the adoption of new agricultural technologies. Farmers who are members of various agricultural credit institutions are likely to adopt more components of IPM than those who do not have any access to credit.

CHAPTER 4

4.1 Data description

The data used in this study are derived from a primary survey conducted in Wundanyi Division of the Taita District in Kenya in the month of January 2009. A multi stage sampling procedure was used in selecting a sample size of 120 households. The study area was first stratified into three communities according to the three distinct agro-ecological zones in the division.

The first community (Makandenyi community) covered Makandenyi coffee factory to Shimbo primary school. This community covers an agro-ecological zone characterized by an altitude between 1730m to 1900m above the sea level and it has the widest agro-ecological diversity which includes indigenous trees, maize-bean farms, bananas, several varieties of horticultural crops and dairy farming. This zone has the steepest slopes with very low settlements distributions.

The second community (Mwakishimba) stretched from Shimbo secondary school to Mwakishimba primary school. This community covers a zone that has a medium agro-ecological diversity which includes planted forests, maize-bean farms and coffee plantations. The zone has mid steep slopes and has the highest settlements distribution.

The last community (Kishuse) settles in a zone that can be called lowlands and it covers Kishushe area.

The zone is flat and has the lowest agricultural land use which includes maize-bean farms, sorghum plantations with over seventy percent of the households being pastoralists. Agricultural activities in this zone are purely rain-fed and the farms are huge with an average size six hectares per household compared to the other two zones that had an average of a half hectares per household.

The second step involved selecting a random sample of at least 40 households in each of the communities within each of the three agro-ecological zones, which totaled to a sample size of 120. The survey contains detailed information including household membership in such-economic groups, relationships, contributions to the groups and sources of information. The survey instrument further included information on household composition and incomes, farm characteristics, access to market and other infrastructural facilities, and IPM practices mainly for 2007/2008 farming season.

4.2 Social Capital Data

Social capital in the context of this study is understood as a property of a community rather than that of an individual. Part B of the questionnaire (see appendix 1) provides information on the household participation in a group, communal trust, and contributions to communal activities. The household participation can either be formal or informal.

The measure of social capital in this study has put more weight on household membership of a social group, level of participation and reciprocity.

The summary statistics of the social capital data are provided in the table 2 below.

Table 2: Descriptive Statistics of Social Capital Variables

Variable	Makendenyi Community		Mwakishimba Community		Kishushe Community	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Membership in any group*	0.6	0.49	0.9	0.30	0.43	0.5
Number of groups a household belong to	1.12	1.13	1.45	1.15	0.95	1.0
Number of meetings per year	1.78	1.87	1.75	2.0	1.6	2.4
Total monetary contributions per year (KES)	765	1408	926	2279	670	1319
Number of close households a household can turn to in crisis	3.5	4.96	3.8	2.4	2.3	1.7
Number of households you can borrow farming tools from	1.68	1.7	2.9	1.7	1.3	1.8
Number of community projects a household participated in	1.6	1.9	1.8	2.1	2.3	2.6
Radio important source of information*	0.25	0.43	0.2	0.4	0.13	0.33
Neighbors important source of information*	0.33	0.47	0.25	0.43	0.4	0.49
Government agencies important source of information*	0.1	0.3	0.13	0.33	0	0
Group important source of information*	0.47	0.51	0.2	0.38	0.43	0.5

Source: Field Data April 2009
* Dummy variables (Yes – 1 No – 0)

Table 2 above provides the extent of community participation and should be a reasonable measure of social capital arising from both formal and informal engagements in voluntary groups. Membership of groups, number of groups and number of meetings per year provides an insight on how much households put in association, and the Mwakishimba Community has higher values. The monetary contributions mirror the strength in associations and Mwakishimba Community again has the highest values.

The numbers of close friends a household can turn to in times of crisis and the number of households a household can freely borrow tools from attempts to measure the dimension of social capital assessing the trust and ties between households. Kishushe community registered very week ties. The data from households in Kishushe community portrays a relatively weak association among households.

The other important dimension of capital is the exchange of information. Information is fundamental for technology adoption. Social networks provide the household with the ability to obtain information through formal and informal chats. Aggregating the field data on social capital variables to come up with the two latent (non observable) variables (Association and Trust) of our interest is hard. The use of principal component analysis (CPA) to overcome this problem is far beyond the scope of this study.

We will therefore use a number of groups a household belongs to and number of households a household can turn to in case of a crisis as proxy variables for an association and trust respectively for further analysis.

The information variables concerns sources of information available to the households on pest management practices. All the social capital variables will be used in further analysis.

4.3 Descriptive Statistics of IPM, Household and Plot Characteristics

This study assumed that social capital along with household and plot characteristics, and other institutional factors (extension services and credit availability) shape technology adoption decision thus revealing their preferences on the number of IPM components to be adopted. Table 3 below provides descriptive statistics on the IPM, household and plot characteristics variables.

Table 3: Descriptive Statistics of IPM, Household and Plot Variables

Variable	Makandenyi Community		Mwakishimba Community		Kishushe Community		All Communities	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
IPM	1.025	1.3	1.275	1.585	0.5	1.09	0.933	1.39
Gender	0.85	0.36	0.75	0.44	0.85	0.36	0.817	0.39
Experience	13.95	5.87	14.075	6.15	12.6	5.28	13.53	5.77
Education	5.43	3.37	4.125	4.789	5.6	5.03	5.05	5.07
Labor	3.48	1.6	4.875	1.98	5.12	2.39	4.5	2.16
Farm size	39.33	85.63	15.52	32.52	5.98	5.62	20.3	54.39
Farm Security	0.25	0.44	0.2	0.405	0.35	0.48	0.267	0.444
Expected farm yield per hectare	997.76	3444.95	995	2022	516	1606	836.6	2525.4
Cost of IPM	130.25	217.44	259.7	288.0	196	285	195.33	270.15
Extension services	0.2	0.40	0.25	0.44	0.1	0.30	0.183	0.38
Availability of credit	0.3	0.464	0.25	0.44	0.3	0.46	0.183	0.388
Sample size	40		40		40		120	
IPM Adopters	21		25		11		57	
IPM Non Adopters	19		15		29		63	
Percentage of Adopters	52.5%		62.5%		27.5%		47.5%	

Several previous studies on farm based technology adoption employ most of the above variables to model individual farm level adoption. These models assess the likelihood of adoptions given household and plot characteristics.

In my case, the dependent variable (IPM) is a double censored variable taking a minimum value of 0 if none adoption of any of the IPM components and a maximum value of 6 (six) if all the IPM components are adopted. Overall, the number of absolute adopters of IPM components is relatively high in the Mwakishimba community and lowest in Kishushe community. Note that, analysis of adoption intensity by the three regions has not been considered.

Household characteristics included gender, farming experience, years of education and family size (those above the age of 10 and below 60). On average, the majority of households are male headed with the least (75%) found in Mwakishimba location. The mean number of years of farming experience is least (12.6 years) in Kishushe location. Years of education affect adoption decisions and on average, the location with the lowest years of formal education is Mwakishimba. The household characteristic variables are of interest because they reveal human capital of the household.

Plot characteristics included farm size and farm security (title deeds). Consistent with the varying population densities in the three locations, land holding per household is largest in Makandenyi location (39.33 ha) and least in Kishushe location (5.98 ha). Poorly defined land rights have been blamed for low long term investments on farmlands by most rural farmers in Kenya.

In Kishushe location, on average, 35 percent of the households had title deeds for their farms and this situation is confounded in Mwakishimba where only 20 percent had title deeds. Note that from Table 3 above, the highest number of IPM adopters is found in Mwakishimba and the least found in Kishushe. It is therefore not very evident that these differences explain the observed location differences in IPM components adoption and hence the need to employ the use of regression models.

4.4 Empirical Result

As stated above, the main interest of this study is to analyze the effects of social capital on the numbers (count) of IMP components adoption by rural farmers. Additionally, it is of interest to demonstrate the effect of human (household characteristics), physical (plot characteristics) and financial capital (access to credit) on IPM components adoption.

A Tobit model seems to be a natural choice for analyzing the data because a significant proportion (52.5 percent) of the data for the dependent (IPM) variable is 0 (zero).

The second motivation for the use of this model is that an individual household (our unit of analysis) must first decide whether in the current farming season it will use any of the pest control strategies or not. Once a decision had been made to adopt a pest control strategy, the household then has to choose either exclusive use of chemical pesticides or the IPM strategy.

The choice of the IPM strategy prompts the household to select component mix which in our case ranges from 1 (one) to 6 (six). The distribution that applies to the sample data is discrete distribution with double censoring. The censoring points are at zero and six.

Table 4 presents the parameter estimates based on a double censored Tobit model with IPM fit as dependent variable using a constant term including among others twelve social capital variables. .

Table 4: Estimated Tobit results of IPM adoption decisions

Variables	Coef.	Std. Err.	t	P-Value
▪ **Social Capital Variables**				
Association Variables				
Group membership	-0.817	0.490	-2.07	0.009
No. of groups	0.453	0.148	3.04	0.003
No. of meetings	-0.011	0.103	-0.10	0.919
Participation in communal projects	0.049	0.0758	0.65	0.518
Trust Variables				
Monetary contributions to groups	0.002	0.001	2.30	0.023
No. of Close friends	0.218	0.136	1.60	0.114
No. of people who can help in crisis	-0.096	0.100	-0.96	0.340
Borrowed tools from neighbors	0.029	0.131	0.22	0.826
Information Variables				
Radio	0.579	0.488	1.19	0.238
Neighbors	1.042	0.379	2.75	0.007
Government	-0.464	0.776	-0.60	0.551
Groups	1.145	0.389	2.94	0.004

Variables	Coef.	Std. Err.	t	P-Value
▪ **Household Variables**				
Gender of household head	0.120	0.463	0.26	0.797
Years of farming experience	0.041	0.038	1.32	0.191
Years of education	-0.0121	0.044	-0.27	0.790
Household size	-0.346	0.114	-3.04	0.003
▪ **Plot Variables**				
Total land holdings	-0.008	0.006	-1.30	0.195
Land security	-0.433	0.440	-0.98	0.328
Farm yield	-.000	.000	-0.56	0.577
▪ **Institutional Variables**				
Cost of IPM	0.000	0.000	0.38	0.703
Access to extension services	1.802	0.503	3.58	0.001
Access to credit	0.907	0.372	2.44	0.017
▪ **Location Dummies**				
Kishushe	-0.952	0.485	-2.96	0.002
Mwakishimba	0.871	0.440	2.98	0.001
Constant	-1.307	0.980	-1.33	0.188
Dependent Variable	IPM			
Number of Observations	120			
Log likelihood	-115.4			
Chi-squared	119.43			
Significance level	0.000			
Pseudo R^2	0.44			

The chi square is significant at 1 percent implying that the independent variables taken together influence IPM adoption decisions. Some social capital variables included in the model are significant at 1 percent level of confidence and all signs are generally as expected with the exception of negative sign in voluntary group membership. Social capital is hypothesized as having a demeanor on both incidence and intensity of IPM adoption. In our case, various variables showing the degree of association, trust and information sources are included in the Tobit model.

Voluntary group membership, number of groups a household subscribes to and the number of group meetings attended annually are taken provide an insight on the level of association and cooperation. The Tobit estimate for voluntary group membership is negative and significantly correlated with the likelihood of IPM adoption. This suggests that joining any voluntary group diminish the likelihood of IPM adoption. This finding is puzzling and contravenes the findings on the effect of voluntary group membership in most adoption decision studies. This can be attributed to a weak data set and hence need to increase the data set.

The estimated coefficient for a number of groupings a household subscribes to is positive and significantly correlated with the likelihood of IPM adoption. This implies that having many social ties increases the likelihood of IPM adoption. The finding is compatible with our expectations because the more groups a household subscribes increase the chances that some of the groups will be economically oriented.

In most rural areas, economically oriented groups are known to provide informal credit, pooled labor under rotational (reciprocal) arrangement, pooled farm equipments and pooled knowledge. Investments in most farm based technologies require access to most of these resources. Other previous studies have also found number of groups a farmer subscribes to in his/her local networks to be positively correlated with adoption of farm related technologies (Nyangena 2004).

A monetary contribution to groups by household is the only trust variable that is positive even though the estimated coefficient is very negligible. This suggests that pooled financial resource is critical for IPM adoption decisions.

Availability of relevant farm specific information is vital for most farm management decisions. The ability to obtain this information freely through informal chats for most rural farmers is very critical as the majorities of these rural farmers are poor and cannot access paid information (news prints, television and extension services). Neighbors and groups are the only sources of information found to have statistically significant and positive coefficients. These results suggest that information received from neighbors and groups enhance IPM adoption. This is an indication that households tend trust information transmitted through those within their social networks.

The coefficient of household size (proxy for Labor - number of household members above 10 years and less than 60 years) is negative and statistically significant implying that households with larger labor force have low likelihood of adopting IPM component. This does not support earlier findings by Bonana (1998). There was a strong feeling among the farmers in the study area that most IPM components are mostly attractive to poor households with very small farms.

Land is a proxy for wealth in most rural areas and a household with huge chunks of land tends to be in polygamous marriages, hence larger household sizes and vice versa. This in effect suggests that most IPM adopters are land poor and are in monogamous marriages hence the smaller family size.

There are several explanations this. First, poor farmers with small land holdings cannot afford chemical pesticides and hence the incentive to adopt less costly pest management practices with the hope of getting enough food to feed their household members. Secondly households with a large chunk of land are likely to be wealthier which increases the chances of purchasing chemical pesticides. Thirdly, households with a large chunk of land are likely to practice land following thereby decreasing severe pest pressure.

However, the coefficient estimates for total land holding size negative but insignificant. This is against the finding of Adesina and Zinnah (1993) who found that total land holding is positively and significantly correlated adoption.

The coefficient for access to extension visits is positive and significant. This confirms the findings of several other studies including Abdulai and Huffman (2005) and Chitere and Doome (1985). Households exposed to frequent visits by agricultural extension officers have a higher likelihood of adopting IPM components compared to their counterparts with none or fewer visits. This suggests that extension services increases awareness and understanding of the technology thereby increasing chances of adoption.

With respect to credit, the results show that access to credit enhances the likelihood of IPM Adoption. Byerlee (1996) found that farmer's easy access to credit significantly explains the adoption of new agricultural technologies. It is interesting to note that the formal credit market is non existence in the study area as most farmers are resource poor and cannot secure loans from commercial banks.

Farmers who had access to credit were mainly members of informal credit associations ("merry go round"). This confirms the earlier feeling that membership in groups with economic orientation enhances IPM adoption.

Two location dummies, Kishushe (1-yes, 0-no) and Mwakishimba (1-yes, 0-no) are included in the Tobit model to compensate for location differences. It is interesting to note that the both coefficients are significant. However, it is positive for Mwakishimba location, and negative for Kishushe location.

This suggests that independent variables cannot be relied on entirely to explain IPM adoption. Arguably, location specific variables can be used to explain the variations in IPM adoption in the study area though it may be insufficient. In essence, this motivated the study on the effect of social capital on IPM adoption to help understand the underlying facts.

Table 5 below presents the elasticities of coefficients presented in table 4. These elasticities show the effect of a percentage change of the independent variable on the probability of IPM adoption.

Table 5: Estimated Elasticities of likelihood of IPM Adoption

Variable	**dy/dx**	**Std Err.**	**z**	**P>z**
▪ **Social capital variables**				
Association Variables				
Group membership*	-0.817	0.490	-2.07	0.006
No. of groups	0.453	0.149	3.04	0.002
No. of meetings	-0.011	0.103	-0.10	0.918
Participation in communal projects	0.049	0 .076	0.65	0.517
Trust Variables				
Momentary contributions to groups	0.001	0.000	2.30	0.021
No. of close friends	0.218	0 .136	1.60	0.110
No of people who can help in crisis	-0.096	0.100	-0.96	0.338
Borrowed tools from neighbors	0.0289	0.131	0.22	0.826
Information variables				
Radio*	0.579	0.488	1.19	0.235
Neighbor*	1.042	0.379	2.75	0.006
Government*	-0. 464	0.777	-0.60	0.550
Groups*	1.145	0.389	2.94	0.003

Variable	dy/dx	Std Err.	z	P>z
▪ **Household variables**				
Gender of household head*	0.119	0.463	0.26	0.796
Years of farming experience	0.049	0.037	1.32	0.187
Years for education	-0.012	0.044	-0.27	0.790
Household size	-0.346	0.113	-3.04	0.002
▪ **Plot characteristics**				
Total land holdings	-0.008	0.006	-1.30	0.192
Land security*	-0.433	0.440	-0.98	0.325
Farm yield	-0.000	0.000	-0.56	0.576
▪ **Institutional variables**				
Cost of IPM	0.000	0.000	0.38	0.703
Access to extension services*	1.802	0.503	3.58	0.000
Access to credit*	0.907	0.372	2.44	0.015
▪ **Location Dummies**				
Kishushe*	-0.952	0.485	-2.96	0.001
Mwakishimba*	0.871	0.440	2.98	0.000

(*) dy/dx is for discrete change of dummy variable from 0 to 1

The elasticities presented in table 5 above are measures of changes on the likelihood of IPM adoption given a unit change in the dependent variables. New entrance in a social group decreases the chances of IMP adoption by 81.7% but subscribing to an additional group increases the likelihood of IPM adoption by 45.3%. This is an area that requires further investigation using a larger data set.

Increasing membership monetary contribution to a group by one Kenyan shilling increases the probability of IPM adoption by 0.01%. The impact on the magnitude of likelihood of IPM adoption is highest when a farmer receives the information on IPM from neighbors and groups. Table 5 shows that information on IPM from neighbors and groups increases the probability of IPM adoption by 100 percent.

An increase in household size (members between the age of 10 and 60) by one reduces the likelihood of IPM adoption by 34.6%. This supports the widely held belief in the study area that IPM is attractive to those with small farms. Households with smaller farms are always small in size. It was further evidence that a small farm encourages proper farm management due to pressure to provide enough to feed the household.

The likelihood of IPM adoption is very responsive to access to extension services and credit. Farmers with access to extension services have 100 percent chances of adopting IPM. Exposing the farmer to credit increases the chances of IPM adoption by 90.7 percent.

Location dummies provided a mixed result on their effect on the probability of IPM adoption. Farming households relocating to Kishushe location have reduced chances of adopting IPM by 95.2 percent. However, by moving to a Mwakishimba location, household increase the likelihood of IPM adoption by 87.1 percent. Interestingly, farm technology adoption patterns in smaller scale farms in rural Kenya tend to be location specific. Future studies should conduct detailed investigations on the social capital stock in these locations in relation to farm technology adoptions as the scope of this study is very limited and very insufficient.

4.5 Discussion and Conclusion

This study used a cross section data thereby facing a serious data limitation. IPM adoption is essentially a dynamic process and an adoption decision in one period is influenced by adoption decisions made in previous periods. Cross section data with a very small sample size cannot provide a clear cut understanding on household adoption behavior.

This study puts an emphasis on 2008 farming seasons yet IPM was first adopted in the study area in 1995. It is important to select and periodically survey a panel of IPM adopters and dis-adopters in order to monitor the changing patterns in terms of incidence and intensity. A panel data will further allow assessment for the impact of IPM on farm productivity and well-being of the households (whether or not IPM adopters have a significant difference in terms of income and food security compared to non adopters).

Absent in the analysis is the effect of location differences in social capital in IPM adoption. Putman (1993) found that difference in the level of social capital between North and South Italy significantly explained the difference in economic development and democracy in the two regions. Further studies is therefore necessary to shed light on how regional differences in social capital impact on the incidence and intensity of agro based technology adoptions.

Despite the limitations, the study is still rather unique and provides an insight into variables that can be used for policy interventions. This study suggests that some social capital variables are important determinants of IPM adoption. The policy response will therefore to improve and strengthen those variables with positive impacts.

Number of groups households subscribe to and monetary contributions to these groups are important determinants of IPM adoption. The policy implication is as follows: To speed adoption, government and development partners should initiate programs that strengthen association and trust among the rural small scale farmers prior to the diffusion of such technologies.

Mutual chats with neighbors and information flow through social groups promote IPM adoption. Most rural farmers spend more time chatting with neighbors and social group meetings also provide an opportunity for extensive chats making information and knowledge to flow easily and intensively. The policy implication is as follows: Government and development partners need to support farmers' education in order to improve on the quality of information. This can be done through forums that bring households together. The choice of groups as avenues for training programs is motivated by the finding that they are an effective channel for transferring information which is trusted by farmers thus promoting adoption decisions.

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Appendix 1: Survey Questionnaire

1. Name of enumerator ____
2. District: ____
3. Division ____
4. Location ____

Part A. Household characteristics

5. Farmer's name ____
6. Years of farming experience _________________________________
7. Farmers marital status 1-Single , 2- Married,
   3- Divorced/Separated, 4- Widowed
8. Farmer's household composition

Household composition (Those who live in the household for at least 9 months a year)	Sex 1. Male 2. Female	Age Actual years	Actual years of education	Main occupation 1. .Farming 2. Business 3. Civil servant 4. Private sector 5.Other (specify)	Average monthly income
1. Head					
2.					
3.					
4.					
5.					

9. What is your highest level in basic agricultural training?

1	2	3	4	5
Farm level	Certificate	Diploma	Degree	Other(specify)

10. Approximately how much income do you earn from all the off-farm activities in a month?
11. How many days in a week do you work off-farm?
12. Approximately how much income does your spouse remit to the household in a month?

Part B. Social Capital Information

13. Do you or any member of your household belong to any formal/informal groups or associations in this location? 1-Yes, 2- No

14. If yes, name the groups (e.g. farmer groups, trade and business associations, Church groups, Soccer clubs, Credit and finance groups, merry go round, vigilante group, village committees, cultural groups, etc.) starting with the most to the least important and stating whether it is registered by the Ministry of Social Services or not.
15. If no, why haven't joined any?
16. Provide the information on how much money, goods and services, and time your household contributed to each of the groups last year.

Name of group/association	**Membership fees (KES)**	**Annual Contribution (KES)**	**Contributions in Kind (Goods or services)**	**Time in hours**

17. How many times do you or members of your household meet or participate in each of the group activities in a month?
18. What are the major benefits your household has realized so far from joining each of the above mentioned groups? (Name at least two from each group/association)
19. Do any of the groups/associations help your household with any of the following?

Type of Services	List the services offered	Fee paid for the service (if free, mark put 0)	Name of the group
Agricultural Inputs			
Credit/Saving			
Pest conservation advice/information			
Price and market opportunities			

20. How many close friends do you have? (The people whom you can freely talk to on your private matters or go to incase of emergency)
21. How many people beyond your immediate family would you go to If you suddenly wanted some help in terms of farming tools, farming advice, seeds or small money to buy farm input?
22. Suppose you face serious farm problem such as serious pest invasion in your farm, how many people beyond your immediate family would you consult for advice for free?
23. For the past one year, how many people with farming related problems have turned to you for assistance or advice for free?

24. Please provide details of farming related inputs/services that you and your neighbors assist each other for free

Name of input/service	**Frequency at which you the same in a month**	**Frequency at which your neighbors seek the same in a month**

25. Would you contribute time or money to a community project that benefits others directly but not you?
26. Did you participate in any of the community projects last year?
27. If yes, please state the activity
28. If no, state the reason
29. What are the most three important sources of information on pest management practices?
    (a) Immediate family members, (b) Neighbors and friend, (c) Radio/television, (d) Community leaders, (e) NGOs, (f) groups/association, (i) Government extension officers, (j) others(specify)

Part C. Pest Management Practices

30. Please give the monetary cost of pest management strategy, yields, and labor requirement in your three major plots.

Plot Name	Plot size (Ha)	Pest Management Strategy	Cost (KES)	Yield (Kgs)	Labor requirement	Skills required

31. **If IPM is used, then provide the IPM strategies that are used in each of the plots**

IPM Strategies	Plot name	Crop type
Intercropping		
Crop rotation to destroy pest life cycle		
Interim crops (use of pest repellants)		
Bio-control		
Pest scouting		
Pest traps		
Botanical pesticides		
Others (specify)		

32. Before IPM adoption, what pest management practices did you use in your farms?

Part D. Farm characteristics

Plot Name	Crop type	Hectares	Terrain type	Farm preparation strategy	Farm tenure	Farming system	Estimated annual income (KES)

KEY: Crop type: 1= Food crop, 2 = Cash crop; **Terrain type:** 1 = Upper slope; 2 = mid-slope; 3 = Valley bottom; **Farm preparation strategy:** 1 = manually; 2 = Use animal traction; 3 = Use tractor; **Farm tenure:** 1 = own title deed; 2 = Rented land; 3 = Family land; 4 = Share cropping; 5 = Borrowed land; 6 = other (specify); **Farming system:** 1 = Rain-fed; 2 = Irrigation

33. Did any of your crops in the field get spoilt or destroyed during the last season? Yes/No __________

If yes, indicate which crops were destroyed and by what.

Crops destroyed	Cause of destruction

34. How long did the crops harvested in 2004 sustain the family _________(in months)

If it did not take you to the last harvesting season, how did you meet the deficit?

Part E. Institutional factors

35. During the past one year, did you ever attend an agricultural field day or on-farm demonstration? Yes/No ____________________

If yes,

Who sponsored it	What did you learn	Was it useful or waste of time

36. During the past one year, how many times has an extension technicians assisted you? __________________Times. (Please fill the table below if appropriate)

Agency of the technician	Type of assistance	Number of visits

37. How far does the extension officer live from your farm? ______km
38. Who first informed you about IPM? ________________
39. Do you ever have had an agricultural loan since you started farming? Yes/No ___

40. If yes, indicate the source and the form in which you were given the loan

Source	Year	Loan in cash	Loan in form of farm inputs	
			Equipment	Estimated value

41. Where do you mostly sell your crops?

1	2	3	4
On farm	Local market	Urban market	Other (specify)

42. How do you transport your produce to the market?

1	2	3	4	5
Head	Bicycle	Donkey/Ox-cart	Matatu/Bus/Lorry	Other(specify)

43. Approximately, how much did it cost you to transport your produce to the market in 2007?
44. Have you ever tried and were unable to sell your farm produce? Yes (1), No (2)
45. If yes, indicate the reasons

1	2	3	4
Lack of buyers	Prices too low	Lack of transport	Other(specify)

46. Indicate the quantity (number) of the following properties that are owned by the household.

PROPERTY	Number/Size
Bicycle	
Motor cycle	
Car	
Radio	
Television	
Sewing machine	
Goats	
Sheep	
Cows	
Donkeys	
Total hectares of land owned by household	
Other (specify)	

47. What are the major problems that farmers face in this location? (list in the order of importance) ____
48. What is your general opinion on the IPM practices? ________________
49. Can you briefly suggest on how farmers in this location can be helped and motivated to participate actively in agricultural production.