DETERMINATION OF ACCESS TO AND USE OF INFORMATION ON MANGO FRUIT FLY (*Ceratitis cosyra)* CONTROL BY SMALL-SCALE FARMERS IN MURANG'A SOUTH SUB-COUNTY, KENYA

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DECLARATION AND RECOMMENDATIONS

This thesis is my original work and has not, wholly or in part, been presented for an award of a degree in any other university.

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DEDICATION

This thesis is dedicated to small scale mango farmers in Murang'a South Sub-County in Murang'a County.

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ABSTRACT

The mango is the third most important fruit in Kenya after banana and pineapples for food and cash. Murang'a South Sub- County is endowed with a flourishing mango growing as major cash earner. However, mango production is constrained by pest problems especially the mango fruit fly. Although technologies are available to effectively control the mango fruit fly, farmers continue to incur heavy losses. This brings questions as to whether farmers in the Sub- County actually access and use information available on mango fruit fly control. Small-scale farmers lose significant portions of their harvests to pests and diseases due to lack of effective control measures. Consequently, they lose out on the benefits of the many possible existing technologies that could increase their production and improve farm incomes. This study therefore sought to determine the extent of access and use of information on "mango fruit fly" control and the factors influencing the access and use portfolios by small-scale farmers. The target population consisted of all the 834 small-scale mango farmers who own 10 to 300 mature mango trees in the main mango growing area of the district. The study used cross-sectional survey design with ex-post- facto approach. A sample of 131 farmers was taken using simple random sampling from the target population. Data were collected between October and December 2011 using structured questionnaires. The statistical package for social sciences (SPSS) program was used for managing and analyzing the data. Significance of empirical findings was tested and inferences interpreted at $\alpha = 0.05$. The study found out that the majority (91.1 %) of farmers in the district actually accessed information on mango fruit fly control mainly from government extension services, particularly, the Ministry of Agriculture, private chemical companies and non-governmental organizations. However, the information accessed was not sufficient in controlling the pest even though 93.5 % of the farmers used the information they accessed. Group membership influenced both access to and use of information. Household size and education level influenced use of information. The study recommends further research to be conducted to establish how information on mango fruit fly control delivered by extension service providers is packaged. The study further recommends that farmers in the district should be educated on the importance of media and the internet as sources of technical information.

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LIST OF ACRONYMS AND ABBREVIATIONS

AICM	Agricultural Information and Communication Management
AIIM	**Association for Information and Image Management**
AKIS	Agricultural Knowledge and Information Systems
CTA	*Technical Centre for Agricultural and Rural Co-operation*
CBO	*Community Based Organisation*
DAO	District Agricultural Officer
FAO	Food and Agriculture organization of the United Nations
GOK	Government of Kenya
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
ICTs	Information and Communication Technologies
ICIPE	International Centre of Insect Physiology and Ecology
IOPS	International Organisation of Pensions Supervisors
KARI	Kenya Agricultural Research Institute
KHDP	Kenya Horticultural Development Program
MOA	Ministry of Agriculture
Mg	Milligrams
Mcg	micrograms
NGO	*Non Governmental Organisation*
PSDA	Private Sector for Development of Agriculture
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
Spp	Species
SPSS	*Statistical Package for Social Sciences*
SRA	Strategy for Revitalisation of Agriculture

CHAPTER ONE
INTRODUCTION

1.1 Background

The mango (*Mangifera indica L.*) belongs to the family Anacardiaceae. The fruit is native to India, Bangladesh, Myanmar and Malaysia, but can be found growing in more than 60 other countries throughout the world (Salim, Simons, Orwa, Chege, Owuor & Mutua, 2002). It is one of the most important fruit crops in the tropical and subtropical lowlands (Salim *et al*., 2002). It is the fifth largest fruit crop produced worldwide after banana, grapes, apples and oranges. It is the second most important tropical fruit with 27 million tons being produced annually worldwide (Bally, Lu & Johnson, 2009).

It contains almost all the known vitamins and many essential minerals (Morton, 1987). Studies show that one mango fruit can provide 1.06 grams protein, 135 calories, and 3.7 grams dietary fibre (Bowden, 2007). It also contains 323 mg potassium, 23 mg phosphorus, 19 mg magnesium, 21 mg calcium, 4 mg sodium, 0.27 mg iron, 1.2 mcg selenium, 0.056 mg manganese, 0.228 mg copper, and 0.08 mg zinc (Bowden, 2007). In addition there are many essential vitamins available from the fruit which include Vitamin A, B1 (thiamin), B2 (riboflavin), Niacin, folate, pantothecic acid, B6, C, E and K (Bowden, 2007; Griesbach, 2003; Morton, 1987).

The mango fruit is best adapted to a warm tropical monsoon climate with a pronounced dry season (>3 months) followed by short rains. It is naturally adapted to tropical lowlands between 25°N and 25°S of the equator and elevations of between 0 to 1200 m. The mango is successfully grown on a wide range of soils so long as the soil is at least 3 metres deep, well drained and with a ph value of 5.5 -7.5. It requires appropriate rainfall of 500-1000 mm and a temperature of 20-26°C (Griesbach, 1981). In Kenya, the mango tree has been cultivated for over six centuries. Traders in ivory and slaves introduced it in the country during the 14th century (Griesbach, 1981). It has been the third most important fruit in terms of area and total production, over the last ten years after bananas and pineapples (Moturi, Ngunjiri, Otieno & Nyambane, 2009).

Production of quality mangoes in Kenya is constrained by a combination of challenges: less productivity enhancing agronomic practices, losses due to insect pest and disease infestation and poor market access (Nyambo, Varela & Seif, 2006; Serem, 2010). A wide range of insect pests and diseases attack the mango fruit. In particular, fruit fly (*Ceratitis* spp. and *Bactrocera* spp.) and mango seed weevil [*Sternnochetus mangifera* (F.)] are the most damaging insect pests of mangoes in Kenya. Other pests include aphids, scales, mealy bugs, coconut bugs, mosquito bugs (*Helopeltis* spp.) and mango gallflies (Griesbach, 1992). The major diseases of the mango in Kenya are powdery mildew (*Oidium mangiferae*) and anthracnose (*Colletotrichum gloeosporioides)* (Nyambo *et al*., 2006).

Among the major pests of mangoes, the fruit fly is the most destructive with regard to export quality and fruits for local market (Griesbach, 2003; Cugala, Santos & Albano, 2010). Different types of fruit flies are known to attack mature and ripening mangos in almost all mango-producing areas. Yield losses of more than 50% have been reported (Griesbach, 2003). Consequently, exports of mangoes to markets in South Africa, Europe, the Middle East, and Japan have reduced significantly (ICIPE, 2009).

The bulk of mangoes produced in Kenya are consumed in the domestic market but there are very high post harvest losses that reduce the incomes of mango producers (KHDP, 2009). Similarly mango exports from Kenya are declining despite the expansion in demand for fresh fruits in Europe and the Near East. Mangoes from Kenya cannot compete effectively in the world markets due to unreliable supplies (MOA, 2010 a).

One of the critical factors that influence production decisions by farmers is information (Patrick, Gerald, Ortmann, Wesley & Doster, 1993). Access and its use contribute greatly to improving the lives of poor people (Sarah and Herman, 1998). In agriculture, the role of information in enhancing agricultural development cannot be over emphasized. Information is vital for increasing production and improving marketing and distribution strategies (Oladele, Ogunlade and Falaki, 2006). Information also opens up opportunities for sharing experiences, best practices, sources of financial aids and new markets (Aina, 2007). According to Aina (2006), information has a vital role to play in improving and sustaining agricultural production in any

nation. Lack of timely information can prevent making of good quality decisions and thus lower the efficiency of production by farmers (Patrick *et al.*, 1993).

The Agricultural Knowledge and Information Systems (AKIS) of Kenya's smallholder farmers are diverse and complex, varying with agricultural enterprise, agro ecological zone, and from county to county(Rees, Momanyi, Wekundah, Ndungu, Odondi, Oyure, Dymphina, Kamau, Ndubi, Francis, Mwaura & Joldersma, 2000). According to Rees *et al*. (2000), small-scale farmers in Kenya require agricultural information relating to awareness, operational skills, technical knowledge, marketing information and enabling as well as supportive policy. The farmers also require information to link them to various input markets at reasonable prices, and to output markets (Adekunle, Olowu & Ladele, 2004).

The major sources of information for small-scale farmers in Kenya include community, neighbours, churches, *barazas*[1], non-governmental organisations and government extension services (Rees e*t al*., 2000). Among these sources, government extension services rank the highest (Njuguna and Kooijman, 1999; Rees *et al*., 2000; Salasya and Hassan, 1999; Kimenye, 1999). However, although government extension services have been ranked the highest, the communities and the extension personnel themselves admit that their interactions are not adequate partly due to few officers with limited training (Rees *et al*., 2000; Aina, 2007).
Agricultural extension by its nature is a service that relies on linkages and networks as it recognizes institutional multiplicity in service provision (Madukwe, 2006). An extension service that is not linked to research, farmers, and other service providers cannot be effective. Unfortunately, the linkages between extension and research and extension and farmers in most developing countries have been very weak over the years (Madukwe, 2006). This is mainly due to national agricultural and rural policies. The policies inhibit the flexibility of the research and extension organizations in their requirement to be responsive to both farmers and each other needs (Madukwe, 2006). According to Arokoyo (2005), a strong extension linkage complimented by flawless information flow and enhanced by the effective use of information and communication technologies (ICTs) will significantly boost agricultural production and improve rural livelihoods in developing countries.

[1] A baraza is a public place where meetings for dissemination of information are held.

The use of the World Wide Web (www) can provide an avenue for lots of information on existing and new technologies and go a long way in filling the gaps left by government and private extension providers. However, internet access, though growing, is still limited in growth in Kenya and elsewhere in rural Africa (Aina, 2007; Easdown and Starasts, 2004). This is contributed largely by the technological conditions in many African countries, mainly, lack of adequate internet infrastructure (Jagun, 2007).

The main fruits grown in Murang'a South Sub-County are banana, mango, avocado, passion, citrus and pawpaw. The mango fruit is the second most important fruit in the Sub-County after banana as a source of income. In 2012 the area under the mango fruit was about 400 hectares with a total production of 1,950 tonnes and an estimated value of Kshs. 28, 323,000 (MOA, 2012). However, the Sub-County loses about 750 tonnes of mangoes annually due to various constraints. In 2012 pests and diseases contributed to a loss of about 420 tonnes (56%) out of the 750 tonnes of production lost. The most destructive pest is the mango fruit fly. In 2012 Farmers in the Sub-County lost about 310 tonnes of mangoes with an estimated value of Ksh. 4, 200,000 as a result of the mango fruit fly (MOA, 2012).

The great amount of mango produce lost, and consequent revenue lost by small-scale farmers in Murang'a South Sub-County due to the damage by the mango fruit fly poses the question: Do farmers in this Sub-County access and use appropriate information on the control of the pest? This study therefore investigated small-scale farmers' access and use of information on mango fruit fly control in Murang'a South Sub-County.

1.2 Statement of the Problem

The mango fruit fly remains the most constraining pest to mango production in Murang'a South Sub-County. Although appropriate technology to effectively manage the pest is available, farmers in the Sub-County continue to lose their produce to the pest damage. Several factors could be contributing to this, including not accessing and use of the information on its control. However no studies have been conducted to understand those factors contributing to continued losses. This study therefore endeavoured to investigate whether small scale farmers in the Sub-

County access and use information on mango fruit fly control. It further explored whether some social economic factors influenced access and use of information on Mango fruit fly control.

1.3 Research Justification

Mango is the second most important fruit crop after banana in Murang'a South Sub-County, but its production is greatly constrained by the mango fruit fly, which leads to loss of millions of shillings that could be accrued by small-scale farmers every year. In 2012 alone, farmers in the Sub-County lost mangoes worth Ksh.4.2 million from the fruit fly damage. Effective control of the mango fruit fly in the Sub-County would help to reduce the loss due to the pest damage. This would motivate the farmers to increase their mango production and subsequently achieve higher incomes from the sale of the fruit. Inevitably, an increase in farmers' incomes would improve their livelihoods.

1.4 General Objective

The overall objective of the study was to contribute to improved mango production by small-scale farmers in Murang'a South Sub-County, by investigating access and use of information available on mango fruit fly control.

1.5 Specific Objectives

1. To determine whether small-scale farmers in Murang'a South Sub-County access information on mango fruit fly control.
2. To determine whether some social economic factors influence access to information on mango fruit fly control by small-scale farmers in Murang'a South Sub-County.
3. To determine whether small-scale farmers in Murang'a South Sub-County use information on mango fruit fly.
4. To determine whether some social-economic factors influence use of information on mango fruit fly control by small-scale farmers in Murang'a South Sub–County.

1.6 Research Questions

The following research questions were used to address the four objectives above:

1. Do small-scale farmers in Murang'a South Sub-County access information on mango fruit fly control?
2. Do some social economic factors influence access to information on mango fruit fly control by small-scale farmers in Murang'a South Sub-County?
3. Do small-scale farmers in Murang'a South Sub-County use information on mango fruit fly control?
4. Do some social economic factors influence use of information on mango fruit fly control by small-scale farmers in Murang'a South Sub-County?

1.7 Scope of the Study

The study was carried out in Murang'a South Sub-County of Murang'a County and was limited to small-scale mango farmers with between 10 to 300 mango trees. The study focused on information on mango fruit fly control. The study investigated whether small-scale mango farmers in the Sub-County access and use information on mango fruit fly control. This was done through descriptive statistics. The study further investigated the role of social economic factors and their influence on access and use of information on mango fruit fly control. The sources of information on the control of the pest were also identified.

1.8 Limitations of the Study

Operating with small and tight budget, the researcher was not able to engage farmers in more than one Sub-County and therefore the results of the study are limited to Murang'a South Sub-County.

1.9 Definition of Terms

The following definitions apply in this study.

Pest: A pest is an organism, usually an insect, which has characteristics regarded by humans as injurious or unwanted due to the parasitism and damage they cause to crops or livestock (Nyambo *et al*., 2006). In this study, the same definition was adopted.

***Information*:** This is defined as data that is organized, accurate, and timely and when communicated to a recipient it is used by the recipient to make informed decisions (Imboden, 1980). Same definition applied in this study.

***Information Access**:* The Association for Information and Image Management (AIIM) defines information access as the ease of finding information regardless of format, channel, or location (Adekunle *et. al*, 2004). In this study, access to information was narrowed to establishing how available or accessible the information on mango fruit fly control is by small-scale mango farmers in Murang'a South Sub-County.

Mango production: The cultivation of a medium to large evergreen tree with rounded canopy which may be low and dense to upright and open, with dark green foliage that is long and narrow (*Mangifera indica L.*), for its large colourful fruit for food or income (Griesbach, 1981).

***Small-scale farmers**:* These are farmers with limited production resources of land, labour, capital, entrepreneurship and technology (Dorward and Kydd, 2002). In this study, it referred to all the mango farmers in Murang'a South Sub-County with between 10 and 300 mature mango trees.

Food security: This is defined as a state where all people have physical, social, and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preference for a healthy life (FAO, 2000). In this study, food security was considered as the ability of a household to live free from hunger and malnutrition.

***Utilisation of information**:* This is defined as making use of accessible information to make informed decisions in solving problems or improving the status of operations (International Organisation of Pensions Supervisors, 2007). In this study, the same definition was applied.

CHAPTER TWO
LITERATURE REVIEW

2.1 Overview of Mango Production

The mango (*Mangifera indica L.*) belongs to the family Anacardiaceae. It is native to India, Bangladesh, Myanmar and Malaysia, but can be found growing in more than 60 other countries throughout the world (Salim *et al*., 2002). It is one of the most important fruit crops in the tropical and subtropical lowlands (Salim *et al*., 2002). Of all the fruits enjoyed throughout the world, few are as popular or universally acceptable as the mango. The only tropical fruit which outranks it is the banana (Griesbach, 2003). The mango fruit contains almost all the known vitamins and many essential minerals (Morton, 1987). Studies show that one mango fruit can provide 1.06 grams protein, 135 calories, and 3.7 grams dietary fibre (Bowden, 2007). It also contains 323mg potassium, 23 mg phosphorus, 19 mg magnesium, 21 mg calcium, 4 mg sodium, 0.27 mg iron, 1.2 mcg selenium, 0.056 mg manganese, 0.228 mg copper, and 0.08 mg zinc (Bowden, 2007). In addition there are many essential vitamins available from the fruit which include Vitamin A, B1 (thiamin), B2 (riboflavin), Niacin, folate, pantothecic acid, B6, C, E and K (Bowden, 2007; Griesbach, 2003 & Morton, 1987).

The mango fruit is best adapted to a warm tropical monsoon climate with a pronounced dry season (>3 months) followed by rains. It is naturally adapted to tropical lowlands between 25°N and 25°S of the equator and elevations of between 0 to 1200 m. Mango is successfully grown on a wide range of soils so long as the soil is at least 3 metres deep. It requires appropriate rainfall of 500-1000 mm, a temperature range of 20-26°C for optimum productivity, good drainage and preferably a PH value of between 5.5 and 7.5 (Griesbach, 2003).

2.2 Overview of Mango Industry in Kenya

In Kenya, the mango tree has been cultivated for over six centuries. Traders in ivory and slaves brought it first in the country in 14th century (Griesbach, 2003). It is the second most important fruit after banana and in terms of export it is second to avocado (HCDA, 2012). Mangoes in Kenya are produced by both large and small scale farms. They are produced for both export and domestic consumption. A large proportion of the fruits are also processed into juice

and fruit concentrates. The main varieties grown include Sabine, Ngowe, Boribo, Apple, Kent, Haden, Dodo, Tommy Atkins, Van Dyke, Batawi, Sensation, Kensignton, Pears and Sabro.

In Kenya, the area under mango production is estimated at 57,000 hectares with a total annual production estimated at 2.8 million tonnes, with a value of ksh.13.5 billion (HCDA, 2012). As an export fruit crop, mango earns the country foreign exchange while at the same time acting as a source of household income for resource-poor farmers (Gathambiri *et al*., 2004; Muchiri, 2012). In 2009 the country exported 1,789 tonnes of mangoes with a value estimated at Ksh.10, 732,344 (MOA 2010 a). In addition to income opportunities, the mango is important as food to many households (Nyambo *et al*., 2006). The fruit is widely consumed by rural and urban dwellers, although there is a growing demand for export (Nyambo *et al*., 2006). Mango production in Kenya is concentrated in the Coast, Central, and Eastern regions, although some production also takes place in the Western parts of the country; Nyanza and low lying areas of Rift valley (Muchiri, 2012; Serem, 2010). In Central Kenya, the fruit is grown in Murang'a, Kirinyaga and Kiambu Counties. However, the bulk of the crop is grown in the Murang'a County (Griesbach, 2003).

The bulk of mangoes produced in Kenya are consumed in the domestic market but there are very high post harvest losses that reduce the incomes of mango producers (Kenya Horticultural Development Program, 2009). Mangoes from Kenya cannot compete effectively in the world markets due to unreliable supplies (MOA, 2010b).

2.3 Overview of the Mango Industry in Murang'a South Sub-County

Ninety five percent (95 %) of the population in Murang'a South Sub-County depends on agriculture for their livelihoods (MOA, 2012). The Sub-County has a wide range of horticultural crops grown for both export and local market. They include fruits, vegetables, and nuts. The total area under horticulture is about at 6,560 hectares, with 6,232 hectares (95%) being under fruits while the rest of 328 hectares (5%) is under vegetables and nuts. In 2012 the horticultural industry earned the Sub-County Kshs. 1.9 billion. Horticulture is the main source of income in this Sub-County (MOA, 2012).

The main fruits in the Sub-County are banana, mango, avocado, passion, citrus and pawpaw. The mango fruit is the second most important fruit in the Sub-County after banana as an income earner. In the year 2012 the area under the mango fruit was about 400 hectares with a total production of 1,950 tonnes with value estimated at Kshs. 28,323,000 (MOA, 2012). Out of the total area (467.6 km^2) of Murang'a South Sub-County, 346.6 km^2 (74%) has agro climatic conditions suitable for mango production (Jaetzold, Schmidt, Hornetz and Shisanya, 2006)**.** See Table 1 below on rainfall and temperature data for one of the stations in the area.

Table 1 Rainfall and temperature data for Makuyu Divisional Office

Station	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
Rainfall (mm)	29	41	110	265	124	26	10	7	11	107	200	49	979
Average Temp (°C)	21.5	23.0	23.5	22.9	21.9	21.1	20.1	20.3	22.0	23.3	22.2	22.5	Av. 22.6

Source: Farm Management Handbook of Kenya, Vol. II 2nd Edition, 2006.

The problems constraining the mango production in Murang'a South Sub-County include poor marketing, pest and disease infestation, poor infrastructure and high cost of agricultural inputs. The major diseases in the industry are anthracnose (*Colletotrichum gloeosporioides*) and powdery mildew (*Oidium mangiferae*) while the pests of economic importance are the mango seed weevil (*Sternnochetus mangifera),* the mango fruit fly *(Ceratitis* spp. and *Bactrocera* spp.) and mango gallflies (*C. Procontarinia matteriana).* The Sub-County loses about 750 tones of mangoes through the above-mentioned problems annually. Pests and diseases contributed to about 420 tones out of the 750 tones of production lost (56%) in the year 2009 (MOA, 2012). In 2012 the mango fruit fly contributed to about 310 tonnes of mangoes amounting to Kshs 4,200,000 loss (MOA, 2012).

Table 2 Annual Loss of Mangos due to Major Pests and Diseases, Murang'a South Sub-County (2008-2012)

Year	Total Production (tonnes)	Loss due to Pests and Diseases (tonnes)	Loss due to mango fruit fly (tonnes)	% Loss due to mango fruit fly
2008	2050	440	310	70.5
2009	1666	400	300	75
2010	1700	408	303	74.3
2011	1750	416	306	73.6
2012	1950	420	310	73.8

Source: MOA (2012)

2.4 The Problem of Mango Fruit Fly

In Kenya, different types of fruit flies are known to attack mature and ripening mangos in almost all mango producing areas. Yield losses of more than 50% have been reported (Griesbach, 2003). As a consequence of the devastation, exports of mangoes to lucrative markets in South Africa, Europe, the Middle East and Japan have reduced significantly (ICIPE, 2009).
The mango is attacked by fruit flies from different genera: *Bactrocera* in Asia and Africa, *Ceratitis* in Africa and Anastrepha in America. The genus *Ceratitis* is endemic to the Afro tropical region, and comprises over 65 species. The results of surveys conducted in Kenya, Tanzania (mainland and Zanzibar), Sudan, Uganda, Côte d'Ivoire, Nigeria, Namibia, South Africa and the Indian Ocean Islands (Réunion) reveal that the mango is commonly attacked by varying combinations of four major species across Africa: *Ceratitis cosyra* (Walker), *Ceratitis fasciventris* (Bezzi), *Ceratitis rosa* (Karsch) and *Ceratitis anonae* (Graham) and much less frequently, by *Ceratitis capitata* (Wiedemann) (Lux *et al*., 2003). Although the *Bactrocera* genus has been attributed to Asia, a species of it *(Bactrocera invadens)* was reported in Kenya in 2003 and is of economic importance to mango production (Lux *et al*., 2003).

The adult fruit fly is approximately 4.5-6 mm long, brightly coloured, usually in brown-yellow patterns. The wings are spotted or banded with yellow and brown margins (ICIPE, 2006).

Fruit flies cause direct damage by puncturing the fruit skin to lay eggs (Ekesi, 2010; Cugala *et al.*, 2010). The female implants its eggs in the mature and ripening mango fruit (Plate 1). During egg laying, bacteria from the intestinal flora of the fly are introduced into the fruit. These cause rotting of the tissues surrounding the egg. Eggs hatch within 1-2 days; the maggots feed on the fruit flesh making tunnels. These provide entry for pathogens and increase the fruit decay, making fruits unsuitable for consumption. Generally, the fruit falls to the ground as, or just before the maggots pupate, which takes place within 4-17 days. The larvae leave the fruit and the pupae develop in the top layer (top few cm) of the soil. The adult emerges within 10-20 days and upon emergence, it soon starts looking for the nourishment it needs to reach sexual maturity, couple, and lay eggs. Attacked mango fruits usually show punctures (made by females while laying eggs). Around these punctures a necrosis may occur. Small holes on the fruits are visible when the maggot leaves the fruit. The affected part of the fruit becomes soft and colours prematurely (Plate 2). In fruits for export, fruit flies cause indirect losses resulting from quarantine restrictions that are imposed by importing countries to prevent entry of fruit flies (ICIPE, 2006).

Plate 1. An adult mango fruit fly *(Ceratitis fasciventris)*. Source*:* ICIPE, 2006

Plate 2. A fruit destroyed by the maggots of the mango fruit fly. Source: ICIPE (2006).

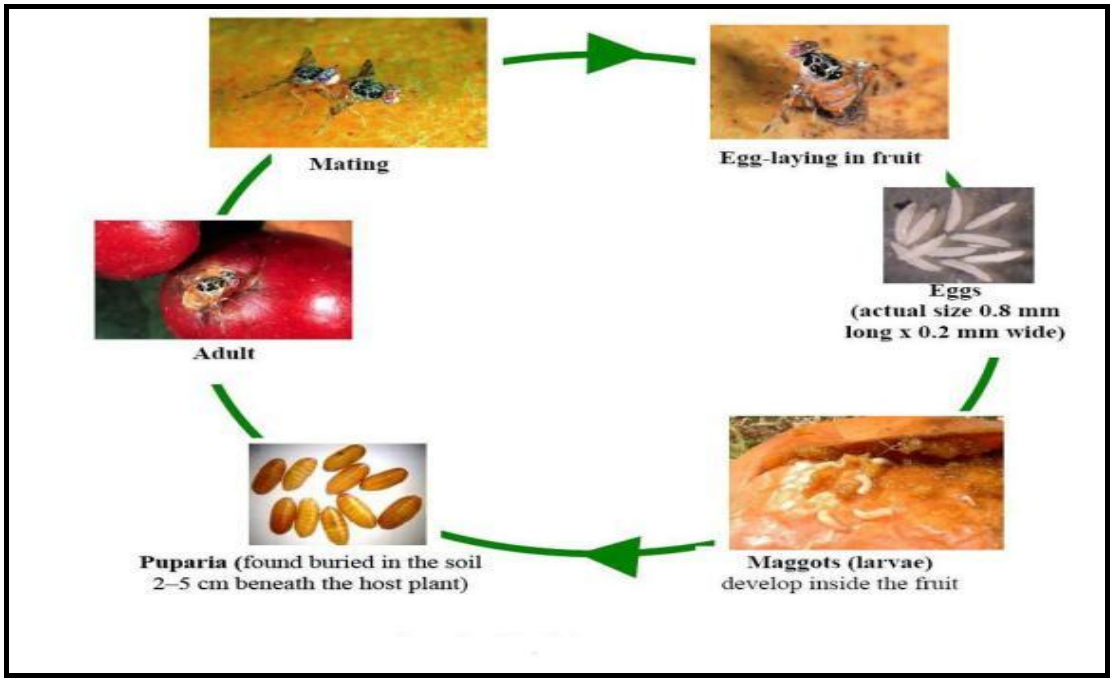


Figure 1. Life Cycle of the Mango Fruit Fly. Source: ICIPE (2006).

2.5.0 Control of the Mango Fruit Fly

There are several methods of controlling fruit flies. The methods are broadly classified under cultural, biological, physical and chemical (Varghese, 2006). Ekesi (2010) recommends that the farmer should not rely on one method but should apply an integrated approach in controlling the mango fruit fly. The type of combinations of methods will depend on severity of the problem and available options for the control of the pest.

2.5. 1 Cultural methods of controlling Mango Fruit Fly

If the fruit fly population becomes too large, there is no control method that will be genuinely effective and profitable. To limit proliferation of the fruit fly populations, the following is recommended: The farmer should pick up dropped fruits every day and then quickly remove them from the orchard and destroy them. Till the top soil (5-10 cm deep) in the orchard to expose the pupae to the sun, parasites and predators such as birds; weed carefully around the trees and avoid the presence of abandoned, untended orchards or wild trees near the mango plot. While establishing a mango orchard, the farmer should avoid planting varieties with different maturity times in the same plot. Presence of infested fruit in the plot or near the fruit-packaging station is highly discouraged. The farmer should sort the fruit and quickly eliminate any fruit with traces of fly attack. Any rejected fruits should be discarded, since they are ideal infestation sites, near the orchard or the packaging station (Ekesi, 2010; Farzana, 2005).

Smoking of the mango trees is another cultural method used by farmers to reduce fruit fly population. Smoke pots with holes in the bottom for air intake, containing wood shavings or sawdust with a topping of aromatic plants like lemon grass (*Cymbopogon citrus*) or lantana (*Lantana camara*) are hung at strategic places within the mango tree. The sawdust is put on fire to produce smoke which chases insects away from the tree. Another option is to place dry grass on the ground below the tree in a position where the wind can blow maximum smoke into the top of the tree, cover it with green aromatic leaves like lantana or lemon grass and light the grass to produce smoke (Ekesi, 2010).

Post–harvest treatment (hot water treatment) is another effective cultural method for controlling the mango fruit fly. Newly harvested fruits are dipped in hot water at 46^0C temperature for 65 minutes (Verghese, 2006).

2.5.2 Biological methods of Mango Fruit Fly control

Biological control of the mango fruit fly involves use of natural enemies. Several natural enemies can contribute to the suppression of fruit flies. Major natural enemies are parasitic wasps and predators such as rove beetles *(Staphylinidae Coleoptera),* weaver ants *(Oecophylla smaragdina),* spiders(*Araneae*), birds(*Aves*) and bats*(Chiroptera).* One parasitic wasp (*Fopius arianus*) has proved to be effective in controlling the fruit fly in Kenya. The wasp parasitizes the fruit fly by feeding on its eggs. Another wasp, *Diachasmimorpha longicaudata*, is being tested to find out if it too would be effective against fruit fly infestations. Weaver ants have also shown to be very efficient in protecting fruit trees from pests, including fruit flies. These ants prey on fruit flies, but most important, they have been known to disrupt the fruit fly from laying eggs on the fruits. This results in reduced fruit fly damage (Van Mele *et al*., 2007; Ekesi, 2010).

For the weaver ants to be effective, they have to be conserved in the mango orchard by reducing the use of chemical pesticides that can kill them or use of less harmful pesticides. Host trees must have food for ants such as homopterans, honeydew or plant nectar that the ants feed on. To retain the weaver ants during the dry season, farmers can provide dried fish, which the ants can feed on, to meet their energy and nutritional requirements. Farmers can tie ropes between mango trees in an orchard to facilitate the movement of the ants from one tree to the next. Existing weaver ant colonies can also be harvested and introduced to other trees in the orchard where they are not present (Ekesi, 2010; Van Mele *et al*., 2007).

Plate 3. A parasitic wasp on a caterpillar. Source: ICIPE (2006).

Although natural enemies alone do not give satisfactory control of fruit flies, efforts should be made to protect them, and to complement their effect on fruit flies with other management options (Van Mele *et al*., 2007). Fungal pathogens are also used in suppression of fruit flies (Ekesi, 2010). This involves inoculating the soil with a fungal pathogen. During development of the fly, mature maggots drop from the fruits to the ground, burrow into the soil and form a resting stage called the puparia. Fruit fly suppression involves soil treatment with fungal pathogens to kill the mature maggot and puparia. One of the pathogens that has been used *Metarrhizium anisopliae*. It is a naturally occurring fungus that is used worldwide as a biological pesticide for controlling different kinds of insect pests. The fungus is formulated as granules and can be manually distributed by hand and then raked into the soil under the mango canopy. Application is usually done once in the season at the onset of fruiting and the fungus can persist in the soil for over one year (Ekesi, 2010).

Biopesticides are also used in the control of the fruit fly. A spray with a pyrethrum solution can be used. A product made from natural pyrethrum called Flower-DS® has been found to be effective in control of the fruit fly. Spray application should start shortly after beginning of flowering, and repeated approximately every 5 days (ICIPE, 2009). Neem (*Azadirachta indica*) has pesticide properties that have different effects on pests and can also be used to suppress the fruit fly (Devi, 2007). It acts as a broad-spectrum repellent, insect growth

regulator (it causes deformities in the insects' offspring) and insect poison. It discourages feeding by making plants unpalatable to insects or suppresses the insect's appetite (anti-feedant effect); if they still attack, it inhibits their ability to moult and lay eggs. Neem pesticides can be prepared from the leaves or from the seeds. The leaves or seeds are crushed and steeped in water, alcohol, or other solvents. The resulting extracts can be used without further refinement (Ekesi, 2010; (Devi, 2007).

2.5.3 Physical Methods of Mango Fruit Fly Control

Physical methods include capturing the flies using traps (Ekesi, 2010). Fruit fly traps are very good in detecting the flies and, if used on a large scale and in large quantities, can hold down population growth early in the season (Technical Centre for Agricultural and Rural Development (CTA), 2007). The traps should be installed at least one month before the fruits become appealing (Farzana, 2005). The farmer is required to install a strip soaked with a specific attractant and treated with a contact insecticide. Malathion and deltamethrin have proved to be effective insecticide while methyl eugenol is a good attractant (Farzana, 2005). However the farmer may use any other effective insecticide and attractant available. Small strips of wood are cut into pieces (Triplex-type chipboard) and soaked in a solution containing the attractant. A nail is driven through each strip and into the trunk of the mango tree. To ensure easy replacement, the nail should not be totally driven in. It is advisable to install these strips in other orchards with fly-sensitive fruit trees, like citrus orchards. A concentrated solution of the insecticide is prepared and applied to the strip with a brush and left to dry. The strips should be 1 for every 10 trees, or about 10 per hectare. The strips have to be renewed once a month. A container, such as a water bottle cut in half, can be attached under the strip to collect the capture. The traps are supposed to be inspected weekly and the number of flies captured counted (Farzana, 2005; ICIPE, 2006; CTA, 2007).

Wrapping or bagging of individual fruits with newspaper or plastic bags to prevent adult fruit flies from laying eggs on the fruits is also a practice of producing fruits that are free from fruit flies. To be effective, the fruits must be wrapped or bagged well before fruit fly attack, at least one month before harvest (Ekesi, 2010).

2.5.4 Chemical Control Measures

Chemical control strategies are based on infestation levels. Fruit fly traps are generally used to capture the flies so as to make a decision on the scale of chemical control to be used (Griesbach, 2003). The traps are supposed to be inspected weekly and the number of flies captured counted (Farzana, 2005; ICIPE, 2006).

According to CTA, (2007), chemical treatment is either localized treatment, and under exceptional cases, full treatment of the orchard. This depends on the number of flies captured by the traps weekly. It is recommended that when the number of flies captured in the traps is less than 25 per week, no treatment is required because the traps will be sufficient to keep the population below economic injury level. However if the number of flies captured is between 25 and 120 there should be localized treatment and when the number is above 120 then a full treatment of the orchard is necessary (CTA, 2007).

The first treatment must be applied on time since the products only have a preventive effect, not a curative effect. When the larva of the fruit fly is inside the fruit it is protected (Farzana, 2005). The products used in spraying are selected on the basis of their spectrum, their effectiveness on the flies, the maximum residue limit for mangoes, and the pre-harvest intervals. With a 7-day pre-harvest interval, certain active ingredients like bifenthrin and lambda-cyhalothrin can be used, even during the harvesting period, as long as the maximum residue limit is respected (Farzana, 2005). The following insecticides are recommended: Karate Max 2.5 WG at a rate of 1 kg/ha or Talstar 100 EC at a rate of 0.5l/ha (CTA, 2007; Griesbach, 2003). The spray volume should be between 4 and 10 litres/ha. The mixture should be applied to the top layer of leaves (about one m^2), rotating around the tree and trying to penetrate the foliage slightly. It is better not to treat the fruits (CTA, 2007). This type of localized application using a knapsack sprayer is acceptable just prior to harvest, and even during harvest since the operator can avoid spraying the fruits (CTA, 2007). When the farmer decides to treat the whole orchard it is advisable to limit the number of treatments to not more than two applications, with an interval of 10 days. This would help protect the natural enemies of the fruit fly (Ekesi, 2010).

2.6 Importance of Information and Farmers' Access to Information

Information is an important resource that contributes to the development of a nation (Siyao, 2012). It provides the core for the development of knowledge and the basis for innovations, making it one of the key commodities for the progress of a society (Majid and Kassim, 2000). Information increases the capacity to see things more clearly and become more focused (Siyao, 2012). Olorunda and Oyelude (2008), add that information is essential for planning, decision-making, and the execution of programmes. When resources, technonolgy and information are made accessible to those who need them, there is improvement of life because economic, social, political, and physical obstacles to improvement of life are removed (Sarah and Herman, 1998).

There is a direct relationship between the provision of effective information and agricultural development (Kalusopa, 2005). According to Manda (2002) there is a positive relationship between the increased flow of information and agricultural development. According to Aina (1995), information has a vital role to play in improving and sustaining agricultural production of any nation. Information is an indispensable factor in the practice of farming (Ofuoko and Agumagu, 2008). Information influences production decisions by farmers (Patrick *et al*., 1993). It is therefore vital for increasing production and improving marketing and distribution strategies which leads to improved rural livelihoods and food security (Masuki *et al*., 2010; Oladele *et al.*, 2006; Ozawa, 1995). According to Aina (2007), information also opens channels of sharing experiences, best practices, sources of financial aids and new markets. Lack of timely information can therefore prevent good quality decisions and thus lower the efficiency of production among farmers (Patrick *et al*., 1993).

The value of any information can only be realized if it is accessed, used or understood (Siyao, 2012). Easdown and Starasts (2004) argue that it is only when agricultural information is valued that farmers will seek and use it. The importance of access and use of information in rural areas just like anywhere else has been demonstrated in several quarters (Siyao, 2012). The experience of some of the rapidly growing economies such as China has shown that improvement in information services was one of the strategies used to achieve agricultural transformation (Xu, 2001). Studies in Nigeria revealed that agriculture cannot be improved if the

practitioners, especially small-scale farmers, are not aware of their information needs and the sources of information (Oladele *et al.*, 2006). However, most farmers in developing countries do not know what information they lack, nor do they know that that information is available to help them solve their problems (Siyao, 2012).

The Agricultural Knowledge and Information Systems (AKIS) of Kenya's smallholder farmers are diverse and complex, varying with agricultural enterprise, agro ecological zone, and from county to county (Rees e*t al*., 2000). Widespread application of new scientific methods is required by small-scale farmers to realize their goals, but the knowledge of these methods is obtained, compiled and stored elsewhere, out of the reach of the farmer (Jaetzold *et al*., 2006)**.** There is no proper flow of technical information from many sources of information to small-scale farmers in Kenya (Rees *et al*., 2000). The result is that small-scale farmers end up lacking vital and timely information to assist them in their production processes (Jaetzold *et al*., 2006; Millennium Project Task Force on Hunger, 2004)**.**

Government extension services rank the highest among the major sources of information to smallholder farmers in Kenya (Njuguna and Kooijman, 1999; Rees *et al*., 2000; Salasya and Hassan, 1999; Kimenye, 1999). However, there is inadequate interaction between extension workers and small-scale farmers because extension workers are few and inadequately skilled (Rees e*t al*., 2000; Aina, 2007). The inadequate number of agricultural extension officers is a barrier to agricultural information access. For example, Ozawa (1995) and Aina (2006) noted that because of the low numbers of agricultural extension workers, farmers hardly obtain new information. State-funded agricultural extension services were significantly reduced throughout the 1980s and 1990s with the rollback of agricultural spending; leaving a gap in services that urgently needs filling (FAO, 1998). Where extension workers are still relatively many, they are often constrained by lack of funds and poor farmers may not access them due to physical remoteness of their locations or low social status (Rees e*t al*., 2000).

Policy makers have recognized the need to revive extension systems and increase access to technologies, with plans to link more closely with the private sector (Aina, 2006). However, the low purchasing power of smallholder farmers and high transaction costs mean that private

provision of extension services is only a partial solution as it is often not profitable, especially in remote, hazard-prone areas (IAASTD, 2009).

A strong extension linkage with proper flow of information will significantly boost agricultural production and improve rural livelihoods in developing countries (Arokoyo, 2005). Agricultural extension by its nature is a service that relies on linkages and networks and for it to be effective there is need for it to be well linked to research, farmers, and other service providers (IAASTD, 2009; Jaetzold *et al*., 2006). However, the linkages between extension and research and extension and farmers in most developing countries (Kenya inclusive) over the years have been very weak (Madukwe, 2006). Information flow from research to the farmer, and vice versa, and among the various institutions involved in rural development is also seriously hampered by the lack of a common source of reference (Jaetzold *et al*., 2006)**.**

Illiteracy is an obstacle to small-scale farmers' meeting their information needs in many developing countries. According to FAO (1983), farmers' access to agricultural technical information and their ability to comprehend and use it are lower when their literacy levels are low. Illiteracy has been cited as a major barrier by Carter (1999), when it comes to using printed information materials. Aina (2006) points out that, farmers in Africa are largely illiterate, so they cannot use the printed materials as a vehicle for accessing agricultural information. The use of print media, that is leaflets and newsletters, as message carriers are of limited use for reaching illiterate farmers (Siyao, 2012). Moreover, the quantity and quality of relevant agricultural information publications in Africa are scarce due to inadequate financial resources (Siyao, 2012; Ozawa, 1995).

Another obstacle in accessing agricultural information is the lack of agricultural libraries in the farmers' vicinity (Aina and Dulle, 1999). For that reason, farmers are hindered from using agricultural libraries as a source of information because of the distance between the source and the areas where they are practicing farming (Siyao, 2012). This means that, even if they know about the existence of information, it becomes difficult to access it (Aina and Dulle, 1999).

Television and radio are good sources of information (Kalusopa, 2005). However, their use is limited for various reasons: they are expensive, rural areas lack electricity which they require, batteries are expensive and the timing of the programmes is sometimes not appropriate, messages are of poor quality and the languages used are inappropriate (Kalusopa, 2005. The internet has a lot of information on existing technologies and can go a long way in filling the gaps left by government and private extension providers, and other sources of information (Aina, 2007). However internet access is still limited in rural Africa (Aina, 2007; Easdown and Starasts, 2004). This is brought about by the technological conditions in many African countries, mainly lack of adequate internet infrastructure (Jagun, 2007), which as noted by Nicholas (1996), makes internet access and online use of information costly.

CHAPTER THREE
MATERIALS AND METHODS

3.1 Study Location

The study was carried out in Murang'a South Sub-County in Murang'a County among small-scale mango producers. Murang'a South Sub-County borders Murang'a North Sub-County to the North, Thika West Sub-County to the South, Yatta Sub-County to the East, Kirinyaga and Mbeere Sub-Counties to the North East and Kigumo and Kandara Sub-Counties to the West. It covers an area of 467.6km^2 of which 280.6 km^2 is potential agricultural land .The Sub-County lies between latitudes 0^0 45'and 1 ^{0} 07'south and Longitudes 36 ^{0} and 37 ^{0} East. The Sub-County rises gradually from an altitude of 1,060 metres above sea level in the East to an altitude of 1,670 metres in the west side. The Sub-County has 5 Agro-ecological zones namely, upper midlands 2, upper midlands 3 upper midlands 3-4, upper midlands 4, lower midlands 3 and lower midlands 4. The Sub-County's main mango growing zone lies in agro-ecological zones upper midlands 3-4, upper midlands 4, lower midlands 3 and lower midlands 4. The total area under these agro-ecological zones is 207 km^2 which is 44% of the total area of the Sub-County.

Murang'a South Sub-County has two divisions namely Makuyu and Maragua divisions. It has six locations; Kambiti, Kamahuha and Makuyu Locations in Makuyu Division and Nginda, Ichagaki and Maragua Ridge Locations in Maragua Division. The study was carried out in five locations. These are all the three locations in Makuyu Division (Kambiti, Kamahuha and Makuyu Locations) and two locations in Maragua Division (Maragua Ridge Location and Ichagaki Location) (Figures 6 and 7).

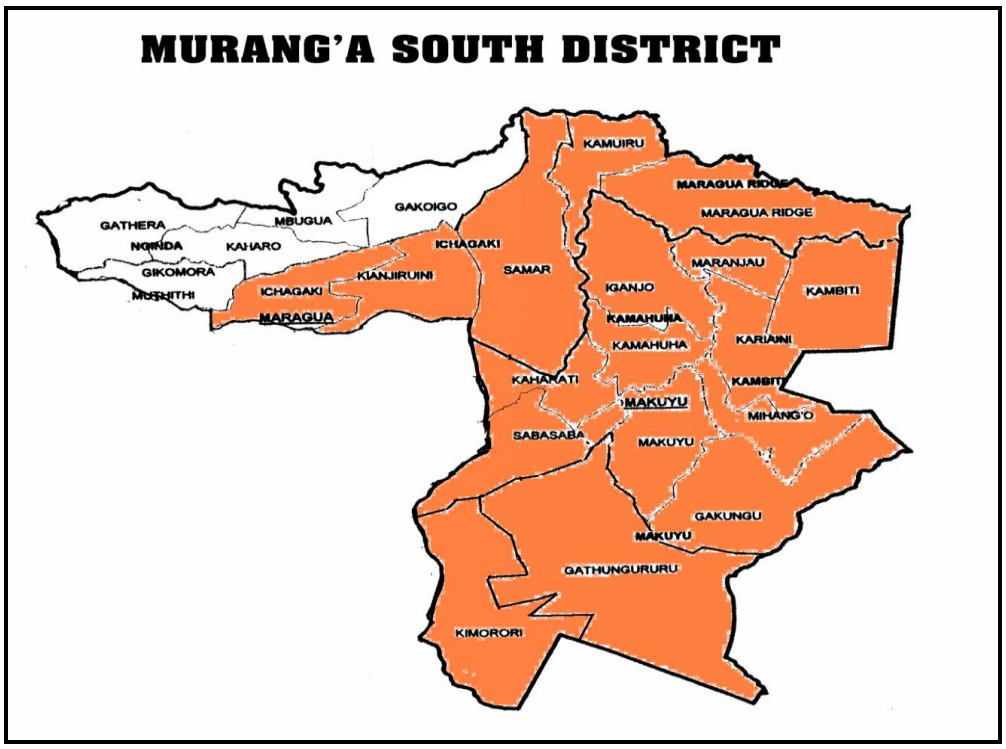
3.2 Research Design

This study used cross-sectional survey design with ex-post- facto approach. According to Fraenkel and Wallen (2000) a cross-sectional design involves collection of data from a sample that has been drawn from a predetermined and specific population and allows the researcher to collect data at just one point in time although the duration it takes to collect all the data may range from one day to a few weeks. Kathuri and Pals (1993) recommend this approach for a study in which the researcher examines the effects of a naturalistically occurring treatment after the treatment occurred. In this study, the mango farmers' access to and utilisation of information

on mango fruit fly control are the dependent variables, and have already happened without the manipulation of the researcher. Surveys are important in research and have been found to be useful in describing the characteristics of a population under research since they allow the researcher to ask individuals to describe the existing phenomena (Fraenkel and Wallen, 2000; Kathuri and Pals, 1993).

Source: Maps of the world at http://www.mapsofworld.com/kenya/

Figure 2. Map of Kenya showing Location of Murang'a South Sub-County



Legend

Division boundary

Location boundary

Sub-location boundary

Main mango growing area in the Sub-County.

Source: Murang'a South Sub-County Agricultural Office

Figure 3 Map of Murang'a South Sub-County showing the main mango growing area

3.3 Target Population

The targeted population consisted of all small-scale mango farmers that had between 10 to 300 mature mango trees in the main mango growing area of Murang'a South Sub-County. Such farmers have some experience in mango production, both for food and income. The total number of mango farmers in the five locations was 1299 in 2010 according to lists compiled by field officers from the Ministry of Agriculture in the Sub-County. Out of this number, 834 farmers had between 10 and 300 mature mango trees. The study was based on this population with a sample of 131 farmers being interviewed.

3.4 Sampling Procedure and Sample Size

Simple random sampling was used to sample 131 respondents (Formula 1). A sample size of 87 farmers was arrived at based on sample size determination described by Israel (2009). However, to cater for non-response as recommended by Gill, Johnson and Clark, (2010) an increase of 50% was added to the determined sample. The sample size was determined at 95% confidence level, and a precision level of 10%. The proportion of the target population that was estimated to have the characteristics being measured was not known and therefore 0.5 was used.

Formula 1 developed by Israel (2009) below was used to estimate the sample size for an infinite population and then formula 2 by Israel as well was used to get a sample size for a known population size based on the results of formula 1 at the same confidence and precision levels and the same estimate of proportion of the target population that have the characteristics being measured.

Formula 1

$$n_o = Z^2 p.\ q / e^2$$

Where: n_o = desired sample size for an unknown infinite population

Z = the standard normal deviate at the required confidence level

p = the proportion in the target population estimated to have characteristics being measured.

q = 1-p

e = desired precision level

In this case:

$n_o = Z^2 p .q / e^2 = (1.96)^2 (0.5) (0.5)/ (0.1)^2 = 97$

Formula 2

$n = n_o/1+ \{(n_o- 1)/N\}$

Where:

n = sample size for smaller known population

n_o =determined sample size for an unknown infinite population

N = size of the target population

In this case:

$n= n_o/1+ \{(n_o- 1)/N\} = 97/1 + \{(97-1)/834\} =87$

The final sample size used was 131 farmers; arrived at by adding 50% to 87 to cater for non-response. The sample size for each location was based on the proportion of mango farmers in that location who had between 10 and 300 mature mango trees. Table 3 gives the sample sizes used for each location.

Table 3 Sample size for Respondents selected in Murang'a South Sub-County

Location	Number of mango farmers with between 10 and 300 mature trees	Proportionate percentage of the target population	Sample size
Ichagaki	21	2.5	3
Makuyu	51	6.1	8
Kamahuha	216	26	34
Kambiti	228	27.3	36
Maragua Ridge	318	38.1	50
Total	834	100.0	131

Source: Sub-County Agricultural Office, Murang'a South, 2011

3.5 Data Collection

Data were collected through use of questionnaires. Five enumerators were trained and they assisted the researcher in administering the questionnaires. The questionnaire had 4 sections. Section I was used to gather background information and data about the respondent.

Section II of the questionnaire was used to gather data and information related to problems of the mango fruit fly in production as perceived by the respondents.Section III of the questionnaire was used to gather data and information related to the respondent's access to information on mango fruit fly control. This included identification of sources of information, frequency of acquiring information, and usefulness of information in controlling the mango fruit fly.

Section IV of the questionnaire attempted to gather data and information related to use of the information accessed. This included methods of control used, reasons for preferring certain methods and hindrances to using the acquired information (Appendix I shows the sample questionnaire).

3.6 Response rate

The response rate of the respondents was high at 94%. The determined sample size was 131 farmers, while the total number of farmers interviewed was 123 with a response rate of 82.4 % in Kamahuha Location, 100% in Maragua Ridge, Kambiti and Makuyu Locations and 33.3% in Ichaagki Location (Table 4).

Table 4 Response rate of respondents as per location

Location	Sampled farmers	No. of farmers interviewed	% Response rate
Kamahuha	34	28	82.4
Maragua Ridge	50	50	100.0
Kambiti	36	36	100.0
Makuyu	8	8	100.0
Ichagaki	3	1	33.3
Total	131	123	93.9

3.7.0 Data Analysis

The collected data were organized, coded and then analysed using both descriptive and inferential statistics in which findings were based on the research questions being answered and inferences made at 0.05 significant level. The Statistical Package for Social Sciences (SPSS) 11.5 was used to process and analyse the data. The analysis of data for the extent of farmers' access and use of information on mango fruit fly control was descriptive. For Analysis of Data for Factors Influencing Access and Use of Information on Mango Fruit Fly control, Logistic regression was used. The logistic function to be estimated was given by the likelihood of the mango farmer accessing or using information on mango fruit fly control. Access = 1 if the mango farmer accessed or used information on mango fruit fly control and 0 if the farmer did not access or use information during the previous year. The likelihood function is given by the following equation:

$$y= \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_{5+} \beta_6 x_{6+} \beta_7 x_{7+} \varepsilon$$

Odds of access or use = β_0 + β_1 age + β_2 household size + β_3 education level + β_4 group membership + β_5 size of the farm+ β_6 distance to nearest market+ β_7 perceived seriousness of the mango fruit fly problem +ε.

Where:

β_0 is a constant (intercept) and β_1 to β_7 are regression coefficient parameters to be estimated;

x_1, x_2, x_3, x_4, x_5, x_6 and x_7 are a set of social economic variables being measured

ε is the error associated with the logit function.

Access to information is a nominal variable with two values, accessed or did not access (McDonald, 2009). The likelihood of the effect of the combination of the variables influencing access to information is validated by the model fitting parameters, while the likelihood of each social economic variable to influence access to information is validated by the likelihood ratio parameter estimates for each variable

Table 5 presents a summary of the research questions underpinning the study, the independent and dependent variables used and the methodologies applied.

3.7.1 Variables measurement

The independent variables being measured were age, level of education, size of household, size of the farm, distance from the nearest market centre, involvement in group activities and perception of the seriousness of the mango fruit fly problem.

Age was measured in number of years from birth.

Education level was measured by the highest level of education attained, no formal education coded as 0, Primary=1, Secondary = 2, Tertiary = 3 (Three dummy variables were used with no formal education acting as a reference category).

Household size was the number of people living under one roof at the time of the study

Size of the farm was measured in acres.

Group membership was measured by number of years one had been a member of a group, not a member of any group coded 0, membership for less than 1 year=1, membership for 1-3 years=2, membership for 3-5years =3, membership for over 5yrs=4 (Four dummy variables were used with "not a member of any group" acting as the reference category).

Distance to the nearest market was measured by number of kilometres to the nearest market.

Perception of the seriousness of the mango fruit fly problem was measured by how the farmer perceived the problem on a scale of 0-3with not a problem coded 0, Just a simple problem=1, A serious problem=2, An extremely serious problem=3(Three dummy variables were used with one "not a problem" acting as the reference category.

Table 5 Summary table for data analysis

Research Question	Independent Variable	Dependent variable	Method of analysis
1. Do small-scale farmers in Murang'a South Sub-County access information on mango fruit fly control?		-Access to information on mango fruit fly control	Descriptive
3. Do small-scale farmers in Murang'a South Sub-County use information on mango fruit fly control?		-Use of information on mango fruit fly control	
2. What factors influence small-scale farmers in Murang'a South Sub-County access information on mango fruit fly control?	A set of selected social economic factors(age, education level, household size, group membership, farm size, distance to the nearest market and perceived seriousness of the mango fruit fly problem)	-Access to information on mango fruit fly control.	Logistic regression
4. What factors influence use of information on mango fruit fly control by small-scale farmers in Murang'a South Sub-County?		-Access to information on mango fruit fly control	

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1.0 Socio Economic Characteristics of the Respondents

4.1.1 Gender Classification

Results show that 71.5% of the respondents were men as compared to women who were 28.5%. See Table 6. This is a clear indication that mango farming in the Sub-County is mainly done by men. Mango farming, being an income generating activity in the Sub-County is mainly done by men. According to Kiriti and Tisdell (2003), married women seem to lose their decision-making ability with growth of agricultural commercialization, as husbands make most decisions to do with cash crops.

Table 6 Gender classification based on number and percentage.

Gender	No. of farmers	Percent
Male	88	71.5
Female	35	28.5
Total	**123**	**100.0**

4.1.2 Age of the Respondents

Most of the respondents (41) were aged between 51-60 years. This constitutes 33.3% of the total number of respondents. Those aged between 41 and 50 years were 38. This was followed by age group of 61-70 years who were 22. Respondents aged between 31-40 years were 16 and over 70 years were 6 (Table 7). The results evidently show that mango farming in Murang'a South Sub County is carried out by the elderly. It is necessary to sensitize the youth in the Sub-County to change their attitude towards farming and take it as business. Otherwise if the situation remains as it is for a long time, there may be no farming in future in the Sub-County.

Table 7 Age of the respondents.

Age Group	No. of Farmers	Percentage (%)
31-40	16	13
41-50	38	30.9
51-60	41	33.3
61-70	22	17.9
>70	6	4.9

A majority (63.4%) of the respondents had attained primary level of education (Table 8). These are followed by 29.3% who had attained secondary level of education. Respondents with no formal education were only 4.1% while 3.3% had attained formal education beyond secondary school level. Most of the respondents had attained primary level of education. It is evident that most respondents were literate. Majority (93.7%) of the respondents were either in the primary or secondary level of education categories. The chi-square statistics show that the level of formal education acquired among the respondents is not statistically different between the two divisions of Maragua and Makuyu.

Table 8: Level of formal education of the respondents per Division

Division	Level of Formal Education				
	No Formal Education	Primary	Secondary	Post Secondary	Total
Makuyu	4	51	28	3	86
Maragua	1	26	10	0	37
Total	5	77	38	3	123
Pearson Chi-Square			**Value**	**Df**	**Sig. (2-sided)**
			2.286	3	.515

The level of education is very important in farming activities. According to FAO (1983), it is assumed that farmers' access to agricultural technical information and their ability to comprehend and use it are lower when they lack minimum formal education. However in Murang'a South Sub-County most farmers have at least primary level of education and above and therefore they would not have much problem to comprehend and use agricultural technical information. However if the technical information contains complicated scientific information there will be need for simplifying it for them to understand it well. Information on mango fruit

fly control in Murang'a South Sub-County is available to most of the farmers irrespective of their education levels. This is because the main sources of information (Government extension agents, private chemical companies and no-government organizations) give technical information to farmers at organized farmer field days where different stakeholders participate. In these field days attendance is open to all farmers and therefore any farmer attends irrespective of their education level. This may explain why there is no difference between the respondents as far as formal education is concerned in their likelihood of access to information on mango fruit fly control.

4.1.3 Respondents' household size

Households with at least 5 persons had the largest number of respondents (40). Generally households with persons around the mean of the total sample had relatively the largest percentage of farmers (Table 9).

Table 9 Respondents' household sizes

No. of persons	No. of farmers	Percent
1	1	0.8
2	5	4.1
3	6	4.9
4	18	14.6
5	40	32.5
6	24	19.5
7	9	7.3
8	16	13.0
9	2	1.6
10	2	1.6
Total	**123**	**100.0**

4.1.4 Respondents' Farm sizes

The farm sizes of the respondents range from 1 to 15 acres with a mean of 3.1380 acres in Makuyu and 3.6378 acres in Maragua Division. ANOVA test shows that the mean farm sizes are not statistically different between the two divisions.

Table 10 Mean Farm sizes and ANOVA

Division	Mean Farm Size	N	Std. Deviation		
Makuyu	3.1380	86	2.70759		
Maragua	3.6378	37	1.74489		
ANOVA	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
	6.463	1	6.463	1.067	.304

4.1.5 Respondents' Distances from their farms to trading centres

Most (67.3%) of the respondents resided at a distance of 1 to 2 kilometres to their trading centres, while the farthest respondents were only 5 km away from their nearest trading centre. Majority of the respondents can reach their trading centres easily and get any new information released. It is therefore not difficult for the farmers to access any useful information on mango production.

Table 11 Distances from respondents farm to the nearest trading centre

Distance in Km	No. of farmers	Percent
0.3	2	1.6
0.5	19	15.4
1.0	41	33.3
1.5	11	8.9
2.0	31	25.2
2.3	2	1.6
2.5	8	6.5
2.7	1	.8
3.0	7	5.7
5.0	1	.8
Total	**123**	**100.0**

4.1.6 Respondents' Duration of membership to groups

Majority (94.3%) of the respondents had been members of groups for more than 1 year and only 7 (5.7 %) respondents had been in groups for less than one year or did not belong to any

group. Thirty eight (30.9%) respondents had been members of groups for between 1-3 years, 45 (36.6%) for 3-5years and 33 (26.8%) for over 5 years.

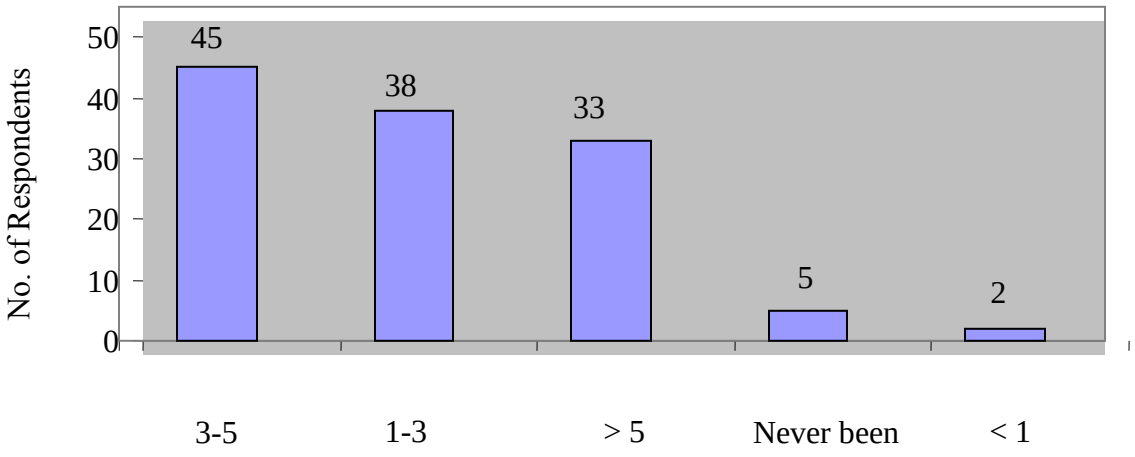


Figure 4 Respondents duration of membership to groups in years

Most of the respondents had a keen interest in joining groups and being consistent members for several years. According to Anandajayasekeram *et al*. (2008), farmer groups provide opportunity to share ideas and the exchange of information and thus create a multiplier effect, which facilitates the spread of relevant technologies. Most stakeholders doing agricultural extension reach farmers through group approaches. Group approach enhances the dissemination of agro-information to a wider spectrum of users and therefore is cost effective (Baldeo and Poonam, 2004). Since most of the farmers are members of groups service providers wishing to pass any technical information to small scale mango farmers in Murang'a South Sub-County can do it easily through mango growers groups and other organized groups.

4.2.0 Mango farming and the challenge of the Mango Fruit Fly

4.2.1 Number of mango trees owned by respondents

Out of the seven varieties, most of the respondents had more mature trees of all the varieties as compared to the young trees. Tommy Atkins was the most preferred variety owned by the majority (97.6%) of the respondents with a total of 2769 mature trees and 61(49.6%)

respondents owned a total of 454 young trees. The four main varieties are Tommy Atkins, Apple, Ngowe and Kent. Sabine and Haden varieties were not common among the respondents. Almost all (106) the respondents had more than three of the four main varieties in their farms. Figure 9 presents the overall number of respondents growing only one, two, three or all the four main varieties. From the results, it is evident that among the 123 respondents, 55.3% of them had all the four main varieties (Apple, Kent, Tommy Atkins and Ngowe) while 30.9% were growing three of the four main varieties and only very few (13.8%) of the respondents had less than three of the four main varieties in their farms.

The respondents had grown different varieties in their farms without regard for whether the varieties were early medium or late maturing. This increases the incidences of mango fruit fly attack because according to Farzana (2005), to limit proliferation of the fruit fly populations, it is recommended that the farmer should avoid having several varieties with successive harvesting dates in the same plot. In this case the farmers should have avoided establishing Ngowe and Apple or Ngowe and Kent in the same orchard. This is because Ngowe is an early maturing variety while both apple and Kent are late maturing. Similarly establishing Tommy Atkins together with Apple or Kent should have been avoided by the farmers because Tommy Atkins is an early maturing variety just like Ngowe.

Table 12 Number of mango trees owned by respondents

Variety type	Mature trees			Young trees			Total mature and young trees
	N	%	Total trees	N	%	Total trees	
Apple	118	96.0	2686	70	57.0	421	3107
Ngowe	91	74.0	904	23	18.7	149	1053
Sabine	41	33.3	166	14	11.4	88	245
Tommy Atkins	120	97.6	2769	61	49.6	454	3223
Kent	89	72.3	512	27	22.0	162	674
Vandyke	72	58.5	666	18	14.6	74	740
Haden	16	13.0	198	8	6.5	75	273

{N = No. of respondents}

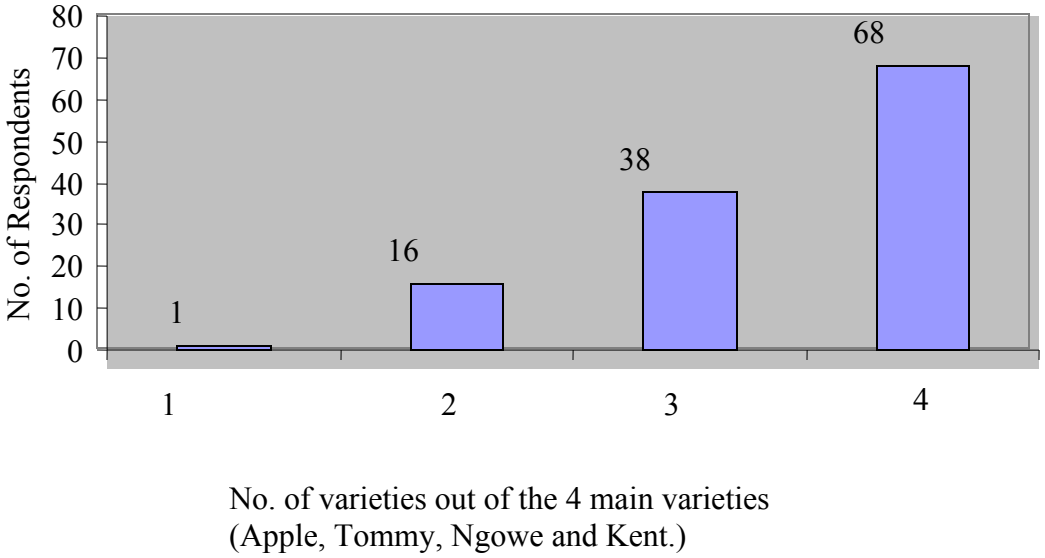


Figure 5 Number of Respondents growing various mango varieties

4.2.2 Reasons for respondents engaging in mango farming

Most (88.6%) of the respondents engaged in mango farming for commercial purposes. In addition 48.0% of the respondents indicated that they engaged in mango farming for food. There are also some minor reasons as to why farmers grew mangoes. These are soil and water conservation and sale of other parts of the mango tree for income. Mango fruit is an important fruit for income and food in Murang'a South Sub-County. This fact is underscored by Nyambo *et al*. (2006).

Table 13 Reasons that prompted respondents to engage in mango farming

Reason	Yes		No	
	N	%	N	%
Income from fruit sales	109	88.6	14	11.4
Source of food	59	48.0	64	52.0
Soil and water conversation	13	10.6	110	89.4
Income from other parts of tree(timber, firewood, charcoal etc)	2	1.6	121	98.4
Just as a hobby	2	1.6	121	98.4

{N= No. of respondents}

Table 14 Reasons for respondents remaining in mango farming

Reason	Yes		No	
	N	%	N	%
Income from fruit sales	62	50.4	61	49.6
Source of food	29	23.6	94	76.4
Soil and water conservation	18	14.6	105	85.4
Income from other parts of tree(timber, firewood, charcoal etc)	5	4.1	118	95.9
Just as a hobby	1	0.8	122	99.2

{N = No. of respondents}

4.2.3 Mango pests encountered by respondents in mango production

All the 123 respondents had encountered both mango fruit fly and the mango seed weevil in their farms. In Murang'a South Sub-County, the mango fruit fly and the mango seed weevil are the main insect pests that attack the mango. This agrees with Griesbach (2003), that among the insect pests that attack mango fruit, fruit flies (*Ceratitis* spp. and *Bactrocera* spp.) and mango seed weevil (*Sternnochetus mangifera*) are by far the most damaging in Kenya. Efforts to control them will be of economic importance to the farmers in the Sub-County.

Table 15 Mango pests encountered in mango production

Pest	Yes		No	
	N	%	N	%
Mango seed weevil	123	100.0	0	0.0
Mango fruit fly	123	100.0	0	0.0
Mango gall midge	113	91.9	10	8.1
Thrips	101	82.1	22	17.9
Scales	86	69.9	37	30.1

{N=No. of respondents}

4.2.4 Seriousness of the mango fruit fly problem

A 51.2% of the respondents rated the mango fruit fly as a serious problem (Table 16). Mango fruit fly is a real problem to mango production in the Sub-County.

Table 16. Level of seriousness of the problem of mango fruit fly in mango production.

Rating of mango fruit fly problem	No. of respondents	Percent
Not a problem	1	0.8
Just a simple problem	2	1.6
A serious problem	63	51.2
An extremely serious problem	21	17.1
Not able to identify mango fruit fly	36	29.3
Total	123	100.0

4.2.5 Comparison of mango losses to the mango fruit fly with other pests (2010)

Majority (70.7%) of the respondents lost 60-80% of their mangoes through the pest and 20-40% through other pests. 13.8% of the respondents indicated that they lost over 80% of their mangoes through the mango fruit fly and less than 20% through other pests. In Murang'a South Sub-County Mango fruit fly is a big problem. Efforts to manage the pest would reduce the loss due to the pest and lead to improved livelihoods of the small scale farmers in the Sub-County.

Table 17. Proportion of mangoes lost through the mango fruit fly compared to other pests during the year 2010

% loss from Mango fruit fly	% loss from Other pests	No. of farmers
100	0	10
80-100	0-20	17
60 -80	20-40	87
20 -40	60-80	9

4.3.0 Access to Information on how to control the Mango Fruit Fly

Most of the respondents (91.1%) accessed information on how to control the mango fruit fly (Table 18).

Table 18 Access to Information on mango fruit fly control

Have the respondent ever accessed any information on mango fruit fly control?	No. of farmers	Percent
Yes	112	91.1
No	11	8.9
Total	123	100.0

4.3.1 Reasons for not accessing any information on mango fruit fly control

Among the 11 respondents who had never accessed any information on how to control the mango fruit fly most of them (63.6%) did not know where to get the information from, 27.3% had tried to get the information but did not, while 9.1% of the respondents did not bother to get any information (Figure 10).

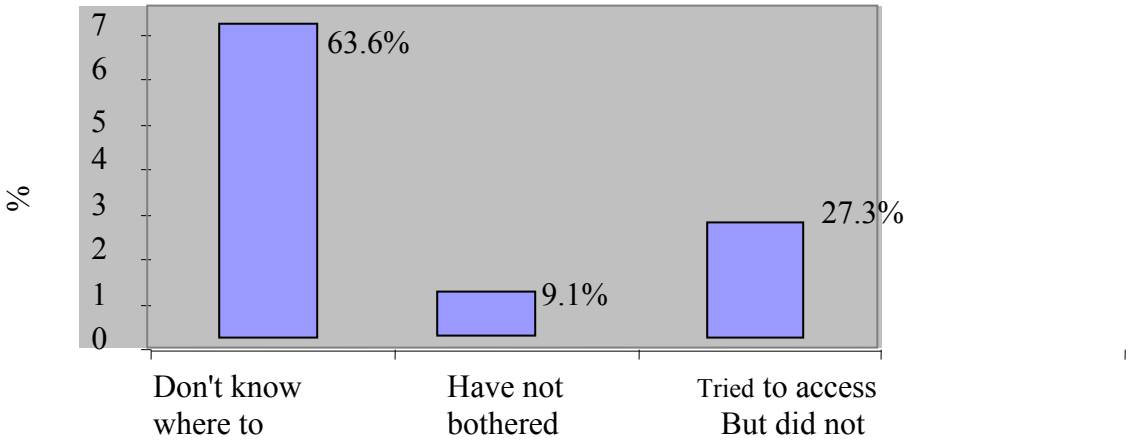


Figure 6 Reasons for not accessing information on mango fruit fly control

4.3.2 Frequency of accessing the information on mango fruit fly control

Most of the respondents had accessed information in 4 to 6 weeks time (36.6%) and only (3.3%) had accessed information in less than one week time (Table 19). This suggests that the

respondents frequently accessed the information on mango fruit fly. Technical information is readily available to small scale farmers in the Sub-County.

Table 19 Frequency of access to information on Mango Fruit Fly control by respondents.

Time in Weeks	Frequency	Percent
Less than 1 week ago	4	3.3
Between 1 and 2 weeks ago	12	9.8
Between 2 weeks, 1 day to 4 weeks ago	22	17.9
Between 4weeks, 1day and 6 weeks ago	45	36.6
Over 6 weeks ago	16	13.0
Cannot remember	13	10.6
Never accessed information	11	8.9
Total	123	100.0

4.3.3 Sources of information on Mango Fruit Fly control

Most of the respondents (84.6%) accessed the information from the government extension services through the Ministry of Agriculture. Private chemical companies ranked second with 50.4% respondents. Non-government Organisations ranked third with 21.1% of the respondents. Some of the respondents accessed information from more than one source.

Table 20 Distribution of sources of information

Source of information	Yes		No	
	N	%	N	%
1. GOK extension services e.g. Ministry of agriculture, during field days.	104	84.6	19	15.4
2. Private chemical companies e.g. Osho Chemicals, Agriculture tool Ltd, Sygenta	62	50.4	61	49.6
3. NGO'S e.g. Techno Serve, World vision	26	21.1	97	78.9
4. Neighbors' and relatives	22	17.9	101	82.1
5. Media (Radio, Newspapers and magazines)	4	3.3	119	96.7
6. CBO'S	0	0.0	123	100.0
7. The internet	0	0.0	123	100.0

{N = No. of respondents}

4.3.4 Usefulness of the information on Mango Fruit Fly control

Majority (58%) of the respondents found the information useful. Moreover the information was very useful to other 28% of the respondents.

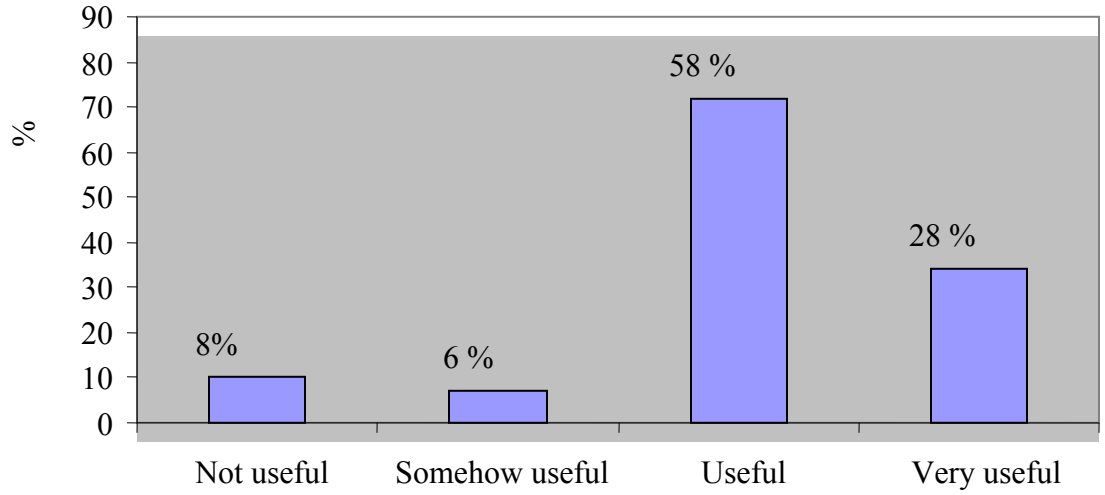


Figure 7 Relative usefulness of the information accessed by the respondents

A majority (58.5%) of the respondents indicated finding it easy to access information from the government extension services. Those who found it easy to access information from private chemical companies were 42.3% while 18.7% found it easy to access information from

non-government organizations. From these results, it can be deduced that it is easy for most farmers to get Agricultural information from different sources.

Table 21 Ease of access to the information from various sources

Source	Not easy at all		Not very easy		Easy		Very easy		No response	
	N	%	N	%	N	%	N	%	N	%
Government extension services	2	1.6	7	5.7	72	58.5	34	27.6	8	6.5
Non Governmental Organisations	5	4.1	9	7.3	23	18.7	6	4.9	80	65.0
Community based organizations	0	0.0	0	0.0	0	0.0	0	0.0	123	100.0
Neighbours and relatives	14	11.4	4	3.3	10	8.1	6	4.9	89	72.4
Private Chemical companies	12	9.8	8	6.5	52	42.3	11	8.9	40	32.5
Mango Marketing companies	15	12.2	4	3.3	5	4.1	5	4.1	94	76.4
Media(Radio, Newspapers, Magazines	18	14.6	6	4.9	1	.8	3	2.4	95	77.2
Internet	0	0.0	0	0.0	0	0.0	0	0.0	123	100.0

{N = No. of respondents}

4.5.0 Factors influencing Access to Information on Mango Fruit Fly control

4.5.1 Model Fitting

The chi-square (27.739) of the model is significant ($p< 0.05$). This means that there is a good fit of the model and therefore, there exists a significant relationship with some of the independent variables considered.

Table 22 Model Fitting Information for access to information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	74.100			
Final	46.361	27.739	14	.015

4.5.2 Likelihood ratio parameter estimates

Only group membership among all the seven independent variables had a significant likelihood ratio parameter ($p<0.05$). This means that group membership influenced access to information.

Results indicated that group membership positively and significantly influenced the likelihood of access to information on mango fruit fly control by smallholder farmers in Murang'a South Sub-County. There was no significant difference between respondents who had been group members for less than one year and those who had never belonged to any group in their likelihood of accessing information on mango fruit fly control. However, respondents who had been members of groups for between one and three years were 31.69 times more likely to access information on mango fruit fly control than respondents who had never been group members. Similarly, respondents who had been members of groups for between three to five years are 76.60 times more likely to access information on mango fruit fly control than respondents who have never been group members. However there was no significant difference between respondents who had been group members for over five years and those who had never belonged to any group on their likelihood of accessing information on mango fruit fly control.

Table 23 Likelihood ratio parameter estimates for access to information

Access to Information	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Intercept	-39.008	7.130	29.931	1	.000			
Age	-.074	.044	2.784	1	.095	.928	.851	1.013
Farm size	.172	.234	.542	1	.462	1.188	.751	1.881
Distance to the nearest Market centre	.677	.346	3.824	1	.051	1.968	.998	3.879
H hold size	-.426	.276	2.380	1	.123	.653	.380	1.122
Primary	1.663	6.481	.066	1	.797	5.275	1.606E-05	1733086.5
Secondary	2.214	6.519	.115	1	.734	9.150	2.584E-05	3239846.5
Post Sec.	17.095	.000	.	1	.	26561803.5	26561803.48	26561803.5
Group Membership -< 1 Yr.	19.446	.000	.	1	.	278707156.4	278707156.37	278707156.4
Group Membership -1 to 3Yrs	3.456	1.501	5.302	1	.021	31.682	1.672	600.244
Group Membership -3 to 5Yrs	4.338	1.613	7.237	1	.007	76.592	3.247	1806.970
Group Membership over 5 yrs	2.217	1.477	2.254	1	.133	9.180	.508	165.860
Fruit Fly - Simple problem	-.514	.000	.	1	.	.598	.598	.598
Fruit Fly - serious problem	-21.887	3783.6	.000	1	.995	3.123E-10	.000	.(c)
Fruit Fly - extremely serious problem	-3.751	.000	.	1	.	.023	.023	.023

The reference category is yes.

Note:

1. For level of formal education the reference category is no formal education

2. For group membership the reference category is never been a member of group

3. For seriousness of fruit fly problem the reference category is fruit fly not a problem

The longer a farmer has been a group member the more likely they are to access information on mango fruit fly control. However when a farmer was a member of a group for less than one year, their likelihood of access to information was the same as the farmer who had

not joined any group. Similarly when farmers are in groups for longer than five years the benefits of the group as far as information flow and sharing is concerned start getting lost.

Most of the respondents have a keen interest in joining groups and being consistent members for several years. According to Anandajayasekeram *et al*. (2008), farmer groups provide opportunity to share ideas and exchange of information thus creating a multiplier effect, which facilitates the spread of relevant technologies. Most stakeholders doing agricultural extension reach farmers through group approaches. Group approach enhances the dissemination of agro-information to a wider spectrum of users and therefore is cost effective (Baldeo and Poonam, 2004). Since most of the farmers are members of groups, service providers wishing to pass any technical information to small scale mango farmers in Murang'a South Sub-County can do it easily through mango growers groups and other organized groups.

The age-old practice of extension agent-farmer contact on a one-to-one basis, though very effective, is expensive and unsustainable as the sole means of reaching farmers with agricultural technology (Baldeo and Poonam, 2004). Therefore farmers should be sensitized and encouraged to form or join groups so as to benefit from the group approach extension strategies (Baldeo and Poonam, 2004; Anandajayasekeram *et al*., 2008)

4. 6.0 Use of information on Mango Fruit Fly control.

The Respondents in the Sub- County used information on mango Fruit fly control. A majority (93.5%) of the respondents used the methods mango fruit fly control known to them (Table 24).

Table 24 Proportion of respondents using information on of mango fruit fly control

Does the respondent use any of the methods?	Frequency	Percent
Yes	115	93.5
No	8	6.5
Total	123	100.0

Most (74.0%) of the respondents used chemical methods to control the mango fruit fly. Less than a fifth (19.5%) use the cultural methods to control the mango fruit fly (Table 25).

Table 25 Methods of mango fruit fly control used by the respondents

Mango fruit control	No. of respondents	Percent
Cultural	24	19.5
Chemical	91	74.0
No response	8	6.5
Total	123	100.0

4.6.1 Knowledge on methods of controlling the mango fruit fly

Most (87.8%) of the respondents knew about chemical control methods while only 8.1% knew about cultural control methods. Other methods of control are rarely known to the respondents. However, 3.3% of the farmers did not know any method of controlling the mango fruit fly (Figure 7).

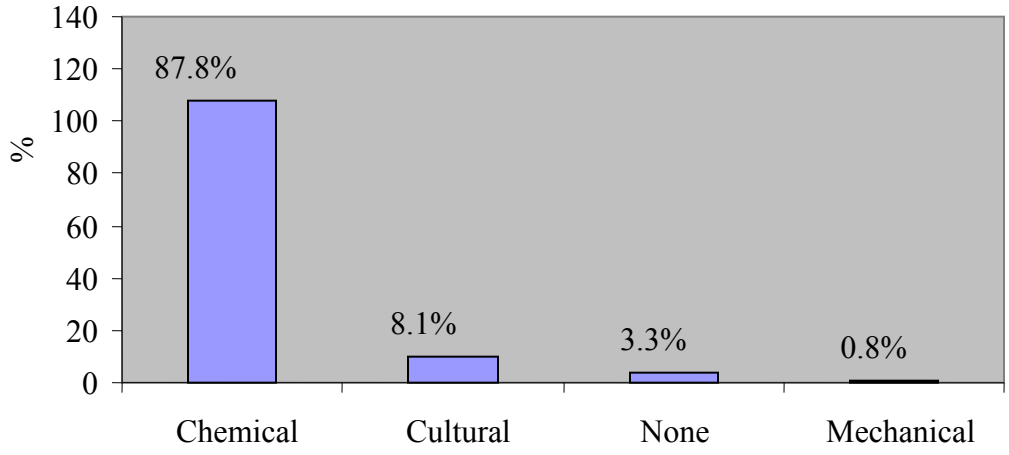


Figure 11 Methods of controlling the mango fruit fly known to respondents

4.7.0 Factors influencing use of information on Mango fruit fly control

4.7.1 Model Fitting

The chi-square (17.521) of the model was not significant (p> 0.05) (Table 26). This means that the model does not have a good fit and that there exists no significant relationship between the combined effects of the social economic variables being tested, that is age, farm size, household size, formal education level attained, membership to groups, distance from the nearest market centre and perceived seriousness of the mango fruit fly problem, and the independent variable considered, use of information on mango fruit fly control.

Table 26 Model Fitting Information for use of information.

Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	53.485			
Final	35.964	17.521	14	.229

4.7.2 Likelihood ratio parameter estimates

Household size and membership to groups influenced use of information on mango fruit fly control. The bigger the household size the less the respondent is likely to use the information on mango fruit fly control. However, respondents who have been in groups between three to five years are more likely to use information on mango fruit fly control than those who have never been group members.

Since most of the farmers are members of groups service providers wishing to pass any technical information to small scale mango farmers in Murang'a South Sub-County can do it easily through mango growers groups and other organized groups.

Table 27 Likelihood ratio parameter estimates for use of information

Use of information (a)	B B	Std. Error Error	Wald Wald	df df	Sig. Sig.	Exp(B) Exp(B)	95% Confidence Interval 95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Intercept	35.581	4.591	60.068	1	.000			
Age	-.091	.053	2.889	1	.089	.913	.823	1.014
H hold size	-.940	.419	5.043	1	.025	.391	.172	.887
Distance	.221	.647	.117	1	.733	1.247	.351	4.432
Farm size	-.525	.482	1.188	1	.276	.591	.230	1.521
Primary	-22.990	1.345	292.194	1	.000	1.036E-10	7.424E-12	1.446E-09
Secondary	-21.184	.000	.	1	.	6.307E-10	6.307E-10	6.307E-10
Post Sec.	-6.853	.000	.	1	.	.001	.001	.001
Gp Membership - < 1 Yr.	17.333	.000	.	1	.	33696089.9	33696089.9	33696089.9
Gp Membership - 1 to 3Yrs	2.441	1.827	1.786	1	.181	11.488	.320	412.443
Gp Membership - 3 to 5Yrs	4.647	2.173	4.575	1	.032	104.250	1.475	7367.787
Gp Membership - > 5Yrs	2.099	2.130	.971	1	.324	8.158	.126	530.229
Fruit Fly -Simple problem	-6.626	.000	.	1	.	.001	.001	.001
Fruit Fly -serious problem	-17.512	1.474	141.099	1	.000	2.481E-08	1.380E-09	4.462E-07
Fruit Fly-extremely s. problem	-16.700	.000	.	1	.	5.586E-08	5.586E-08	5.586E-08

The reference category is yes.

Note:

1. For level of formal education the reference category is no formal education

2. For group membership the reference category is never been a member of group

3. For seriousness of fruit fly problem the reference category is fruit fly not a problem

4.8.0 Other Findings

4.8.1 Chemical methods of fruit fly control.

The majority (74%) of the respondents used chemical methods to control the mango fruit fly (Table 28). Results show that the main reason why the respondents preferred chemical control methods was because they knew no other methods. This indicates that most of the respondents do not know about cultural, biological or physical methods of fruit fly control.

Table 28 Reasons given by respondents for preferring chemical method of fruit fly control.

Reason for using chemical control methods	No. of Respondents	Percentage (%)
Do not Know other methods	89	72.5%
Easy to use, the farmer just buys chemical and sprays	20	16.5 %
Uses it as routine when controlling other pests and diseases	9	7.7%
It is effective	4	3.3 %
Total	123	100%

4.8.2 Cultural methods of fruit fly control

About a fifth (19.5%) of the respondents indicated that they used cultural methods of fruit fly control because they were less expensive since it did not involve purchasing of any chemical involved. Farmers did not access information on mango fruit fly control separately from other information on mango production. However, they got all the information together at organized farmers' field days. The attendance of the farmer to the field days did not depend on the seriousness of the fruit fly problem but on generalized interest to learn on mango production practices.

The respondents have grown different varieties in their farms without regard for whether the varieties were early medium or late maturing. This increases the incidences of mango fruit fly attack because according to Farzana (2005), to limit proliferation of the fruit fly populations, it is recommended that the farmer should avoid having several varieties with successive harvesting

dates in the same plot. In this case the farmers should have avoided establishing Ngowe and Apple or Ngowe and Kent in the same orchard. This is because Ngowe is an early maturing variety while both apple and Kent are late maturing. Similarly establishing Tommy Atkins together with Apple or Kent should have been avoided by the farmers because Tommy Atkins is an early maturing variety just like Ngowe.

The main source of information to the respondents in the Sub-County is government extension services. This is consistent with the findings that among the major sources of information to smallholder farmers in Kenya, government extension services rank the highest (Njuguna and Kooijman, 1999; Rees *et al*., 2000; Salasya and Hassan, 1999; Kimenye, 1999). There is also a clear indication that very few respondents accessed any information on mango fruit fly through the media and none at all through community based organizations (CBOs) or the Internet. Internet access is still limited in Kenya and elsewhere in rural Africa (Aina, 2007; Easdown and Starasts, 2004). This is due to technological conditions in many African countries, mainly, lack of adequate internet infrastructure (Jagun, 2007).

Farmers in Murang'a South Sub-County do not have sufficient information to control the Mango fruit fly. Further, most farmers are only aware of chemical control methods, a few have some knowledge about cultural methods but no farmer is aware of biological or mechanical methods of fruit fly control. The information passed on to farmers is insufficient to support them control of the mango fruit fly.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Mango (*Mangifera indica L.*) farming is very important to farmers in Murang'a South Sub- County for income and food. It is also a source of income to other stakeholders in the industry. However mango fruit fly is a great challenge to the industry in the Sub-County. Mango farming in the Sub-County is mainly carried out by the elderly.

5.2 Conclusions

1. Farmers in Murang'a South Sub-County accessed agricultural technical information on mango fruit fly control. However the information accessed by farmers is not adequate and do not really help the farmers to control the mango fruit fly.
2. Membership to groups influenced access to information on mango fruit fly control positively.
3. Farmers in Murang'a South Sub-County used information they accessed on mango fruit fly control.
4. Use of the information on mango fruit fly control was influenced by household size and group membership.

5.3 Recommendations

1. Concerted efforts need to be put together to assist the farmers reduce looses due to fruit fly damage. Different stakeholders involved in dissemination of agricultural information in Murang'a South Sub-County need to work together to have a holistic approach to the issue of control of the mango fruit fly.
2. There is need to give farmers advise before they establish a mango orchard, so that they are able to select the varieties to grow together and which ones to avoid. Necessary technical advice should also be given to farmers who have already established orchards on methods of top working so as to eventually have the right combinations of varieties in their farms.
3. There is a great need for farmers to be educated on the importance of media (radio, television, newspapers and magazines), the internet as sources of technical information.

4. There is need for an audit of all the CBOs in the Sub-County to establish their main areas of rural development and to bring to them the importance of dissemination of agricultural information for rural development.

5.4 Recommendation for Further Research

There is need for further research to find out what information is available with service providers on mango fruit fly control in Murang'a South Sub-County. If the service providers do not have the right information, then ways should be sought on how to furnish them with the relevant and adequate technical information on mango fruit fly control.

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APPENDICES

Appendix I: QUESTIONNAIRE TO BE USED IN GATHERING DATA AND INFORMATION FROM MANGO FARMERS

This Questionnaire is to be used to gather information and data from mango farmers in Murang'a South Su-County.

Objective:

It is intended to collect data and information to be used for a study leading to the award of a Master of Science in Agricultural Information and Communication Management of Egerton University. Topic **'Investigating Access and Use of Information on Mango Fruit Fly Control by Small Scale Farmers."**

This information will strictly be used for academic purposes and for the benefit of mango farmers in the sub-County. The researcher will ensure confidentiality by not disclosing any information provided by the respondents to unauthorized users.

Name of the enumerator:……Telephone No……

Date of interview: ……Time……..(Morning/Afternoon)

INSTRUCTIONS:

Fill the needed information in the blank spaces provided or put a tick beside the selected response(s).

Respondents Name .....

Phone of Respondent .....

Gender of Respondent Male ( ) Female ( )

Division .....

Location .....

Sub location .. ..

Section I: Background Information

1. What is your age?……years

2. What is the highest level of formal education you've attained?
    1. No formal education=0 ( )
    2. Primary=1( )
    3. Secondary = 2( )
    4. Post Secondary = 3 ( )

3. What is the current size of your household?……persons

4. What is the size of the farm you are using?..... acres

5. What is the distance from the farm to the nearest trading centre? _____km

6. Have you ever been a member to a group?
    1. Never been a member of any group = 0 ( )
    2. Been a member for less than 1 year=1 ( )
    3. Been a member for 1-3 years=2 ( )
    4. Been a member for 3-5years =3 ( )
    5. Been a member for over 5yrs=4 ( )

7. How many mango trees do you have?

Variety	**Mature**	**Young**	**Total**
Apple			
Ngowe			
Sabine			
Tommy Atkins			
Kent			
Vandyke			
Haden			
Total			

8. What is the main reason that prompted you to engage in mango farming?

1. Food ( )
    2. Income from fruit sales ( )

3. Income from other parts of tree (timber, firewood, charcoal etc) ( )
4. Soil and water conservation ( ) 5. Just as a hobby ( )

9. Have the reason that prompted you to engage in mango farming changed?
1. Yes ( ) 2.No ( )

10. If the answer to question 9 above is yes then what is the main reason for engaging in mango farming currently?
1. Food ( ) 2. Income from fruit sales ( )
3. Income from other parts of tree (timber, firewood, charcoal etc) ( )
4. Soil and water conservation ( ) 5. Just as a hobby ( )

Section II: Problems associated with the mango Fruit Fly in Mango Production

11. What mango pests have you encountered in your mango production? (Tick all that have been encountered)
1. Mango seed weevil ( )
2. Mango fruit fly ( )
3. Scales ( )
4. Mango gall midge ( )
5. Scales ( )
6. Thrips ( )

12. Are you able to identify the mango fruit fly?
1. Yes ( ) 2.No ( )

13. How serious is the mango fruit fly problem to your mango production?
1. Not a problem=0 ( ) 2. Just a simple problem=1 ( )
3. A serious problem=2 ( ) 4. An extremely serious problem=3 ( )

14. What do you think is the percentage of your mangoes lost through the mango fruit fly compared to other pests? (Tick one)
1. Mango fruit fly100% other pests 0% ( )
2. Mango fruit fly >80% other pests < 20% ( )
3. Mango fruit fly60-80% other pests 20-40% ( )
4. Mango fruit fly20-40% other pests 60-80% ( )
5. Mango fruit fly<20% other pests> 80% ( )
6. Mango fruit fly 0% other pests 100% ( )

Section III: Access to information on mango fruit fly control.

15. Have you ever accessed any information on how to control the mango fruit fly?
1. Yes=1 ( ) 2.No=0 ( )

If NO,

What are the reasons behind you not having accessed any information on mango fruit fly control?

1. Don't know where to access it from ( )
2. Have not bothered to access it ( )
3. Tried to access it but was not successful ( )
4. Other (Please explain)……..

16. If YES,

a) When did you last access information on mango fruit fly control?

1. Less than 1 week ago ( ) 2. Between 1 and 2 weeks ago ( )
3. Between 2 weeks and 4 weeks ago ( ) 4. Between 4 and 6 weeks ago ( )
5. Over 6 weeks ago ( ) 6. Cannot remember ( )

b) Which source did you access the information from?

1. GOK extension services ( ) Specify.....
2. NGO's ( ) Specify….....
3. CBO's ( ) Specify….....
4. Neighbours and relatives ( )
5. Private chemical companies ( ) Specify….....
6. Media (Radio, TV, Newspapers and magazines) ( )Specify.....
7. The internet ( )

17. (a) How useful was the information you accessed from the source indicated in 16(b) above in controlling the mango fruit fly in your farm?

1. Not useful ( ) 2. Some how useful ( )
3. Useful ( ) 4. Very useful ( )

(b) How easy was it to access the information from the source ?
(Use the scale of 1-5)

1-Not easy at all 2-Not very easy 3- Easy
4-Very easy 5-Extreemely easy

Government extension services ( ) Non government Organisations ( )
Community based organizations ( ) Neighbours and relatives ( )
Private chemical companies ( ) Mango marketing companies ( )
Media (Radio, TV, Newspapers and magazines) ( ) The internet ( )

Section IV: Use of Information on Mango Fruit Fly Control

18. What methods of controlling the mango fruit fly do you know? (Tick all that you know)

1. None ( ) 2. Cultural ( ) 3. Mechanical ( )
4. Chemical ( ) 5.Biological ( )
6. Other (specify).....

19. Do you use any of the methods you know in controlling the mango fruit fly?

1. Yes=1 ( ) 2.No=0 ( )

20. If the answer to 19 above is no, what are the reasons for not using any of the methods that you know?

Method of control	Reasons for not using it

21. If the answer to 19 above is yes, which methods of controlling the mango fruit fly do you use?(Tick all that you use)

1. Cultural ( ) 2. Mechanical ( )
3. Chemical ( ) 4.Biological ( )
5. Any other (specify).....

22. What are the reasons that make you prefer to use any of the methods of fruit fly control mentioned in question 21 above? **(Start with the most preferred method that you use.)**

Method of control	**Reasons for preferring the method**

23. As a mango farmer what measures would you recommend to effectively control the mango fruit fly in Murang'a South sub-County?

.....
.....
.....

Thank you for your participation and honesty.