



Management Plan for Fruit Fly (Diptera: Tephritidae) Pests in Tanzania



Africa
TERVUREN

**Management Plan for Fruit Fly
(Diptera: Tephritidae)
Pests in Tanzania**

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Directorate of Research and Postgraduate Studies.
2013

ISBN 9987 640 35 4

Design & Layout
Placid K.J. +255 717 177653

ACKNOWLEDGEMENTS

We would like to thank the Belgian Directorate General for Development Cooperation (DGDC), for funding the project on Integrated Pest Management of fruit flies in Tanzania. The project was implemented through collaboration between Sokoine University of Agriculture (SUA), Morogoro, Tanzania and the Royal Museum for Central Africa of Tervuren, Belgium. This management plan is one of the proposed outputs of the project. We would also like to thank the Ministry of Agriculture, Food Security and Co-operatives (MAFC) of Tanzania for participating in the development and subsequent implementation of this management plan. We are also thankful to individuals who edited the draft of this management plan and these include: Prof. R. Makundi, the Director of SUA Pest Management Centre (SPMC); Prof. A.P. Maerere, the Deputy Director of Directorate of Research and Postgraduate Studies of SUA; Prof. C.L. Rweyemamu, the Head of the Department of Crop Science and Production, Faculty of Agriculture, SUA; Dr. D. Mamiro, Senior Lecturer in the Department of Crop Science and Production, Faculty of Agriculture, SUA; Dr. Hashim Mohamed, Senior Lecturer in the Department of Social Sciences, Faculty of Science, SUA; and Mr. Richard Kasuga, Head of Government Communications, MAFC. Special thanks to Ms. Suma Mwaitulo, Lecturer in the Department of Crop Science and Production, Faculty of Agriculture, SUA, for formatting the resource tables. Finally, our appreciations should go to everyone who in one way or another assisted in the development of this management plan.

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The correct citation of this management plan should be as follows:

Mwatawala, M. W., De Meyer, M., Seguni, Z., Rwegasira, G. M., Muganyizi, J., Senkondo, F. and Shechambo L. (2013). Management plan for fruit fly (Diptera: Tephritidae) Pests in Tanzania. Sokoine University of Agriculture, Directorate of Research and Postgraduate Studies, Morogoro, Tanzania.

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LIST OF ABBREVIATIONS

AMAGRO	Association of Mango Growers
ARIPO	African Regional Industrial Property Organisation
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
AWPM	Area Wide Pest Management
DCDG	Directorate General Development Cooperation
EAC	East African Community
EAPIC	East Africa Phytosanitary Information Committee
FAO	Food and Agriculture Organization of the United Nation
FAR	Fasciventris Annonae Rosa
GATT	General Agreements of Trade and Tariffs
IAEA	International Atomic Energy Agency
IOR-ARC	Indian Ocean Rims - Association for Regional Cooperation
ICIPE	International Center of Insect Physiology and Ecology
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPMs	International Sanitary and Phytosanitary Measures
MAFC	Ministry of Agriculture Food and Cooperatives
MARI	Mikocheni Agricultural Research Institute
MAT	Male Annihilation Technique
MDGs	Millennium Development Goals
ME	Methyl Eugenol
MT	Metric Tons
NACC	National Agriculture and Cooperatives Commission
NGO	Non Governmental Organisation
NPPO	National Plant Protection Organisation
PHS	Plant Health Services
PPA	Plant Protection Act
PPPA	Public Private sector Partnership Act
PEQPS	Post Entry Plant Quarantine Services
PQPS	Plant Quarantine and Phytosanitary Services
PRA	Pest Risk Analysis
RMCA	Royal Museum for Central Africa
SADC	Southern African Development Community
SIT	Sterile Insect Technique
SPS	Sanitary and Phytosanitary Standards
SUA	Sokoine University of Agriculture
TAHA	Tanzania Horticulture Association
TPRI	Tropical Pesticides Research Institute
URT	United Republic of Tanzania
USD	United States Dollar
WTO	World Trade Organisation

1.0 TITLE

Management plan for fruit fly (Diptera: Tephritidae) pests in Tanzania

2.0 INTRODUCTION

2.1. Background

Tanzanian economy largely depends on agriculture which provides employment to almost 75 percent of Tanzanians, particularly the rural populations. Furthermore, agriculture accounts for about 24 percent of the GDP (URT, 2012a) and about 35 percent of export earnings (URT, 2012b). However, agriculture in Tanzania is dominated by smallholder farmers (peasants) who cultivate an average of between 0.9 ha and 3.0 ha farm sizes. Furthermore, sixty-four (64%) percent of the agricultural land is cultivated by hand hoe, 24 percent by animal power and 14 percent by tractor (URT, 2012a). Most of the crops are predominantly grown under rain-fed condition whereas 5 percent of the cultivated land area (about 10.2 million hectares) is under irrigation. Women are believed to constitute a larger part of agricultural labour force.

2.2. Crop production in Tanzania

Tanzania mainland is classified into seven major agro-ecological zones basing on weather conditions, soil characteristics, topography and demography. These include; the Central zone (Dodoma and Singida Regions); the Eastern zone (Coast, Dar es Salaam, Morogoro and Tanga Regions); the Lake zone (Kagera, Mara, Mwanza, Geita, Simiyu and Shinyanga Regions); the Northern zone (Arusha, Kilimanjaro and Manyara Regions); the Southern Highland zone (Iringa, Mbeya, Njombe and Ruvuma Regions), the Southern zones (Lindi and Mtwara Regions) and the Western zone (Kigoma, Katavi, Rukwa and Tabora).

The diverse climatic conditions make the country suitable for the production of a variety of food and cash crops. The available statistics indicate that there has been an increase in the

production of the main food crops at a rate of 3.5 percent since 1985, with urban agriculture flourishing as one of the livelihood coping strategies. Vegetables and fruits production have been dominating urban agriculture because of an increase in the demand of such crops resulting from ever increasing urban population, which is triggered by the rapid urbanization whose annual growth is estimated at 20 percent.

2.3. Fruit and vegetable production

Fruit production sector in Tanzania has, for a long time, been considered as of minor importance. Involvement in the sector was based upon an individual's interest. As a result, the sector had little or rather no contribution to the national agenda as there was no economic value attached to fruit and vegetable crops. Changes in the agricultural policies in 1990s led to the opening up of the sector to private investment in production and processing, input imports, distribution and marketing. This galvanized individual famers and companies into active participation in the production of high-value horticultural crops. Organizations such as Tanzania Horticulture Association (TAHA), Horticultural Development Council of Tanzania (HODECT) and Association of Mango Growers (AMAGRO) were established and spearheaded the growth of the horticultural industry in the country.

The existing statistics indicate that the quantities of vegetables produced in Tanzania increased in early 2002, but declined in subsequent years before increasing again and reached the highest levels in 2010 (Fig. 1). Fruit export increased from 2005/2006 to 2009/2010 before declining to the lowest levels in 2011 (Fig. 2). The lowest level of fruit export was recorded in 2011/2012. Such a decline is a reflection, in real terms, of the severity of agricultural constraints such as pests like fruit flies. An increase in vegetable export is an indication that vegetables have a huge potential in making a significant contribution to

the current export-based economy in Tanzania. Similarly, the export market for most of Tanzania fruits is constrained by the presence of quarantine pests, like fruit flies. Currently, the export markets are restricted to countries in the Middle East and within the Central, Eastern and Southern African blocks.

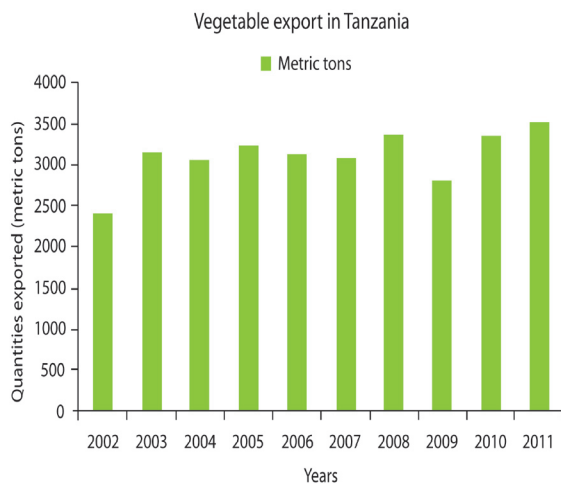


Figure 1: Vegetable exports from Tanzania (Source: TAHA and FAO¹)

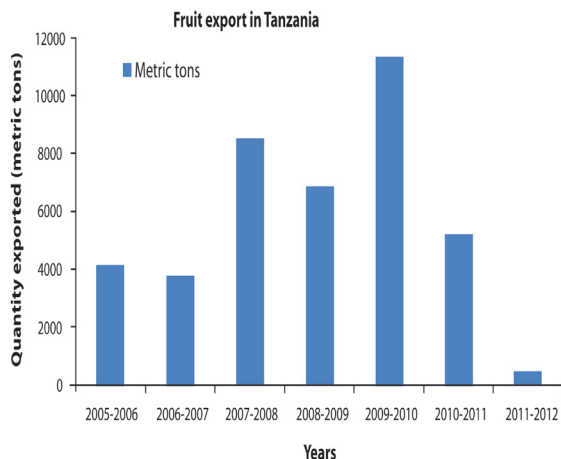


Figure 2: Fruits exports from Tanzania (Source: MAFC²)

¹ Data provided by TAHA Secretariat also available at www.tanzaniahorticulture.com and www.faostat.com

² MAFC, Plant Health Services, Annual Report 2011/2012

2.4. Fruit flies constraints to fruit production and trade

Vegetable and fruit industry in Tanzania is constrained by many factors which include limited access to capital, limited ability of individual farmers of purchasing the necessary inputs, limited expertise, unreliable water sources for irrigation, poor infrastructural services, pandemic diseases, and insect pests. Out of these constraints insect pests, and particularly fruit flies (Diptera: Tephritidae) are considered to be one of the most challenging constraints worldwide. Because of their life history and the polyphagous nature, fruit flies attack a wide spectrum of fruits. Almost all commercially grown fruits (including several seed bearing crops categorized as vegetables, (such as Cucurbitaceae and Solanaceae) are prone to infestation by these pests. In Tanzania, both indigenous and exotic invasive fruit fly species have had negative impact on the production and trade of fruits and fruit bearing vegetables.

2.5 Management plan for fruit fly pests and expected outputs

There is a need for an appropriate management plan in order to address the damage and economic losses caused by fruit flies. The overall objective of the proposed management plan, which involves the use of area-wide approach, is to reduce losses resulting from fruit flies in Tanzania. Specific objectives can be clustered into two main groups;

- (i) To generate knowledge required in formulating an ecologically sound Integrated Pest Management (IPM) program for fruit flies.
- (ii) To optmise, an area wide approach and proven management techniques that have been tested in limited agro-ecologies in the country and abroad.

Specific objectives have been listed in Section 5.0 of this management plan. The strategies to

meet these objectives are listed in Section 6.0 while the expected outputs of the management plan are listed in Section 10.0.

3.0 RATIONALE

In recent years as a result of recent introduction of two exotic invasive flies, fruit flies have become one of the major threats to fruits production in Tanzania (Mwatawala *et al.*, 2010b), leading to increased losses in both yields and export markets. The management plan of using an area-wide approach aims at combating two types of losses: the actual losses (yield) in the field, and the export markets losses due to stringent quarantine laws. Tanzania has the potential of producing 2.0 million MT of fruits worth USD 1.0 billion annually and approximately 1.2 million MT of vegetables worth approximately USD 0.62 billion annually³. This implies that the country achieves only about 45% and 30% of the production potential of vegetables and fruits respectively. Ghana has an estimated market potential of USD 26,453,433 and USD 1,640,083 per annum for organic fruit and organic vegetable respectively, suggesting a huge market potential for organic fruits that is in that country (Owusu and Owusu, 2010). The export of banana alone from Mozambique to neighbouring South Africa, the largest destination market for horticultural produce from the country, are estimated to be worth around USD 20 million annually (Cugala *et al.* 2011). Unfortunately, the presence of fruit flies that attracts imposition of quarantine jeopardizes the export potential of fruits in Mozambique.

In Kenya, the losses of up to KSh 477.6 million have been reported annually due to export restrictions of fruits and vegetables to South Africa alone⁴. Furthermore, losses in terms of unrealized earnings due to ban of avocado

exports alone amount to KSh 167 million. Nevertheless, there are regions with less stringent quarantine measures like the Middle East, and which have very high demand for fruits. This trend is exemplified by imports of mango in 2005, valued at USD 40.2 million, which is an increase of 23% per annum in the period from 2004 - 2005⁵. Two scenarios emerge (i) Access to markets with less stringent quarantine laws is jeopardized by actual losses in yield due to fruit flies; in other words, export quota may not be satisfied, therefore, there is a need to reduce losses caused by fruit flies in order to improve quantities of fruits harvested to satisfy the quotas (ii) Access to markets with stringent quarantine laws is jeopardized because of presence of the fruit flies of quarantine importance; therefore, there is a need of developing phytosanitary measures of combating fruit flies in order to abide by the regulations of the importing countries.

So far in more than eight years since the introduction of *Bactrocera invadens* Drew Tsuruta & white into Tanzania, there has never been a nationwide management program for fruit flies. Activities in the fields of data gathering, developing and testing control techniques, and awareness creation, which have been conducted by several independent actors and institutions in the country, have been uncoordinated, and have been within limited agro-ecologies, particularly the Eastern Coastal areas. In recent years, despite an increase of knowledge on fruit flies among the stakeholders, several aspects about fruit flies namely, their biology, distribution, host status and population dynamics, have not yet been determined for some species. These aspects are the prerequisites for the formulation of an effective management program worth a name. Therefore, there is a need, to (a) further determine the prerequisites and (b) implement a

³ According to data available at www.kilimo.go.tz

⁴ As cited by Muchemi *et al.* <http://www.kari.org/conference/conference12/docs/PHYTOSANITARY%20PERSPECTIVE%20OF%20BACTROCERA%20INVADENS.pdf>

⁵ According to East and Southern Africa Agribusiness Network http://www.ntwk.esaanet.com/index.php?option=com_content&view=article&id=124:fresh-mangos-from-tanzania&catid=1:latest-news&directory=53

management program in an area wide approach by optimizing and harmonizing control techniques in a coordinated fashion.

4.0 SITUATIONAL ANALYSIS

4.1. General background on fruit flies

The Diptera of Tephritidae family belongs to the Acalypterate Brachycera or higher flies. In the Afrotropical region (i.e. Africa south of the Sahara), about 1000 species in 150 genera have been recorded. Majority of these are native to the region; however, some have been introduced through human activities. The life history of fruit flies is varied. In the juvenile stage the majority are phytophagous whereas some species are saprophagous. The phytophagous species attack a variety of host parts and tissues including fruits, flowers, stems, buds, leaves, and roots. From an economic perspective, species that attack fruits (frugivory) are the most important group of fruit flies. This group comprises about 400 species in Africa. The host range is very variable, from specialists which are confined to a single host plant to those that are extremely polyphagous, and which attack more than 300 different hosts. Species of economic significance are found among the polyphagous and some oligophagous fruit flies that attack representatives of a particular plant family or families of agricultural importance such as Cucurbitaceae or Solanaceae. The fruit infesting species from Africa are grouped into eight genera, the most economically significant ones being *Bactrocera*; *Capparamyia*; *Ceratitis*; *Dacus*; *Neoceratitis*; and *Trirhithrum*. Their taxonomic position, specific identity and adult morphological recognition have been reviewed in a series of papers published over the last 15 years. Those publications provide key dichotomies for the taxa within the respective revisions. All (re-) descriptions are also available through the internet, together with images of diagnostic characters, distribution maps and information on specimens housed in natural history collections of the world. ([http://](http://projects.bebif.be/fruitfly/index.html)

projects.bebif.be/fruitfly/index.html).

4.2. Status of knowledge of Tephritid fauna of Tanzania

The tephritid fauna of Tanzania has never been the topic of a thorough research. Several species were collected and described as new to science during the colonial period and some general collections were made within the scope of general agricultural surveys. There were no studies conducted on the life history of economically important species, neither were there studies on the economic impact of fruit flies on horticultural or agricultural produce in general. Research on fruit fly pests started to receive some attention at the turn of the century. In Tanzania, the African Fruit Fly Initiative (AFFI) was undertaken through the coordination of the International Centre for Insect Physiology and Ecology (ICIPE). Later on, a collaborative research project between Sokoine University of Agriculture (SUA, Morogoro) and the Royal Museum for Central Africa (RMCA, Tervuren, Belgium) was initiated with the aim of generating baseline data on the bionomics (biodiversity, population dynamics, seasonality, host range) of fruit fly pests in Morogoro region. These data were gathered with the aim of developing an Integrated Pest Management program, and this was developed and tested in the second phase of the project. The starting of Phase I of the program coincided with the first recording of *B. invadens* in Tanzania, which led to a significant shift of the research focus towards this invasive species, notwithstanding the fact that indigenous pest species were also studied.

In total, 179 species of Tephritidae are currently known to prevail in Tanzania (see Appendix 1 for details). Figure 3 shows a map of the locations in which fruit flies have been reported. The country coverage is rather general; however there is more focus in the north-eastern and central eastern parts of the country. Moreover, not all locations have been

sampled with the same intensity. For instance, a large number of locations have been sampled specifically with regard to a survey for *B. invadens*. In real terms, the knowledge on the occurrence and distribution of fruit flies in Tanzania is inadequate. Several pest species are found in Tanzania, however the major ones are to be recorded and discussed in detail, include: *Bactrocera cucurbitae* (Coquillett); *B. invadens*; *B. latifrons* (Hendel); *Ceratitis capitata* (Wiedemann); *C. cosyra* (Walker); *C. rosa* Karsch; and *Dacus ciliatus* (Loew). Majority of these are polyphagous species, attacking a wide variety of commercially grown fruits such as mango and citrus. Other species are cucurbit or solanaceous feeders. Four of these are indigenous while three are exotic invasive species.

4.3. Status of knowledge on distribution and host range of the main indigenous pest species

Ceratitis capitata (Wiedemann)

Ceratitis capitata, also known as medfly or Mediterranean fruit fly, is considered to be the major fruit fly pest and one of the major frugivorous pests worldwide. The species is of African origin, but it has spread to virtually all continents through human activities. It is the main fruit pest in subtropical horticulture industry; it occurs throughout the whole of the African continent including areas with a relatively dry climate. This species has been reported from more than 100 hosts in Africa (Appendix 2). In Tanzania, this pest species has been recorded in dispersed localities throughout the country (except in the north-western part, although this could be the result of sampling bias). Currently, this pest species seems to be less abundant, probably due to the introduction of *B. invadens*. The exact cause of the population decline is unknown; however, interspecific competition is suspected to have been the cause of the decline of this species. Thus, although it (*C. capitata*) is still considered to be a

major fruit pest species, its current impact on Tanzanian horticulture is rather minimal.

Ceratitis rosa Karsch

Ceratitis rosa, the Natal fruit fly, is a widespread species found throughout southern and eastern Africa. It belongs to a species complex, namely, the FAR complex (Virgilio *et al.*, 2008); the current research indicates that the species might actually constitute two different forms (entities) although this hypothesis needs further investigation. *Ceratitis rosa*, is a polyphagous species known to be reared from more than 50 different hosts (Appendix 3) including a number of fruits from temperate climates such as apples, plums, and peaches. In Tanzania, the species is apparently restricted to the north-eastern, central, and eastern parts of the country. Comparative studies along an altitudinal transect in Morogoro (Geurts *et al.*, 2012) have shown that it (or at least one of the two forms) can withstand colder and/or wetter conditions and therefore can demonstrate niche partitioning with regard to *Bactrocera invadens*. Because of this, it (*C. rosa*) should be considered as a major pest species with the potential of causing damage in regions that are largely unsuitable to some other fruit flies.

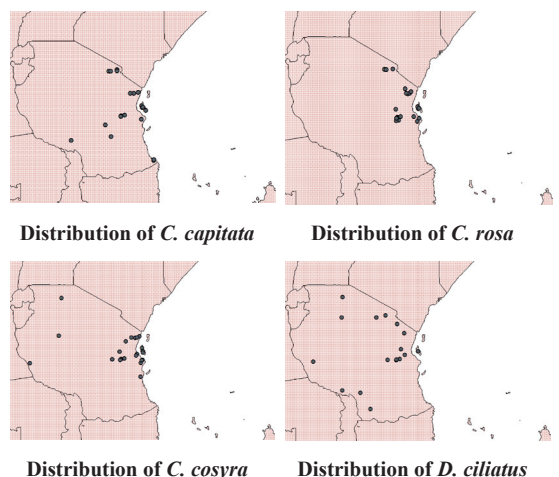


Figure 3: Distribution of native fruit fly pests in Tanzania.

***Ceratitis cosyra* (Walker)**

Ceratitis cosyra, also known as the mango fruit fly or marula fruit fly, is an African species that can be found throughout the continent (except in the Saharan region and the colder parts of South Africa). Prior to the introduction of *B. invadens*, *C. cosyra* was considered to be the major fruit fly pest species on mango. Although polyphagous (*C. cosyra* has been recorded from more than 20 different hosts, cf Appendix 4), the host spectrum is more limited and is largely confined to *Annonaceae*, *Anacardiaceae* and *Apocynaceae* and families. In Tanzania, *Ceratitis cosyra* is widely distributed throughout the country, and shares fundamental niches with *B. invadens*. However, comparative developmental studies have shown that the latter has a more advantageous development threshold than *C. cosyra* (Salum *et al.*, in press). The current impact of *C. cosyra* on the fruit industry (in particular mango producing industry) is partially reduced because of this. Nevertheless, *C. cosyra* should still be considered a pest species of major importance in the country.

***Dacus ciliatus* (Loew)**

Dacus ciliatus is a notorious pest found in all major areas in the African region and the Arabian Peninsula. The pest is probably an African species that has been subsequently introduced in the near and Middle East although there is no historical evidence for this. *D. ciliatus* is an oligophagous species attacking a large variety of different Cucurbitaceae (Appendix 5); the species is also occasionally recorded in other host families. In Tanzania, the species is widespread and recorded in many regions. Together with some other *Dacus* species (like *D. bivittatus* and *D. punctatifrons*), *D. ciliatus* forms a group of cucurbit infesters that seem to compete with the invasive *B. cucurbitae*. The exact interaction between these species is however not well understood. Nevertheless, *D. ciliatus* should be considered as a pest species

of some importance in the country.

4.4. Status of knowledge on distribution and host range of invasive fruit fly species

Information on the invasive fruit fly species in Africa is available in: <http://www.africamuseum.be/fruitfly/AfroAsia.htm>

***Bactrocera invadens* Drew Tsuruta & white**

Bactrocera invadens, sometimes referred to as the invasive fruit fly, is of Asian origin. It belongs to the *B. dorsalis* species complex, a group of Asian and Australasian fruit flies including a number of notorious pests and several invasive species (*Bactrocera dorsalis*, *Bactrocera carambolae*). The pest's specific status is currently under investigation through a Co-ordinated Research Program initiated by the International Atomic Energy Agency (IAEA). *Bactrocera invadens* was first reported in Kenya in 2003 and later in Tanzania in 2004, before spreading to other countries over eight years that followed (Appendix 6). The species is currently found throughout sub-Saharan Africa. An ecological niche model (De Meyer *et al.*, 2010) suggests that *B. invadens* prefers hot and humid environments with high annual precipitation although not necessarily continuous. In Tanzania, the species is widespread throughout the country and seems to occur in most regions except perhaps the driest parts and in high altitude areas.

Although previously unknown and apparently of no economic significance in its region of origin, *B. invadens* has made a tremendous impact in Africa since its introduction. The species has demonstrated an unprecedented dispersal rate and a wide host range (recorded from 65 plant species belonging to 26 families). It is currently considered as one of the major pest species, especially for horticultural industry of tropical fruits such as mangoes. *Bactrocera invadens* is also a strong competitor displacing indigenous

pest species of fleshy fruits, particularly the representatives of the genus *Ceratitis*. Because of its economic significance and invasive behaviour, it is considered as a potential threat in many other regions with significant fruit based economies.

Currently, the taxonomic status of *B. invadens* is being investigated within the framework of a Co-ordinated Research Programme on cryptic species by the International Atomic Energy Agency. There is some evidence that a separation between *B. invadens* and *B. dorsalis* s.s. is perhaps not reflecting the true status of both entities. However, no conclusion has been reached on this subject and for the time being we should keep considering *B. invadens* as a separate species from the closely related taxa within the *Bactrocera dorsalis* complex.

detected in Africa in 2006 particularly in Morogoro Region in Eastern Central Tanzania. A nationwide survey was conducted and the species was found to prevail in different parts of the country. Within Africa, *B. latifrons* has been reported in Tanzania and Kenya. However, its abundance appears to be much lower than that of *B. invadens* or *B. cucurbitae*. However, lack of an appropriate potent attractant to be used in detection and monitoring might have distorted the actual population situation: alpha ionol and latilure have proven to be less effective than has been the case with the general attractant of protein bait in Tanzania. Generally, *B. latifrons* seems to have lower dispersal ability than *B. invadens*. More intensive and focused surveys should be conducted in different parts of Africa in order to establish the actual impact of the species. *Bactrocera latifrons* is a typical oligophagous species attacking mainly Solanaceae.

In its native range, *B. latifrons* is reported in 30 hosts, predominantly belonging to Solanaceae but also representatives of other families. It (*B. latifrons*) has been reared from a number of commercially grown solanaceous hosts such as eggplant, tomato, and chilli in Tanzania. A few exceptional records of non-solanaceous hosts (mainly Cucurbitaceae) are also known. The host species recorded in Tanzania are listed in Appendix 8.

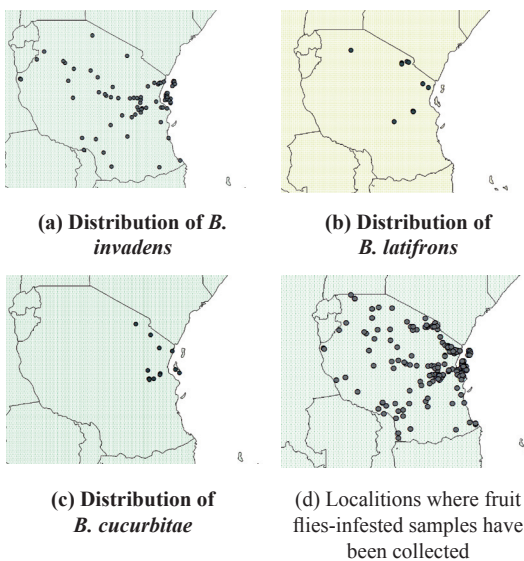


Figure 4: (a-c) distribution of exotic fruit fly pests in Tanzania (d) Localities where positive samples of fruit flies have been collected.

***Bactrocera latifrons* (Hendel)**

Bactrocera latifrons or the Solanum fruit fly is of Asian origin. The species was first

***Bactrocera cucurbitae* (Coquillett)**

Bactrocera cucurbitae or the pumpkin fruit fly is also of Asian origin. It has been introduced to Africa and is currently widespread in the continent. The pest's chronological appearance in Africa is summarized in Appendix 7. The oldest records are from Eastern Africa, that is, Tanzania and Kenya. Other records in the second half of the 20th century originate from the islands of Mauritius and Réunion in the western Indian Ocean. However, at the turn of the century, the species was also reported

in a number of western African countries. *Bactrocera cucurbitae* has also been recently recorded in other countries in eastern Africa. It is however unclear whether these records are a reflection of a recent spread of the species or an artifact due to a change in collecting effort. Some cases, such as the occurrence of the species in the Seychelles, appear to be a result of recent introductions. In Tanzania, it is known in the restricted parts of the country, namely, the eastern, the northern and the central parts. Since no nationwide survey has been conducted, it is not clear whether or not this is a true reflection of its occurrence as the available data may not reflect a country-wide coverage.

Bactrocera cucurbitae is an oligophagous species, attacking mainly *Cucurbitaceae*. This species has been recorded in a wide range of cucurbit hosts both in its native region as well as in Africa. (The African hosts are listed in Appendix 7). As such, the species is considered as a serious pest. There are also some records from non-cucurbit hosts although these are limited and some need confirmation.

4.5. Status of knowledge on bionomics of fruit flies

The general life history of fruit flies is well documented. Like many other organisms, the life cycle of fruit flies starts with the mating of adults. After mating, female fruit flies start searching for oviposition sites. Fruit volatiles are a major influence on host searching behaviour of some frugivorous tephritid flies (Cornelius *et al.*, 2000). Tephritid flies detect fruits on host plants using odour, colour, shape and size as well as the presence of volatiles (Fletcher and Prokopy, 1991). After finding the proper fruit, the females puncture the skin of the fruit by the ovipositor and lay their eggs. After the hatching of the eggs, the emerging larvae burrow through the fruit flesh, feeding internally and initiating rots. Fruits may fall off prematurely or get spoiled if the eggs are laid just before the fruit

is harvested, as the fruits ripen after the eggs have hatched (Waite, 2002). Christenson and Foote (1960), Bateman (1972), Hill (1983) and Aluja *et al.* (1997), have reviewed the general biology of fruit flies.

4.5.1 Development rates, demographic and population parameters of fruit fly pest species *C. capitata*

The development rates of different stages of *C. capitata* have been summarized by White and Elson-Harris (1994), while Duyck *et al.* (2002) present the comparative development biology of *C. capitata*, *C. rosa* and *C. catorii* Guérin-Méneville. Demographic parameters of *B. invadens* have been reported by Ekesi *et al.* (2006) while Salum *et al.* (In Press) have compared demographic and population parameters of *B. invadens* and *C. cosyra*.

4.5.2 Spatial and temporal abundance of fruit flies

Abundance of insects is determined by the inherited properties of individuals of a species and the attributes of effective environment (Pedigo, 1996). In determining the abundance of fruit flies, biotic and abiotic factors have also been mentioned and these are explained as follows;

4.5.2.1 Abundance and wide spread availability of preferred hosts

Large numbers of fruits produced by preferred hosts as well as wide spread availability of the hosts are among the biotic factors responsible for large populations of many fruit fly species (Leblanc and Allwood, 1997; Vayssières *et al.*, 2005; Drew and Hooper, 1983; Vargas *et al.*, 1990; Tora Vueti *et al.*, 1997).

4.5.2.2 Temperature, humidity and rainfall

High rainfall, an increase in temperature, and a widespread availability of hosts have been reported as among the factors causing a rapid increase in the number of various fruit fly

species. On the other hand, low population density of many species has been attributed to drought through its effect on fruiting of plant species (Amice and Sales, 1997; Lewiniquila *et al.*, 1997; Manrankhan and Price, 2000; Vayssières (2009).

4.5.2.3 Natural enemies

In a few cases, natural enemies have been shown to play a key role in the population dynamics of some tephritid species. The impact of generalist predators would affect more or less equally the different tephritid species in a given biotope. Parasitoids, however, are more specific and could affect differently the tephritid species coexisting in a biotope. Despite this fact, the impact of natural enemies on tephritid population appears limited except in a few cases (Duyck *et al.*, 2004).

4.5.2.4 Competition

Exotic invaders like *B. invadens* tend to be more competitive (Byers, 2000; Petren and Case, 1996) and are able to quickly dominate the indigenous species. Where polyphagous tephritid species have been introduced into an area which is already occupied by other polyphagous tephritids, interspecific competition has resulted into a decrease in numbers and niche shift of pre-established species (Duyck *et al.*, 2004).

4.5.3 Spatial and temporal abundance of fruit flies in Tanzania

Geurts *et al.* (2012) studied the relative abundance of indigenous and invasive frugivorous fruit flies along an altitudinal transect between 581-1650 m in the Uluguru Mountains range in Morogoro, Tanzania. In this study, the polyphagous invasive *B. invadens* and the indigenous *C. rosa* showed a similar temporal pattern, but largely separated in space, with *B. invadens* being abundant at lower elevation while *C. rosa* being predominant at higher elevation. The polyphagous indigenous

species *C. cosyra* coincided with *B. invadens* but shows an inverse temporal pattern. Studies conducted by Mwatawala *et al.* (2006) show that the highest populations of *B. invadens* and *C. rosa* were recorded during the rainy seasons, whilst the lowest population levels were recorded during the dry season, especially from late July to October. Generally, population recorded during the long rainy season is higher than that recorded during the short rainy season. On the other hand, the population of *C. rosa* generally had no obvious peaks.

4.5.4 Status of knowledge on factors that affect abundance of fruit flies in Tanzania.

4.5.4.1 Fruit phenology

Phenology is the study of the timing of recurring biological events in the animal and plant world, the causes of their timing with regard to biotic and abiotic forces, and the interrelationships among phases of the same or different species (Lieth, 1974). Plant phenology can be used as a tool for predicting the phenology of insect pests. Phenological events have been correlated with *B. invadens* abundance in Morogoro Tanzania (Shechambo, 2008). These studies were undertaken in Morogoro Region, which lies in the transition zone between unimodal and bimodal rainfall regimes and need to be extended to other areas with different rainfall regimes. Furthermore, the studies involved only one fruit fly species; thus there is a need to study abundance of other important species in relation to fruit phenology. Below are some examples of phenological events of the selected important fruits.

Phenological events of mango varieties

Phenological events of mango are presented in Figure 5. Flower buds often develop from the third week of July to the first week of October in all other mango varieties except late varieties namely “Kent”, “Keitt” and “Alphonso”. For the “Kent” variety the flower

buds have been observed to occur from the last week of September to the second week of November. Open flowers and pollen are usually observed from the second week of August to the second week of October in all other mango varieties and from the last week of October to the third week of November for the late varieties. Consequently, the immature fruits are observed from the third week of August to the fourth week of November in all other varieties and from the fourth week of November to the second week of January for the “Kent” variety. Mature fruits are observed from the first week of November while ripen fruits are first observed from the fourth week of December through the last week of January in all other varieties, and from the third week of January and the fifth week of February through the second week of March in the late varieties. Fruits have never been observed on trees from the first week of February in early varieties and from the third week of March in the late varieties. Fruiting in most mango varieties usually take about 126 days from flower buds formation to fruit maturation in the mid altitude areas of eastern Tanzania. Mangoes require about 100 to 150 days from flowering to maturing of fruits (Shechambo, 2008).

Phenological events of Sweet orange

Figure 5 presents phenological events of sweet orange. In low to mid-altitude parts of Eastern Tanzania, the flower buds usually develop from the first week of November in most of sweet orange varieties grown in Tanzania (Fig. 5). By July, trees of these varieties bear a mixture of immature, mature and ripened fruits except for the “Jaffa” variety which at that time would still be undergoing vegetative growth. Flower buds start showing up from the third week of October for the “Jaffa” variety and from the first week of November for the other varieties. Open flowers and pollen are usually observed from the last week of October for “Jaffa” variety and from the third week of November for the other sweet

orange varieties. Immature fruits are often formed during the third week of November for “Jaffa” variety and during the first week of December for other varieties. Mature and ripe fruits are observed during the first week of March and the last week of April for the “Jaffa” variety and from the third week of March and fourth week of May for other sweet orange varieties. Sweet orange trees are usually devoid of fruits from the third week of July to the second week of October (Shechambo, 2008).

Phenological events of guava

In Eastern Tanzania, guava flower buds are initiated from the third week of July to the first week of August for the first flush (Fig. 5), then from the second week of November to the second week of December for the second flush and again from the second week of March to the third week of May for the third flush. Open flowers and pollen are observed from the third week of July to the third week of August and from the third week of November to the third week of December, and again from the third week of March to the fourth week of May. Immature fruits are continuously observed on fruit bearing trees almost throughout the year. Mature and ripe fruits are continuously available except for a few weeks interval from the first to the second week of November and from the second week of January to the third week of February (Fig. 5). In guava trees, one or more phenological events would always be observed (Shechambo, 2008).

4.5.4.2. Competition and demographic parameters

The invasive *B. invadens* seems to outcompete and dominate indigenous species in many parts of Africa. As Ekesi *et al.* (2009) reported, under interspecific competition larval duration in *B. invadens* is significantly shorter than is the case with *C. cosyra*. Pupal mass in *C. cosyra* was affected by competition and was significantly reduced under competitive interaction



Figure 5: Phenology of selected fruit species superimposed on weather data (July 2006-July 2007).

the rainfall pattern. For example, high populations of *B. invadens* and *C. rosa* were recorded during the short and long rainy seasons. The former corresponds to the main mango season, and the latter is the main season of many fruit species including guava and citrus. Temperature also seems to influence the distribution of the three major fruit fly species (Fig. 7). For example, numbers of *B. invadens* were positively correlated to temperature (Fig. 7) and consequently high populations were recorded in the low and medium altitude areas. These areas are generally warm throughout the year.

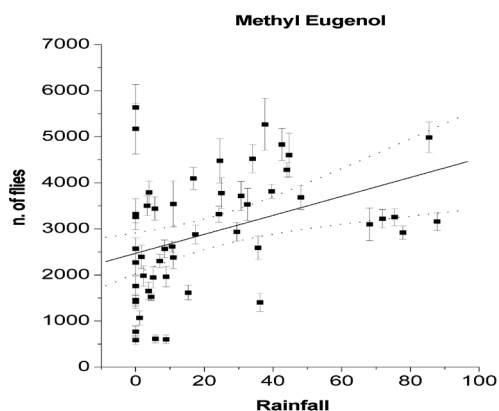


Figure 6: Correlation between rainfall and abundance of *B. invadens*.

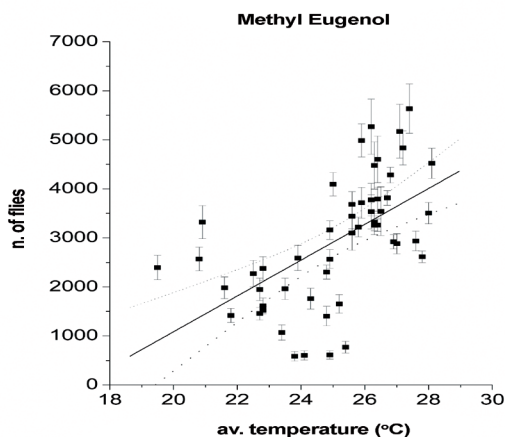


Figure 7: Correlation between temperature and abundance of *B. invadens*.

4.5.4.4 Widespread availability of the hosts

The availability of the hosts had also a marked effect on the populations of *B. invadens*, *C. rosa* and *C. cosyra*. Among the three species, *B. invadens* attacked a wide range of fruits including cucurbits. Of the studied species, *C. rosa* had the widest host range of all *Ceratitis* species in the study area. The data show that *C. rosa* is a major pest of temperate fruits like peach and feijoa grown in the highlands; while *B. invadens* is the major pest of tropical fruits grown in low and medium altitude areas. Competition seems to play part in the observed population patterns. It can be suggested that *B. invadens* could exploit resources better than *C. cosyra* or probably *B. invadens* denies access to food or target sites to *C. cosyra* (i.e. behavioural interference). Interference competition implies that a more aggressive species (in this case *B. invadens*) gains access to resources to the detrimental effects on the other species (in this case the established species like *C. cosyra*).

4.5.4.5 Natural enemies

Natural enemies have not been well studied in Tanzania. The parasitoid *Fopius arisanus* (Sonan) has been released in the coastal areas but it is not well known if the parasitoid has successfully established in the field. Studies on various aspects of weaver ants, *Oecophylla longinoda* Latreille, as a biological control agent of fruit flies, are currently undertaken by SUA in Mtwara, Coast, and Tanga Regions.

4.6. Status of fruit flies management in Tanzania

4.6.1 Area Wide Management of fruit flies

Area wide pest management (AWPM) is a concept of preventive suppression of a mobile insect pest species throughout its geographical range, as opposed to the reactive field-by-field control. Area wide pest management can be contrasted with traditional pest management in the sense that pest management tactics are used over a broad spatial area, often treating

the whole area simultaneously to maintain the pest below economic levels or, in some cases, eradicate it completely (Elliot *et al.*, 2008). AWPM has potential advantages over the traditional approach. Suppression over a broad area may reduce infestation from nearby unmanaged areas; an ecologically based pest management tactics can be more effective when applied over a wide area (Elliot *et al.*, 2008).

AWPM program for fruit flies is desirable because of the high dispersal ability of the fruit fly species and of the fact that most of them have wide host ranges including wild hosts in uncultivated areas. AWPM for fruit flies should integrate various control components into a comprehensive economically viable, environmentally acceptable, and sustainable package that intends to achieve an area-wide suppression of fruit flies, and a reduction in the use of industrial pesticides in order to provide impetus for growth and development of the fruit industry.

Since the introduction of *B. invadens* in Tanzania in 2003, the Government in collaboration with national and international institutions has undertaken various research activities and on farm trials to validate Integrated Pest Management (IPM) options in controlling the pest. The options include surveillance, orchard sanitation, Male Annihilation Technique (MAT), toxic food baits, early harvesting of fruits, post-harvest fruit treatment, biological control and judicious use of selected insecticides as cover sprays. The tested and validated IPM technologies in the Coast, Dar es Salaam and Tanga regions with farming community groups have proven to be effective. However, in order for these technologies to be sustainable, they have to be applied by fruit farming communities over expansive areas under AWPM approach. There is great need to test and implement such technologies under AWPM of fruit flies in Tanzania.

4.6.2 Some techniques of managing fruit flies in limited agro-ecologies as components of IPM for fruit flies in Tanzania

4.6.2.1 Surveillance of fruit flies

Fruit fly surveillance aims at establishing pest distribution and density that can enable the selection of appropriate management options to be undertaken including quarantine. In Tanzania, surveillance with regard to invasive *Bactrocera* species was conducted from 2003 to 2011. A detection survey in the regions of Arusha, Coast, Dar es Salaam, Kilimanjaro and Tanga and a country-wide delimiting survey (Table 1) were conducted in the country in December, 2003 and March, 2005, to determine the presence and distribution of the exotic fruit fly. The survey indicated that *B. invadens* was present in all five regions. The delimiting surveys indicated that *B. invadens* had spread throughout the country (Fig. 6 and 7), and this has serious potential repercussions on fruit production for local consumption and international trade.

A detection survey on *B. latifrons* was conducted in 2006 and 2007 and covered Dar es Salaam, Coast, Tanga, Kilimanjaro, Arusha, Morogoro, Iringa and Mbeya regions. Other regions covered in the survey were Dodoma, Singida, Tabora, Shinyanga, Kagera and Mwanza. The results of the survey are presented in Mwatawala *et al.* (2010a). Another survey was conducted in 2010/11 to resolve the controversy on taxonomic identity of *B. invadens*, following the same routes used for *B. latifrons* surveys, with the inclusion of Lindi and Mtwara Regions.

Monitoring of fruit fly population has been ongoing at SUA in Morogoro since 2004 to 2013. It is recommended that, spatial and temporal abundances of fruit flies should be determined in various agro-ecologies.

Table 1: Detection surveys conducted in 2003 showing *B. invadens* catches by ME traps

Region/Area	No. of fruit flies/trap	Density of mango trees	Remarks
	Overall mean		
Tanga	174 ± 185	High	Mango trees form a salient feature of the areas
Kilimanjaro	104 ± 130.4	Low	Occasional cases of mango trees at homesteads
Arusha	0.3 ± 0.7	Very low	Low temperatures not suitable for growing mango
Dar-es- Salaam/ Coast	239.3 ± 172.3	High	Mango trees form a salient feature of the areas

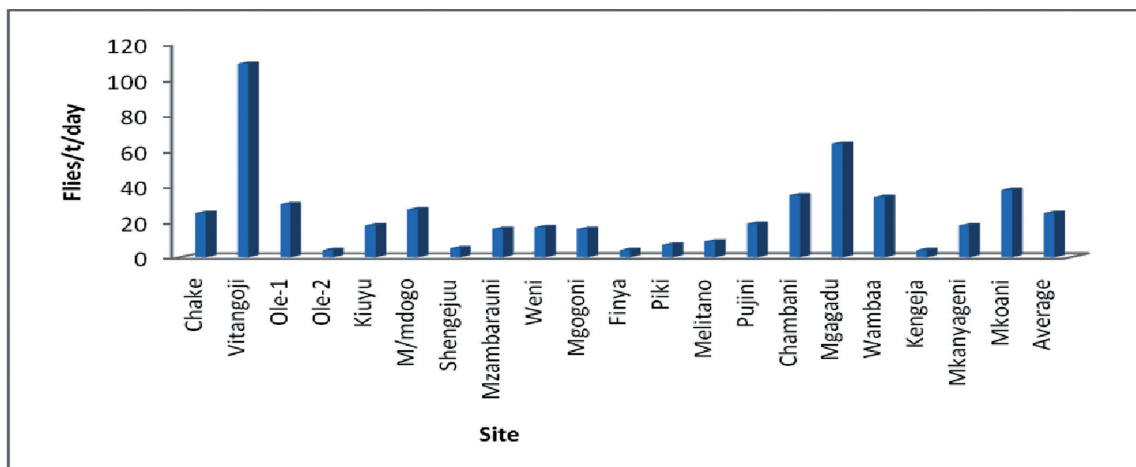


Figure 8: *B. invadens* per trap per day in ME traps in Pemba in 2005.

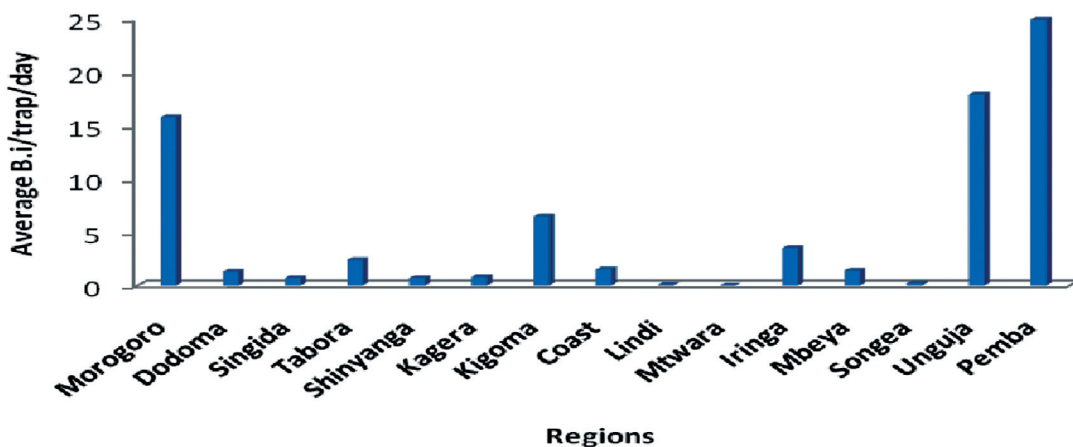


Figure 9: *B. invadens* per trap per day in ME traps in Tanzania mainland in 2005.

4.6.2.2 Orchard sanitation

The removal of fallen fruits and burial in deep pits or fruit collection in black plastic bags and exposure to intense sun were all tested and proven to substantially reduce fruit fly population. Tests were carried out as part of fruit flies IPM program in Morogoro, Tanga, Dar es Salaam and Coast Regions. Such practices can be supplemented by ploughing underneath the tree to expose the buried puparia to the harsh environment. Field sanitation, if implemented well over a larger area, can reduce losses of more than 80 percent. It is proposed that field sanitation should be mandatory to all fruit farmers, backed up with law enforcement.

4.6.2.3 Sterile Insect Technique (SIT)

The SIT involves clearly defined working area where initially the male population is severely suppressed using MAT. The area is flooded with a large number of irradiated sterile males of fruit flies to reduce the chances of fertile wild males getting access to females. The aim of SIT is to eradicate fruit fly population and create fruit fly free areas for commercial fruit production. SIT is more successful in geographically isolated areas. SIT has not been tested in Tanzania, but it can be used to control pests like *B. latifrons*, whose populations are low and localized. SIT can be used in the Islands such as Mafia and in Zanzibar.

4.6.2.4 Toxic food baits

Commercially or locally available food baits can be used in combination with appropriate conventional and novel insecticides during the fruiting season to suppress both female and male populations of different pest fruit fly species. The commonly used baits include Mazoferm, Nulure and GF 102 (SUCCESS bait). Toxic bait is sprayed as spot sprays on the tree canopies at seven-day intervals. Currently, GF 120 and Mazoferm are being used by farmers to control fruit flies in experimental field in Morogoro and in commercial field in Tanga, Dar Es

Salaam and Coastal Regions, after proven to be effective in various trials including the five years of experiments which were conducted by SUA in Morogoro.

4.6.2.5 Biological control

The exotic parasitoids for example, *F. arisanus*, entomopathogens such as *Metarhizium anisopliae* (Metchnikoff) Sorokin and predatory ant *O. longinoda* are used to control fruit flies. *Fopius arisanus* lay eggs in the eggs and maggots of fruit flies eventually killing them resulting into reduced fruit fly population. Predatory ants work by repelling ovipositing females or through predatory effect on adults. Entomopathogens infect and kill larvae forms and adults of fruit flies. *Fopius arisanus* was introduced and released in limited areas of Coastal Tanzania by MAFC, although, data on its establishment in the field are not available. Trials on the use of *O. longinoda* (which occur naturally in many parts of the country) are been conducted by SUA and Mikocheni Agricultural Research Institute (MARI) in Dar-Es-Salaam, Coast, Mtwara, Morogoro and Tanga and the results are promising. The use of entomopathogen nematodes have been tested in the laboratory at SUA. There is need to extend the release of *F. arisanus* to different agro-ecologies of Tanzania. Furthermore, there is a need to perform augmentation of *O. longinoda* in areas where they occur.

4.6.2.6 Male Annihilation Technique (MAT)

Male annihilation technique involves the deployment of a high density trapping stations consisting of male attractants combined with a contact insecticide. MAT aims at reducing male fruit fly populations to low levels that prevents the occurrence of mating. MAT normally involved a large area. MAT has been part of the IPM program tested in Morogoro, Tanzania. Currently, methyl eugenol is being distributed to farmers for free by the MAFC. However, it is not well known how effective it (methyl

eugenol) has been in areas where it has been used.

4.6.2.7 Chemical control

Chemicals can be used as cover sprays for fruit fly management provided that they are judiciously used. The common products include Dimethoate (Rogor) and pyrethroids (e.g. Karate). Other insecticides such as Spinosad are environmentally safe. These chemicals are all effective in reducing fruit flies population, although it is recommended that they should be used as the last resort by also strictly adhering to experts' recommendations.

4.6.2.8 Early harvesting

Early harvesting can be used in some fruits as a control strategy by avoiding the ripening phase that attracts fruit fly infestation and subsequent damage; for instance, in banana, papaya and sapodilla, fruit fly infestation mainly occurs during the ripening stage. However, early harvesting should be done when fruits are at physiological maturity stage in order to maintain the quality of harvested fruits.

4.6.2.9 Post-harvest treatment

The purpose of applying post-harvesting treatment is to ensure that phytosanitary standards are adhered, particularly for fruits meant for export. Post-harvest treatment technologies include;

- Heat treatment at 65°C to increase host fruit temperature above thermal limit of fruit fly
- Cold treatment at 4-8°C that aims at decreasing host fruit temperature below the thermal limit of fruit fly.
- Fruit irradiation, aiming at killing the immature stages of fruit fly within the fruit.

Heat treatment is currently being practiced by some farmers in Tanzania. However, large scale trials on post harvest treatment techniques have to be undertaken in order to develop acceptable

protocols to be used by fruit exporters.

4.6.2.10 Quarantine and legislations

Phytosanitary measure is any legislation, regulation or official procedure having the purpose of preventing the introduction and/or spread of quarantine pests. Phytosanitary procedure is any official rule that prevents the introduction and/or spread of quarantine pests, by regulating the production, movement or existence of commodities or other articles, or normal activity of persons, and by establishing schemes for phytosanitary certification. Quarantine is the official confinement of plants or plant products subject to phytosanitary regulations for observation and research or for further inspection, testing and/or treatment. A quarantine pest is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled.

Enforced isolation or restriction of free movement which is imposed to prevent the spread of contagious pest (s) is guided by international agreements, conventions and standards as well as national laws.

(a) International law

Tanzania is a signatory to a number of international agreements which confer both rights and obligations in relation to decision making and processes related to the assessment and application of sanitary and phytosanitary measures. For example, Tanzania is a member of the WTO since 1994; she is the contracting party to IPPC since 2005, and a signatory to the Paris Convention (WTO, 2012). Tanzania is actively pursuing a regional integration strategy, as she is a member of the International Phytosanitary Council of the African Union (Paris Convention); Southern African Development Community (SADC); East African Cooperation (EAC) and Indian Ocean Rims-

Association for Regional Cooperation (IOR-ARC). SADC member states apply sanitary and phytosanitary measures in accordance with the WTO agreement (Article 16 of the SADC Protocol). Despite that SADC members are obliged to comply with standards and technical regulations on trade (Article 17 of the same protocol); EAC developed a tripartite Free Trade Area Agreement (2008) and an SPS Annex to the agreement whose member states are obliged to comply. The IOR-ARC, initially known as the Indian Ocean Rim Initiative, disseminates information on trade and investment regimes to its members to enable them understand better the impediments on trade and investment within the region with the aim of expanding intra-regional trade. In addition, Tanzania is a member of the African Regional Industrial Property Organization (ARIPO) and East Africa Phytosanitary Information Committee (EAPIC) with the aim of serving the same interests.

(i) The WTO and IPPC

The World Trade Organization is the only body formulating global trade rules with binding effects on its Members (WTO, 2012). It is not only an institution, but also a set of agreements. The IPPC, which is a multilateral treaty for cooperation on plant protection and health, aims at securing common and effective action to prevent the spread and introduction of pests of plants and plant products (Article I, paragraph 1 of the Convention) and to promote appropriate measures for their control.

The International Plant Protection Convention (IPPC) is an international treaty organization that aims at securing coordinated, effective action to prevent and to control the introduction and spread of pests of plants and plant products. Furthermore, it protects cultivated plants, natural flora, plant products and weeds from direct and indirect damage by pests. The IPPC also focuses on plants and plant products involved in the international trade; it also

covers research materials, biological control organisms, germplasm banks, containment facilities and other things such as containers, packaging materials, soil, vehicles, vessels and machinery that can act as a vector for the spread of plant pests.

(ii) The Sanitary and Phytosanitary Measures (SPS) Agreement

The SPS Agreement confirms the right of WTO Member countries to apply measures necessary to protect human, animal and plant life, and health. The Agreement came into effect and set new rules in an area previously excluded from General Agreements on Trade and Tariffs (GATT). The purpose of the SPS Agreement is to ensure that measures established by governments in protecting human, animal and plant life and health are consistent with the obligations prohibiting arbitrary or unjustifiable discrimination on trade between countries where the same conditions prevail.

(iii) International Standards for Phytosanitary Measures

International standards for phytosanitary measures (ISPMs) are the instruments issued under the IPPC and not binding to provide greater guidance on the standards articulated in the IPPC. WTO members are encouraged to base their phytosanitary regulatory measures on the standards developed under the IPPC. The ISPMs are prepared by the Secretariat of the International Plant Protection Convention as part of the United Nations Food and Agriculture Organization's global programme of policy and technical assistance in plant quarantine. This programme makes these standards, guidelines, and recommendations available to FAO Members and other interested parties in order to achieve international harmonization of phytosanitary measures, with the aim of facilitating trade and avoid the use of unjustifiable measures as barriers to trade (FAO, 2005; 2009; WTO, 1998). Some ISPMs

that are relevant to fruit flies management are listed in Appendix 11.

(b) Municipal laws

The Plant Protection Act (1997)

The Plant Protection Act (PPA) states clearly the quarantine measures, plant import and export control under section 8 of the PPA. The importation of plant or plant products, organism, or soil into Tanzania should be in accordance with terms, period and conditions of a prescribed permit issued under PPA, including compliance with the quarantine requirements of the country. Tropical Pesticide Research Institute (TPRI) provides Post Entry Plant Quarantine Services (PEPQS) to prevent movement of quarantine pests in and outside the country. However, the PPA lacks provisions for key areas, in particular, the monitoring and surveillance, pest risk analysis and Pest Free Areas.

5.0 OBJECTIVES

The objectives of this management plan include:

- 5.1 Establishing the status of economically important fruit flies in Tanzania
- 5.2 Assessing the economic impact of fruit flies on the horticultural industry nationwide
- 5.3 Evaluating the available mechanism for fruit fly control
- 5.4 Formulating management program for mitigation of fruit fly problems in horticulture in Tanzania
- 5.5 Re-enforcing long term awareness, capacity building and collaboration

The objectives and strategies (Section 6.0) of this management plan comply with the objectives and priority issues with regard to agricultural development in Tanzania, as stated in several official documents including:

- (i) Millennium Development Goals

(MDG⁶)

- (ii) Agricultural Sector Development Strategy⁷
- (iii) Agricultural Sector Development Policy⁸
- (iv) Tanzania Development Vision 2025⁹
- (v) Agriculture First resolve Kilimo Kwanza¹⁰
- (vi) Agricultural and Livestock Policy¹¹ (see also Appendix 12)

Furthermore, the objective of Public Private Partnership Act (PPP Act, 2010) in the Agricultural policy is to promote private sector for it to be able to provide public services through public/private partnership projects in terms of investment capital, managerial skills and technology. In Tanzania, PPP Policy and PPP Act are already in place, what is required is the institutional framework to facilitate the process.

6.0 STRATEGIES

Strategies for meeting each objective are presented below. Each strategy is further disaggregated into specific activities, their timing, and frequency (Appendix 13);

OBJECTIVE ONE

- 6.1.1. A nationwide detection and delimiting surveys of fruit flies in different biogeographical and agro-ecological zones in the country are required in order to establish the distribution of both indigenous and invasive fruit fly pest species of major economic significance. Such surveys should comprise trapping, using broad

⁶ <http://tz.one.un.org/index.php/core-commitments/millennium-development-goals>

⁷ <http://www.tzonline.org/pdf/agriculturalsectordevelopment-strategy.pdf>

⁸ <http://www.agriculture.go.tz/publications/english%20docs/ASDP%20FINAL%2025%2005%2006%20%282%29.pdf>

⁹ <http://www.tanzania.go.tz/vision.htm>

¹⁰ www.tnbctz.com

¹¹ <http://www.agriculture.go.tz/publications/english%20docs/Tanzania%20Agricultural%20and%20Livestock%20Policy%20%281997%29.pdf>

spectrum of attractants, as well as a potential host collecting component (both from commercial and wild environments). It should also be conducted at different periods in the year, in order to counter for seasonal differences. Trapping guidelines established by IAEA (2003) will be largely followed. Fruit collection will follow procedures used by Copeland *et al.* (2002). It is estimated that 16,200 kms of the major roads, including those covered by Mwaiko *et al.* (2006) and Mwatawala *et al.* (2010a) will be covered. A breakdown of activities is presented in Appendix 13.

- 6.1.2. Monitoring surveys will be conducted in ten selected localities, representing the different agro-ecological zones, in order to gather data on population dynamics, phenology and economic impacts of fruit fly pests. Sampling program used by Mwatawala *et al.* (2006) and yield loss assessment method used by Vayssières *et al.* (2008) will be followed. Appendix 13 presents a breakdown of activities.

OBJECTIVE TWO

- 6.2.1. Repeated sampling of major commercially grown fruits in the country will be done in order to compare infestation rates and incidence between regions within the country, and between varieties of the fruits. These results should be correlated with environmental data such as temperature fluctuations, rainfall patterns, altitude, and the like. Sampling programs used by Mwatawala *et al.* (2006) and Vayssières *et al.* (2008) will be followed. This study will cover 10 locations in the different agro-ecological zones of Tanzania (Appendix 13).

- 6.2.2. Infestation rates and subsequent

economic losses and damage caused by fruit flies across the agro-ecological zones will be assessed following the methodology used by Vayssières *et al.* (2008). Study coverage will be the same as in section 6.2.1 (Appendix 13).

OBJECTIVE THREE

- 6.3.1. Evaluating developed IPM components under area-wide strategy (ISPM no. 26, Appendix 11) including field sanitation, protein bait suppression, Male Annihilation Technique (Christenson, 1963; Vayssières *et al.* (2009) and Mwatawala *et al.* (2010b), Sterile Insect Technique (SIT) and biological control. Tests will be conducted in three districts, covering at least 1000 ha.
- 6.3.2. Tests of various post-harvest treatment protocols will be conducted using the methods used by Sharp *et al.* (1989a; b) and Armstrong *et al.* (1995), based on the breakdown of activities shown in Appendix 13. Three test units will be established, one in each of the three selected fruits growing districts.
- 6.3.3. Conducting Cost–benefit analysis of control measures according to the procedures used by Verghese *et al.*, (2004) and Ha *et al.* (2010). Breakdown of activities is presented in Appendix 13.

OBJECTIVE FOUR

- 6.4.1. Establishing guidelines and package for tailor made IPM programmes, addressing specific needs for the different farming communities in the different agro-ecological zones (Appendix 13).
- 6.4.2. Designing a surveillance program for fruit flies in order to enable early detection of any new exotic fruit flies being brought into the country, as well as establishing the pest population

dynamics of established species (Appendix 13)

- 6.4.3. Advisory role in formulation of subsidiary legislation (by-laws, orders) with particular reference to fruit fly management (Appendix 13).
- 6.4.4. Provide data to facilitate registration of pest-control substances used in fruit fly management (e.g. methyl eugenol, GF120, etc.) (Appendix 13).
- 6.4.5. Designing a framework for public private partnership with regard to fruit fly management (Appendix 13).
- 6.4.6. Formulating post-harvest treatment protocols for imports and exports (Appendix 13).

OBJECTIVE FIVE

- 6.5.1. Organizing training sessions for officers conducting surveys and inspection
- 6.5.2. Supporting formal training in fruit fly related topics (Appendix 13).
- 6.5.3. A nationwide awareness campaign including mass media and publications (posters, leaflets, brochures, etc.) on various aspects of fruit flies (Appendix 13).
- 6.5.4. Strengthening of infrastructure related to fruit fly research and management (Appendix 13).
- 6.5.5. Strengthening of collaboration between the different actors and defining their respective roles with regard to fruit fly research and management nationwide and internationally (Appendix 13).

7.0. RESOURCES

Personnel, financial and material resources required to implement this management plan are outlined in Appendix 13. Total costs have been broken down for each objective and are presented in USD. The breakdown will facilitate the implementation of the management plan in case the funding is only sufficient for undertaking activities in the selected objectives.

8.0. IMPLEMENTATION PLAN

The implementation plan is presented in Appendix 14. A five year implementation plan has been devised as presented in Appendix 14. The activities under each of the five objectives largely overlap; with surveys dominating the first years (1-3) and while capacity building and infrastructure improvement will be undertaken throughout the years. Testing of IPM programs will be done from second to fourth year.

9.0. MONITORING AND EVALUATION

The logical framework is presented in Appendix 15. The management plan will be evaluated against a major goal of reducing losses due to fruit flies. Specifically, the management plan will be evaluated by considering the specific objectives, measurable outputs and means of verification (verifiable indicators) set under each category of objectives. It is anticipated that should each of the planned activity stated in this management plan be effectively and carefully implemented, the projected end results will be attained and will make significant impact on the management and containment of fruit fly problems in Tanzania.

10. OUTCOMES OF THE IMPLEMENTED PLAN

The outcomes of this management plan can be categorized into 10 main outputs:

- 10.1. Database, distribution maps and ecological data for major fruit fly pests;
- 10.2. Predictive distribution models and PRA's for major fruit fly pests;
- 10.3. Designation of pest free and low prevalence areas; pest free places of production, pest free production sites;
- 10.4. Levels of economic losses and cost/benefit trade-off due to fruit flies;
- 10.5. A list of recommended fruits and vegetables to be grown in different agro-ecological zones, with regard to fruit fly impact;
- 10.6. IPM manual, protocols and guidelines

Table 2: Relationships between the different strategies and target outputs										
STRATEGIES\OUTPUTS	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	10.1
6.1. Establishing the status of economically important fruit flies in Tanzania										
6.1.1. survey										
6.1.2. monitoring										
6.2. Assessing the economic impact of fruit flies on the horticultural industry nationwide										
6.2.1. Sampling										
6.2.2. Economic assessment										
6.3. Evaluating available mechanism for fruit fly control										
6.3.1. Testing IPM										
6.3.2. Testing post harvest										
6.3.3. Cost benefit analysis										
6.4 Formulating management program for mitigation of fruit fly problems in horticulture in Tanzania										
6.4.1. Guidelines IPM packages										
6.4.2. Early detection										
6.4.3. Subsidiary legislation										
6.4.4. Registration										
6.4.5. Public private partnership										
6.4.6. Post harvest protocol										
6.5 Re-enforcing long term awareness, capacity building and collaboration										
6.5.1. Training surveyors										
6.5.2. Formal training										
6.5.3. Awareness campaign										
6.5.4. Strengthening infrastructure										
6.5.5. Strengthening collaboration										

with regard to fruit fly management;
 10.7. Advisory document for legal aspects related to fruit fly management (e.g. registration of pest-control substances);

10.8. Networks of different stakeholders with regard to fruit fly research, training, management and related issues;

- 10.9. Trained staff and appropriate infrastructures to deal with aspects of fruit fly management;
- 10.10 Increased information availability to the general public on the impact of fruit flies in agriculture.
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APPENDICES

Appendix 1a: Tephritidae recorded from Tanzania					
S/N	Species	S/N	Species	S/N	Species
1	<i>Acidoxanthopsis advena</i>	31	<i>Ceratitis cosyra</i>	61	<i>Dacus chapini</i>
2	<i>Actinoptera lindneri</i>	32	<i>Ceratitis cuthbertsoni</i>	62	<i>Dacus chiwira</i>
3	<i>Actinoptera schnabeli</i>	33	<i>Ceratitis dumeti</i>	63	<i>Dacus ciliatus</i>
4	<i>Aehtiothemara graueri</i>	34	<i>Ceratitis edwardsi</i>	64	<i>Dacus clinophleps</i>
5	<i>Afraciura quaternaria</i>	35	<i>Ceratitis epixantha</i>	65	<i>Dacus durbanensis</i>
6	<i>Afraciura reculta</i>	36	<i>Ceratitis fasciventris</i>	66	<i>Dacus externellus</i>
7	<i>Afraciura zernyi</i>	37	<i>Ceratitis flexuosa</i>	67	<i>Dacus famona</i>
8	<i>Antoxya oxynoides</i>	38	<i>Ceratitis hamata</i>	68	<i>Dacus frontalis</i>
9	<i>Asimoneura pantomelas</i>	39	<i>Ceratitis mlimaensis</i>	69	<i>Dacus fuscatus</i>
10	<i>Bactrocera amplexa</i>	40	<i>Ceratitis paradumeti</i>	70	<i>Dacus fuscinervis</i>
11	<i>Bactrocera cucurbitae</i>	41	<i>Ceratitis pedestris</i>	71	<i>Dacus hamatus</i>
12	<i>Bactrocera invadens</i>	42	<i>Ceratitis pinax</i>	72	<i>Dacus hargreavesi</i>
13	<i>Bactrocera latifrons</i>	43	<i>Ceratitis punctata</i>	73	<i>Dacus humeralis</i>
14	<i>Bezzina margaritifera</i>	44	<i>Ceratitis punctata</i>	74	<i>Dacus hyalobasis</i>
15	<i>Bistrispinaria fortis</i>	45	<i>Ceratitis punctata</i>	75	<i>Dacus iaspideus</i>
16	<i>Bistrispinaria magniceps</i>	46	<i>Ceratitis querita</i>	76	<i>Dacus inclytus</i>
17	<i>Brachiopterna katonae</i>	47	<i>Ceratitis quinaria</i>	77	<i>Dacus inflatus</i>
18	<i>Brachytrupanea semiatrata</i>	48	<i>Ceratitis rosa</i>	78	<i>Dacus inornatus</i>
19	<i>Campiglossa anomalina</i>	49	<i>Ceratitis roubaudi</i>	79	<i>Dacus katonae</i>
20	<i>Campiglossa argentata</i>	50	<i>Ceratitis rubivora</i>	80	<i>Dacus longistylus</i>
21	<i>Campiglossa ignobilis</i>	51	<i>Ceratitis stictica</i>	81	<i>Dacus lounsburyii</i>
22	<i>Campiglossa salina</i>	52	<i>Ceratitis stipula</i>	82	<i>Dacus magnificus</i>
23	<i>Campiglossa saltoria</i>	53	<i>Chippingomyia manica</i>	83	<i>Dacus mochii</i>
24	<i>Campiglossa shiraensis</i>	54	<i>Clinotaenia superba</i>	84	<i>Dacus nairobiensis</i>
25	<i>Campiglossa siphonina</i>	55	<i>Coelopacidia apicalis</i>	85	<i>Dacus opacatus</i>
26	<i>Capitites aurea</i>	56	<i>Coelopacidia torrida</i>	86	<i>Dacus pallidilatus</i>
27	<i>Capparimymia aenigma</i>	57	<i>Coelotrypes simplex</i>	87	<i>Dacus pergulariae</i>
28	<i>Capparimymia bipustulata</i>	58	<i>Craspedoxantha vernoniae</i>	88	<i>Dacus phloginus</i>
29	<i>Capparimymia melanaspis</i>	59	<i>Craspedoxantha yaromi</i>	89	<i>Dacus plagiatus</i>
30	<i>Capparimymia mirabilis</i>	60	<i>Dacus adenionis</i>	90	<i>Dacus pseudomirificus</i>

Source: Based on Thompson (1999) and own records.

Appendix 1b: Tephritidae recorded from Tanzania					
S/N	Species	S/N	Species	S/N	Species
91	<i>Carpophthoromyia dimidiata</i>	122	<i>Dacus adustus</i>	153	<i>Dacus pulchralis</i>
92	<i>Carpophthoromyia vittata</i>	123	<i>Dacus annulatus</i>	154	<i>Dacus punctatifrons</i>
93	<i>Celidodacus coloniarum</i>	124	<i>Dacus apectus</i>	155	<i>Dacus rufoscutellatus</i>
94	<i>Ceratitis aliena</i>	125	<i>Dacus apostata</i>	156	<i>Dacus rufus</i>
95	<i>Ceratitis anonae</i>	126	<i>Dacus apoxanthus</i>	157	<i>Dacus schoutedeni</i>
96	<i>Ceratitis argenteobrunnea</i>	127	<i>Dacus aspilus</i>	158	<i>Dacus segunii</i>
97	<i>Ceratitis brachychaeta</i>	128	<i>Dacus bivittatus</i>	159	<i>Dacus siliqualactis</i>
98	<i>Ceratitis breinii</i>	129	<i>Dacus brevis</i>	160	<i>Dacus sphaeristicus</i>
99	<i>Ceratitis capitata</i>	130	<i>Dacus brevistriga</i>	161	<i>Dacus telfaireae</i>
100	<i>Ceratitis connexa</i>	131	<i>Dacus ceropegiae</i>	162	<i>Dacus triater</i>
101	<i>Dacus trigonus</i>	132	<i>Ocnerioxa pennata</i>	163	<i>Sphaeniscus sexmaculatus</i>
102	<i>Dacus umbeluzinus</i>	133	<i>Oedaspis amani</i>	164	<i>Stephanotrypeta vittata</i>
103	<i>Dacus vertebratus</i>	134	<i>Oedaspis serrata</i>	165	<i>Tarchonanthea coleoprata</i>
104	<i>Dectodesis eminens</i>	135	<i>Oedaspis trapezoidalis</i>	166	<i>Tephraziura sphenoptera</i>
105	<i>Dicheniotes distigma</i>	136	<i>Oedoncus taenipalpis</i>	167	<i>Tephritinae incertae sedis</i>
106	<i>Dicheniotes erosa</i>	137	<i>Paradesis bomolina</i>	168	<i>Tephritis afra</i>
107	<i>Dicheniotes katonae</i>	138	<i>Pediapelta aenea</i>	169	<i>Trirhithrum albomaculatum</i>
108	<i>Dioxya sororcula</i>	139	<i>Perilampsis curta</i>	170	<i>Trirhithrum coffeae</i>
109	<i>Eumictoxenus leleupi</i>	140	<i>Perilampsis pulchella</i>	171	<i>Trirhithrum demeyeri</i>
110	<i>Gymnaciura austeni</i>	141	<i>Pherothrinx bistellata</i>	172	<i>Trirhithrum divisum</i>
111	<i>Heringomyia zernyana</i>	142	<i>Pherothrinx woodi</i>	173	<i>Trirhithrum fraternum</i>
112	<i>Katonaia arushae</i>	143	<i>Platensina diaphasis</i>	174	<i>Trirhithrum homogeneous</i>
113	<i>Lethyna aequabilis</i>	144	<i>Pliomelaena brevifrons</i>	175	<i>Trirhithrum nigerrimum</i>
114	<i>lettowvorbecki (Ensina)</i>	145	<i>Rhabdochaeta advena</i>	176	<i>Trirhithrum occipitale</i>
115	<i>Metasphenisca bezziana</i>	146	<i>Rhabdochaeta lutescens</i>	177	<i>Trirhithrum quadrimaculatum</i>
116	<i>Metasphenisca micrura</i>	147	<i>Rhabdochaeta nigra</i>	178	<i>Trirhithrum senex</i>
117	<i>Metasphenisca zernyi</i>	148	<i>Rhochmopterum neuropteripenne</i>	179	<i>Trupanea aira</i>
118	<i>Notomma bioculatum</i>	149	<i>Scedella dissoluta</i>	180	<i>Trupanea sandoana</i>
119	<i>Notomma fuelleborni</i>	150	<i>Scedella glebosa</i>	181	<i>Trupanea superdecora</i>
120	<i>Ocnerioxa delineata</i>	151	<i>Scedella longiseta</i>	182	<i>Zacerata asparagi</i>
121	<i>Ocnerioxa lindneri</i>	152	<i>Scedella praetexta</i>	183	

Source: Based on Thompson (1999) and own records

Appendix 2a: Hosts of <i>C. capitata</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	(unknown name)	<i>Erythrophyllum caffrum</i>	31	Goodeniaceae	<i>Scaevola plumieri</i>
2	Anacardiaceae	<i>Harpephyllum caffrum</i>	32	Goodeniaceae	<i>Scaevola sericea</i>
3	Anacardiaceae	<i>Mangifera indica</i>	33	Liliaceae	<i>Asparagus</i> sp.
4	Annonaceae	<i>Annona reticulata</i>	34	Loganiaceae	<i>Strychnos decussata</i>
5	Annonaceae	<i>Artabotrys monteiroae</i>	35	Loganiaceae	<i>Strychnos henningsii</i>
6	Annonaceae	<i>Monodora grandidieri</i>	36	Loganiaceae	<i>Strychnos potatorum</i>
7	Apocynaceae	<i>Acokanthera</i> cf <i>oppositifolia</i>	37	Loganiaceae	<i>Strychnos</i> sp.
8	Apocynaceae	<i>Acokanthera friesiorum</i>	38	Meliaceae	<i>Ekebergia capensis</i>
9	Apocynaceae	<i>Acokanthera oppositifolia</i>	39	Moraceae	<i>Antiaris toxicaria</i>
10	Apocynaceae	<i>Acokanthera schimperi</i>	40	Myrtaceae	<i>Eugenia paniculata</i>
11	Apocynaceae	<i>Acokanthera</i> sp.	41	Myrtaceae	<i>Psidium cattleyanum</i>
12	Apocynaceae	<i>Carissa edulis</i>	42	Myrtaceae	<i>Psidium guajava</i>
13	Apocynaceae	<i>Carissa longiflora</i>	43	N/A	(Unknown)
14	Apocynaceae	<i>Carissa</i> sp.	44	Olacaceae	<i>Ximenia americana</i> var. <i>Caffra</i>
15	Apocynaceae	<i>Carissa tetramera</i>	45	Olacaceae	<i>Olea europaea cuspidata</i>
16	Berberidaceae	<i>Berberis holstii</i>	46	Olacaceae	<i>Olea woodiana</i>
17	Boraginaceae	<i>Bourreria petiolaris</i>	47	Opiliaceae	<i>Opilia amentacea</i>
18	Capparaceae	<i>Capparis sepiaria</i>	48	Opiliaceae	<i>Pentarrhopalopilium umbellulata</i>
19	Capparaceae	<i>Capparis</i> sp.	49	Passifloraceae	<i>Passiflora caerulea</i>
20	Capparaceae	<i>Maerua duchesnei</i>	50	Passifloraceae	<i>Passiflora</i> sp.
21	Cecropiaceae	<i>Myrianthus arboreus</i>	51	Rosaceae	<i>Eriobotrya japonica</i>
22	Celastraceae	<i>Elaeodendron schweinfurthianum</i>	52	Rosaceae	<i>Prunus africana</i>
23	Celastraceae	<i>Mystroxydon aethiopicum</i>	53	Rosaceae	<i>Prunus persica</i>
24	Celastraceae	<i>Salacia elegans</i>	54	Rosaceae	<i>Prunus</i> sp. cf <i>capuli</i>
25	Cucurbitaceae	<i>Coccinia microphylla</i>	55	Rubiaceae	<i>Coffea arabica</i>
26	Cucurbitaceae	<i>Corallocarpus ellipticus</i>	56	Rubiaceae	<i>Coffea canephora</i>
27	Cucurbitaceae	<i>Cucumis dipsaceus</i>	57	Rubiaceae	<i>Coffea</i> sp.
28	Ebenaceae	<i>Diospyros abyssinica</i>	58	Rubiaceae	<i>Guettarda speciosa</i>
29	Ebenaceae	<i>Euclea divinorum</i>	59	Rubiaceae	<i>Lamprothamnus zanguebaricus</i>
30	Ebenaceae	<i>Euclea racemosa schimperi</i>	60	Rubiaceae	<i>Oxyanthus zanguebaricus</i>

Source: Based on specimen database housed at RMCA

Appendix 2b: Hosts of <i>C. Capitata</i> (continues)					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
61	Euphorbiaceae	<i>Antidesma venosum</i>	80	Rubiaceae	<i>Polysphaeria parvifolia</i>
62	Euphorbiaceae	<i>Drypetes gerrardii</i>	81	Rubiaceae	<i>Vangueria</i> sp.
63	Euphorbiaceae	<i>Drypetes natalensis</i>	82	Rutaceae	<i>Atalantia</i> sp.
64	Euphorbiaceae	<i>Drypetes natalensis</i> var. <i>Leiogyna</i>	83	Rutaceae	<i>Casimiroa edulis</i>
65	Euphorbiaceae	<i>Drypetes</i> sp.	84	Rutaceae	<i>Citrus limon</i>
66	Euphorbiaceae	<i>Flueggea virosa</i>	85	Rutaceae	<i>Citrus reticulata</i>
67	Flacourtiaceae	<i>Dovyalis caffra</i>	86	Rutaceae	<i>Citrus</i> sp.
68	Rutaceae	<i>Clausena anisata</i>	87	Sapotaceae	<i>Mimusops bagshawei</i>
69	Rutaceae	<i>Murraya exotica</i>	88	Sapotaceae	<i>Mimusops caffra</i>
70	Rutaceae	<i>Triphasia</i> sp.	89	Sapotaceae	<i>Mimusops kummel</i>
71	Rutaceae	<i>Vepris nobilis</i>	90	Sapotaceae	<i>Mimusops obtusifolia</i>
72	Rutaceae	<i>Vepris simplicifolia</i>	91	Sapotaceae	<i>Sideroxylon inerme</i>
73	Salvadoraceae	<i>Azima tetracantha</i>	92	Simaroubaceae	<i>Brucea</i> sp.
74	Sapindaceae	<i>Filicium decipiens</i>	93	Simaroubaceae	<i>Harrisonia abyssinica</i>
75	Sapotaceae	<i>Argania spinosa</i>	94	Solanaceae	<i>Capsicum annum</i>
76	Sapotaceae	<i>Chrysophyllum viridifolium</i>	95	Solanaceae	<i>Capsicum</i> sp.
77	Sapotaceae	<i>Manilkara butugi</i>	96	Solanaceae	<i>Solanum seafortianum</i>
78	Sapotaceae	<i>Manilkara sansibarensis</i>	97	Solanaceae	<i>Solanum</i> sp.
79	Sapotaceae	<i>Manilkara sulcata</i>	98	Tiliaceae	<i>Grewia tembensis</i>
Source: Based on specimen database housed at RMCA					

Appendix 3: Hosts of <i>C. rosa</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	Anacardiaceae	<i>Harpephyllum caffrum</i>	28	Liliaceae	<i>Gloriosa</i> sp.
2	Anacardiaceae	<i>Mangifera indica</i>	29	Loganiaceae	<i>Strychnos</i> sp.
3	Annonaceae	<i>Annona cherimola</i>	30	Loganiaceae	<i>Strychnos spinosa</i>
4	Annonaceae	<i>Annona muricata</i>	31	Moraceae	<i>Ficus carica</i>
5	Annonaceae	<i>Annona senegalensis</i>	32	Moraceae	<i>Ficus</i> sp.
6	Annonaceae	<i>Lettowianthus stellatus</i>	33	Myrtaceae	<i>Psidium cattleyanum</i>
7	Annonaceae	<i>Monanthes fornicata</i>	34	Myrtaceae	<i>Psidium guajava</i>
8	Annonaceae	<i>Monodora grandidieri</i>	35	Myrtaceae	<i>Psidium japonicum</i>
9	Annonaceae	<i>Sphaerocoryne gracilis</i>	36	Myrtaceae	<i>Psidium</i> sp.
10	Annonaceae	<i>Uvaria acuminata</i>	37	Myrtaceae	<i>Syzygium jambos</i>
11	Annonaceae	<i>Uvaria lucida</i>	38	N/A	(Unknown)
12	Apocynaceae	<i>Carissa grandiflora</i>	39	Olacaceae	<i>Strombosiopsis</i> sp.
13	Apocynaceae	<i>Dictyophleba lucida</i>	40	Opiliaceae	<i>Opilia amentacea</i>
14	Caricaceae	<i>Carica papaya</i>	41	Rosaceae	<i>Eriobotrya japonica</i>
15	Cecropiaceae	<i>Myrianthus arboreus</i>	42	Rosaceae	<i>Prunus persica</i>
16	Celastraceae	<i>Salacia elegans</i>	43	Rubiaceae	<i>Calycosiphonia spathicalyx</i>
17	Cucurbitaceae	<i>Cucurbita</i> sp.	44	Rubiaceae	<i>Coffea arabica</i>
18	Ebenaceae	<i>Diospyros kabuyeana</i>	45	Rubiaceae	<i>Coffea</i> sp.
19	Euphorbiaceae	<i>Drypetes battiscombei</i>	46	Rubiaceae	<i>Tricalysia pallens</i>
20	Euphorbiaceae	<i>Drypetes natalensis</i> var. <i>leiogyne</i>	47	Rutaceae	<i>Toddalia asiatica</i>
21	Euphorbiaceae	<i>Drypetes natalensis</i> var. <i>natalensis</i>	48	Sapindaceae	<i>Allophylus pervillei</i>
22	Fabaceae	<i>Angylocalyx braunii</i>	49	Sapotaceae	<i>Chrysophyllum natalense</i>
23	Flacourtiaceae	<i>Ludia mauritiana</i>	50	Sapotaceae	<i>Englerophytum natalense</i>
24	Flacourtiaceae	<i>Rawsonia lucida</i>	51	Sapotaceae	<i>Pouteria usambarensis</i>
25	Lauraceae	<i>Persea americana</i>	52	Sapotaceae	<i>Synsepalum brevipes</i>
26	Sapotaceae	<i>Synsepalum subvertillatum</i>	53	Solanaceae	<i>Solanum mauritianum</i>
27	Solanaceae	<i>Solanum auriculatum</i>	54		

Source: Based on specimen database housed at RMCA

Appendix 4: Hosts of <i>C. cosyra</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	Anacardiaceae	<i>Mangifera indica</i>	17	Arecaceae	<i>Areca alicae</i>
2	Anacardiaceae	<i>Sclerocarya birrea</i>	18	Canellaceae	<i>Warburgia salutaris</i>
3	Anacardiaceae	<i>Sclerocarya</i> sp.	19	Canellaceae	<i>Warburgia</i> sp.
4	Anisophylleaceae	<i>Anisophyllea laurina</i>	20	Combretaceae	<i>Terminalia catappa</i>
5	Annonaceae	<i>Annona muricata</i>	21	Euphorbiaceae	<i>Drypetes gossweileri</i>
6	Annonaceae	<i>Annona reticulata</i>	22	Fabaceae	<i>Cordyla africana</i>
7	Annonaceae	<i>Annona senegalensis</i>	23	Flacourtiaceae	<i>Flacourtia</i> sp.
8	Annonaceae	<i>Annona</i> sp.	24	Lauraceae	<i>Persea americana</i>
9	Annonaceae	<i>Rollinia mucosa</i>	25	Myrtaceae	<i>Eugenia uniflora</i>
10	Annonaceae	<i>Rollinia</i> sp.	26	Myrtaceae	<i>Psidium guajava</i>
11	Apocynaceae	<i>Carissa carandas</i>	27	Myrtaceae	<i>Psidium</i> sp.
12	Apocynaceae	<i>Landolphia kirkii</i>	28	N/A	(Unknown)
13	Apocynaceae	<i>Landolphia</i> sp.	29	Passifloraceae	<i>Adenia lobata</i>
14	Apocynaceae	<i>Saba comorensis</i>	30	Rubiaceae	<i>Sarcocephalus exculentus</i>
15	Apocynaceae	<i>Saba senegalensis</i>	31	Rubiaceae	<i>Sarcocephalus latifolius</i>
16	Apocynaceae	<i>Tabernaemontana penduliflora</i>	32	Sapotaceae	<i>Englerophytum natalense</i>
Source: Based on specimen database housed at RMCA					

Appendix 5: Hosts of <i>D. ciliatus</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	Apocynaceae	<i>Apocynaceae</i> (unspecified)	15	Cucurbitaceae	<i>Kedrostis leloja</i>
2	Cucurbitaceae	<i>Citrullus lanatus</i>	16	Cucurbitaceae	<i>Lagenaria siceraria</i>
3	Cucurbitaceae	<i>Coccinia trilobata</i>	17	Cucurbitaceae	<i>Momordica balsamina</i>
4	Cucurbitaceae	<i>Corallocarpus ellipticus</i>	18	Cucurbitaceae	<i>Momordica charantia</i>
5	Cucurbitaceae	<i>Corallocarpus schimperi</i>	19	Cucurbitaceae	<i>Momordica rostrata</i>
6	Cucurbitaceae	<i>Cucumis africanus</i>	20	Cucurbitaceae	<i>Momordica trifoliolata</i>
7	Cucurbitaceae	<i>Cucumis dipsaceus</i>	21	Cucurbitaceae	<i>Peponium mackenii</i>
8	Cucurbitaceae	<i>Cucumis melo</i>	22	Cucurbitaceae	<i>Sechium edule</i>
9	Cucurbitaceae	<i>Cucumis sativus</i>	23	Fabaceae	<i>Phaseolus</i> sp.
10	Cucurbitaceae	<i>Cucurbita maxima</i>	24	Malvaceae	<i>Gossypium</i> sp.
11	Cucurbitaceae	<i>Cucurbita pepo</i>	25	N/A	(Unknown)
12	Cucurbitaceae	<i>Cucurbita</i> sp.	26	Passifloraceae	<i>Passiflora caerulea</i>
13	Cucurbitaceae	<i>Cucurbitaceae</i> (unspecified)	27	Solanaceae	<i>Lycopersicon esculentum</i>
14	Cucurbitaceae	<i>Kedrostis foetidissima</i>			

Source: Based on specimen database housed at RMCA

Appendix 6: Hosts of <i>B. invadens</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	Anacardiaceae	<i>Anacardium occidentale</i>	38	Cucurbitaceae	<i>Cucurbita maxima</i>
2	Anacardiaceae	<i>Mangifera indica</i>	39	Cucurbitaceae	<i>Cucurbita pepo</i>
3	Anacardiaceae	<i>Sclerocarya birrea</i>	40	Cucurbitaceae	<i>Lagenaria siceraria</i>
4	Anacardiaceae	<i>Sorindeia madagascariensis</i>	41	Cucurbitaceae	<i>Luffa</i> sp.
5	Anacardiaceae	<i>Spondias cytherea</i>	42	Cucurbitaceae	<i>Momordica charantia</i>
6	Anacardiaceae	<i>Spondias mombin</i>	43	Ebenaceae	<i>Diospyros montana</i>
7	Annonaceae	<i>Annona cherimola</i>	44	Fabaceae	<i>Acacia</i> sp.
8	Annonaceae	<i>Annona diversifolia</i>	45	Fabaceae	<i>Cordyla pinnata</i>
9	Annonaceae	<i>Annona Montana</i>	46	Fabaceae	<i>Gilbertiodendron dewevrei</i>
10	Annonaceae	<i>Annona muricata</i>	47	Irvingiaceae	<i>Irvingia gabonensis</i>
11	Annonaceae	<i>Annona reticulate</i>	48	Lauraceae	<i>Persea americana</i>
12	Annonaceae	<i>Annona senegalensis</i>	49	Liliaceae	<i>Dracaena steudneri</i>
13	Annonaceae	<i>Annona squamosa</i>	50	Loganiaceae	<i>Strychnos mellodora</i>
14	Annonaceae	<i>Exalobus monopetalus</i>	51	Moraceae	<i>Antiaris</i> sp.
15	Apocynaceae	<i>Saba senegalensis</i>	52	Moraceae	<i>Ficus</i> cf. <i>ottonifolia</i>
16	Boraginaceae	<i>Cordia</i> sp. cf <i>myxa</i>	53	Musaceae	<i>Musa acuminata</i>
17	Capparaceae	<i>Maerua duchesnei</i>	54	Musaceae	<i>Musa</i> sp.
18	Caricaceae	<i>Carica papaya</i>	55	Musaceae	<i>Musa</i> x <i>paradisiaca</i>
19	Clusiaceae	<i>Garcinia mangostana</i>	56	Myrtaceae	<i>Eugenia uniflora</i>
20	Clusiaceae	<i>Garcinia mannii</i>	57	Myrtaceae	<i>Psidium guajava</i>
21	Combretaceae	<i>Terminalia catappa</i>	58	Myrtaceae	<i>Psidium</i> sp.
22	Combretaceae	<i>Citrullus colocynthis</i>	59	Myrtaceae	<i>Syzygium jambos</i>
23	Combretaceae	<i>Citrullus lanatus</i>	60	Myrtaceae	<i>Syzygium malaccense</i>
24	Combretaceae	<i>Cucumis sativus</i>	61	N/A	(Unknown)
25	Oxalidaceae	<i>Averrhoa carambola</i>	62	Rutaceae	<i>Citrus</i> x <i>tangelo</i>
26	Rhamnaceae	<i>Ziziphus mauritiana</i>	63	Sapindaceae	<i>Blighia sapida</i>
27	Rosaceae	<i>Eriobotrya japonica</i>	64	Sapotaceae	<i>Achra sapota</i>
28	Rubiaceae	<i>Sarcocephalus latifolius</i>	65	Sapotaceae	<i>Chrysophyllum albidum</i>
29	Rutaceae	<i>Citrus aurantium</i>	66	Sapotaceae	<i>Chrysophyllum cainito</i>
30	Rutaceae	<i>Citrus grandis</i>	67	Sapotaceae	<i>Manilkara zapota</i>
31	Rutaceae	<i>Citrus limon</i>	68	Sapotaceae	<i>Richardella campechiana</i>
32	Rutaceae	<i>Citrus reticulate</i>	69	Sapotaceae	<i>Sapotaceae</i> (Unspecified)
33	Rutaceae	<i>Citrus reticulata x paradise</i>	70	Sapotaceae	<i>Vitellaria paradoxa</i>
34	Rutaceae	<i>Citrus sinensis</i>	71	Solanaceae	<i>Capsicum frutescens</i>
35	Rutaceae	<i>Citrus sinensis x reticulate</i>	72	Solanaceae	<i>Lycopersicon esculentum</i>
36	Rutaceae	<i>Citrus</i> sp.	73	Sterculiaceae	<i>Cola bruneelii</i>
37	Rutaceae	<i>Citrus x paradise</i>			

Source: Based on specimen database housed at RMCA

Appendix 7: Hosts of <i>B. cucurbitae</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	Anacardiaceae	<i>Anacardium occidentale</i>	21	Cucurbitaceae	<i>Kedrostis leloja</i>
2	Anacardiaceae	<i>Mangifera indica</i>	22	Cucurbitaceae	<i>Lagenaria leucaritha</i>
3	Annonaceae	<i>Annona senegalensis</i>	23	Cucurbitaceae	<i>Lagenaria siceraria</i>
4	Canellaceae	<i>Warburgia salutaris</i>	24	Cucurbitaceae	<i>Lagenaria sphaerica</i>
5	Clusiaceae	<i>Garcinia mangostana</i>	25	Cucurbitaceae	<i>Luffa acutangula</i>
6	Cucurbitaceae	<i>Citrullus colocynthidis</i>	26	Cucurbitaceae	<i>Luffa cylindrica</i>
7	Cucurbitaceae	<i>Citrullus lanatus</i>	27	Cucurbitaceae	<i>Luffa</i> sp.
8	Cucurbitaceae	<i>Coccinia grandis</i>	28	Cucurbitaceae	<i>Momordica charantia</i>
9	Cucurbitaceae	<i>Cucumeropsis manii</i>	29	Cucurbitaceae	<i>Momordica foetida</i>
10	Cucurbitaceae	<i>Cucumis anguria</i>	30	Cucurbitaceae	<i>Momordica trifoliolata</i>
11	Cucurbitaceae	<i>Cucumis dipsaceus</i>	31	Cucurbitaceae	<i>Sechium edule</i>
12	Cucurbitaceae	<i>Cucumis figarei</i>	32	Cucurbitaceae	<i>Telfairia occidentalis</i>
13	Cucurbitaceae	<i>Cucumis melo</i>	33	Cucurbitaceae	<i>Trichosanthes cucumerina</i>
14	Cucurbitaceae	<i>Cucumis sativus</i>	34	Myrtaceae	<i>Psidium guajava</i>
15	Cucurbitaceae	<i>Cucumis</i> sp.	35	N/A	(Unknown)
16	Cucurbitaceae	<i>Cucurbita maxima</i>	36	Oxalidaceae	<i>Averrhoa carambola</i>
17	Cucurbitaceae	<i>Cucurbita pepo</i>	37	Rutaceae	<i>Citrus reticulata</i>
18	Cucurbitaceae	<i>Cucurbita</i> sp.	38	Rutaceae	<i>Citrus sinensis</i>
19	Cucurbitaceae	<i>Cylanthra pedata</i>	39	Rutaceae	<i>Citrus</i> sp.
20	Cucurbitaceae	<i>Diplocyclos palmatus</i>	40	Solanaceae	<i>Capsicum frutescens</i>

Source: Based on specimen database housed at RMCA

Appendix 8: Hosts of <i>B. latifrons</i>					
S/N	Plant Family	Plant Latin name	S/N	Plant Family	Plant Latin name
1	Cucurbitaceae	<i>Citrullus lanatus</i>	9	Solanaceae	<i>Solanum anguivi</i>
2	Cucurbitaceae	<i>Cucumis dipsaceus</i>	10	Solanaceae	<i>Solanum incanum</i>
3	Cucurbitaceae	<i>Momordica cf trifoliata</i>	11	Solanaceae	<i>Solanum macrocarpon</i>
4	Solanaceae	<i>Capsicum annuum</i> var. <i>longum</i>	12	Solanaceae	<i>Solanum melongena</i>
5	Solanaceae	<i>Capsicum chinense</i>	13	Solanaceae	<i>Solanum nigrum</i>
6	Solanaceae	<i>Lycopersicon esculentum</i>	14	Solanaceae	<i>Solanum scabrum</i>
7	Solanaceae	<i>Lycopersicon pimpinellifolium</i>	15	Solanaceae	<i>Solanum sodomeum</i>
8	Solanaceae	<i>Solanum aethiopicum</i>			
Source: Based on records at http://www.africamuseum.be/fruitfly/AfroAsia.htm and Mziray <i>et al.</i> (2010).					

Appendix 9: Invasion history of <i>B. invadens</i>					
S/N	Year	Country	S/N	Year	Country
1	2003	Kenya	17	2006	Sierra Leone
2	2003	Nigeria	18	2006	Sudan
3	2003	Tanzania	19	2007	Congo (Brazzaville)
4	2004	Benin	20	2007	Mayotte (France)
5	2004	Cameroon	21	2007	Mozambique
6	2004	Congo (D.R.)	22	2007	Zambia
7	2004	Ethiopia	23	2008	Burundi
8	2004	Ghana	24	2008	Guinea
9	2004	Senegal	25	2008	Liberia
10	2004	Togo	26	2008	Namibia
11	2004	Uganda	27	2009	Botswana
12	2005	Comoro Is	28	2009	Burkina Faso
13	2005	Equatorial Guinea	29	2009	Gambia
14	2005	Ivory Coast	30	2009	Rwanda
15	2006	Mali	31	2010	Madagascar
16	2006	Niger			

Appendix 10: Invasion history of <i>B. cucurbitae</i>					
S/N	Year	Country	S/N	Year	Country
1	1936	Tanzania	13	2003	Ghana
2	1937	Kenya	14	2003	Senegal
3	1942	Mauritius	15	2004	Benin
4	1972	Réunion	16	2004	Niger
5	1999	Gambia	17	2004	Uganda
6	1999	Ivory Coast	18	2006	Congo (D.R.)
7	2000	Burkina Faso	19	2006	Sierra Leone
8	2000	Guinea	20	2006	Sudan
9	2000	Mali	21	2006	Togo
10	2000	Seychelles	22	2010	Burundi
11	2001	Nigeria	23	2010	Ethiopia
12	2002	Cameroon	24	2010	Malawi

Appendix 11: A brief description of the adopted International Standards for Phytosanitary Measures		
ISPM	YEAR	TITLE
ISPM No. 1	2006	Phytosanitary Principles for the Protection of Plants and the Application of Phytosanitary Measures in International Trade
ISPM No. 2	2007	Framework for Pest Risk Analysis
ISPM No. 3	2005	Guidelines for the Export, Shipment, Import and Release of Biological Control Agents and other Beneficial Organisms
ISPM No. 4	1995	Requirements for the Establishment of Pest Free Areas
ISPM No. 5	2010	Glossary of Phytosanitary Terms
ISPM No. 6	1997	Guidelines for Surveillance
ISPM No. 7	1997	Export Certification System
ISPM No. 8	1998	Determination of Pest Status in an Area
ISPM No. 9	1998	Guidelines for Pest Eradication Programmes
ISPM No. 10	1999	Requirements for the Establishment of Pest Free Places of Production and Pest Free Production Sites
ISPM No. 11	2004	Pest Risk Analysis for quarantine Pests Including Analysis of Environmental Risks and Living modified Organisms
ISPM No. 12	2001	Guidelines for Phytosanitary Certificates
ISPM No. 13	2001	Guidelines for the Notification of Non-compliance and Emergency Action
ISPM No. 14	2002	The use of Integrated Measures in a Systems Approach for Pest Risk Management
ISPM No. 15	2009	Regulation of Wood Packaging Material in International Trade
ISPM No. 16	2002	Regulated Non-quarantine Pests: Concept and Application
ISPM No. 17	2002	Pest Reporting
ISPM No. 18	2003	Guidelines for the Use of Irradiation as a Phytosanitary Measure
ISPM No. 19	2003	Guidelines on Lists of Regulated Pests
ISPM No. 20	2004	Guidelines for a Phytosanitary Import Regulatory System
ISPM No. 21	2004	Pest Risk Analysis for Regulated Non-quarantine Pests
ISPM No. 22	2005	Requirements for the Establishment of Areas of Low Pest Prevalence
ISPM No. 23	2005	Guidelines for Inspection
ISPM No. 24	2005	Guidelines for the Determination and Recognition of Equivalence of Phytosanitary Measures
ISPM No. 25	2006	Consignments in Transit
ISPM No. 26	2006	Establishment of Pest Free Areas for Fruit Flies (Tephritidae)
ISPM No. 27	2006	Diagnostic Protocols for Regulated Pests
ISPM No. 28	2009	Phytosanitary Treatments for Regulated Pests
ISPM No. 29	2007	Recognition of Pest Free Areas and Areas of Low Pest Prevalence
ISPM No. 30	2008	Establishment of Areas of Low Pest Prevalence for Fruit Flies (Tephritidae)
ISPM No. 31	2008	Methodologies for Sampling of Consignments
ISPM No. 32	2009	Categorization of Commodities according to their Pest Risk
ISPM No. 33	2010	Pest Free Potato (<i>Solanum</i> spp.) Micropropagative Material and Minutubers for International Trade
ISPM No. 34	2010	Design and Operation of Post-entry Quarantine Stations for Plants
ISPM No. 35	2012	System Approach for Pest Risk Management of Fruit flies
ISPM No. 36	2012	Integrated Measures for Plants for Planting
Source: Guide to Implementation of Phytosanitary Standards in Forestry, FAO, 2009		

Appendix 12: Policy highlights

Highlights of some important policies MDGs, Tanzania Development Vision 2025, Kilimo Kwanza, Agricultural and Livestock Development Policy (1997), Agricultural Sector Development Strategy (ASDS), Agricultural Sector Development Program (ASDP), Plant Protection Act (1997) and its regulation and Public Private Partnership Act (2010)

Agricultural Policy

Policy Issues

Inadequate capacity for pest surveillance, pest risk analysis and biosecurity measures;

- (i) Weak pest monitoring and control mechanisms;
- (ii) Limited management options for pests and diseases;
- (iii) Weakness in phytosanitary services.
- (iv) Weak coordination of research activities and poor research linkages with key stakeholders both local and international;
- (v) Inadequate involvement of the private sector and weak Public Private Partnership in agricultural research services;
- (vi) Insufficient financing for agricultural research;
- (vii) Inadequate research on development of appropriate agro-processing technologies;

Challenges

- (i) Lack of legislations enforcement mechanism
- (ii) Inadequate management at various levels
- (iii) Inadequate financial and human resources
- (iv) Inadequate terms of international trade (price of crops set by buyers)
- (v) Inadequate infrastructure

Policy statements

- (i) Pest and disease surveillance systems and control mechanisms shall be revamped and strengthened;
- (ii) The Government shall collaborate with neighbouring countries, international Organizations and other institutions dealing with plant health services in combating pests and disease outbreaks;
- (iii) Pest Free Areas shall be promoted from introduction of pests of quarantine importance; and
- (iv) The Government shall strengthen phytosanitary, quarantine and plant inspectorate services at farmers’ level.
- (v) Agricultural research system shall be reformed to enhance the participation of a wide spectrum of stakeholders in identifying and setting research priorities;
- (vi) The Government in collaboration with other stakeholders shall participate in funding and management of crop research;
- (vii) A semi autonomous institute shall be established to regulate and coordinate agricultural research agenda;
- (viii) A research outreach arm for providing technology to farmers shall be developed;
- (ix) Public Private Partnership in research activities shall be facilitated.

Agricultural Sector Development Strategy (ASDS)

Provides a basis for action by both the public and private sectors to support Tanzania’s efforts to stimulate agricultural growth and to reduce rural poverty.

MDGs

To eradicate extreme poverty and hunger, ensure environmental sustainability, and develop a global partnership for development

Tanzania Development Vision 2025

By the year 2025 Tanzania expects to have attained a high quality of life of its people through strategies which ensure the realization of among other things, food self-sufficiency and food security.

Agriculture First Resolve (Kilimo Kwanza)

To transform peasant and small farmers to commercial farmers through emphasis on productivity and tradability by mobilize the private sector to increase investments

Pillar 3

Establish a mechanism for public/private partnership in agriculture by establishing a National Agriculture and Cooperatives Commission (NACC)

Pillar 4

Identify priority areas and modalities for the production of horticultural crops by putting in place arrangements for the production of high labour intensive crops such as onions, mangoes, bananas, grapes, avocados, pineapples, tomatoes, vegetables and spices, and which require limited investment and with the potential for significant foreign exchange earnings and contribution to the national economic growth, and undertake value chain analysis with a holistic approach on the priority commodities and on the priority areas including suitable models for integrating agricultural producers and processors.

Pillar 7

Management of post-harvest losses by promoting private sector investments in cold storage facilities for perishable and other commodities; train farmers on proper storage and management of agricultural products; enhancing trade integration and management; and establish market data/information centres to facilitate farmers understanding of market developments.

Pillar 8

Institute mechanism for effective utilization of science, technology and human resource; monitor and evaluate the existing trained manpower in agriculture; support extension officers to establish demonstration farms and to provide guidance on proper farming methods to farmers; support Training of Farmers “Para Professionals” and deploy them in every ward; provide full scholarships/loans to Agricultural undergraduates; and agricultural research and training institutions to effectively utilize the Governments allocation of one percent of GDP to research and development. Establish mechanism for data warehouse and marketing information.

Pillar 9

Identify infrastructure development needs and establish adequate storage capacity at all levels e.g. cold storage, household storage, national storage for commodities and the like.

Public Private Partnership (PPPA), 2010

The objective of PPPA is to promote private sector in the provision of public services through public/private partnership projects in terms of investment capital, managerial skills and technology. In Tanzania, PPP Policy and PPP Act are already in place, what is required is the institutional framework to the process.

Appendix 13

6.1. Establishing the status of economically important fruit flies in Tanzania

6.1.1. A nationwide detection and delimiting survey

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
HUMAN RESOURCES										
Full time senior (Government employees)	4	-	4	-	4	-	4	-	4	-
Full time junior (Government employees)	10	-	10	-	10	-	10	-	10	-
Casual labor	2		2		2		2		2	
Consultants			Nil				0			
Per diems	300USD x 7 days	2,100.00	Nil		300USD x 7 days	2,100.00	Nil		300USD x 7 days	2,100.00
Allowance	250USD x 7 days	1,750.00	Nil		250USD x 7 days	1,750.00	Nil		250USD x 7 days	1,750.00
Travel	Return ticket and local travel	3,000.00	Nil		Return ticket and local travel	3,000.00	Nil		Return ticket and local travel	3,000.00
WORKING COSTS										
Mileage										
Mileage delimiting and detection surveys	16,200kms x 0.45USD/km	7,290.00	Nil		Nil	-	16,200kms x 0.45USD/km	7,290.00	Nil	-
Mileage fruits collection	400 kms x 10 Centre points x 0.45USD/km	1,800.00	Nil		Nil	-	400 kms x 10 Centre points x 0.45USD/km	1,800.00	Nil	-
Mileage training sessions	11,800kms x 0.45USD/km	5,310.00	11,800kms x 0.45USD/km	5,310.00	11,800kms x 0.45USD/km	5,310.00	Nil		Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Per diems										
Delimiting/ Detection surveys	6 personnels x 12 days per route x 5 routes x Per diem	18,701.30	Nil	-	Nil	-	6 personnels x 12 days per route x 5 routes x Per diem	18,701.30	Nil	-
Trainees per diems	2 participants x 3 Districts/Region x 25 Regions x 4.5 days x Per diem	35,064.94	Nil	-	Nil	-	Nil	-	Nil	-
Trainers per diems	3 trainers x 6 Centres x 6.5 days x Per diem	6,077.92	Nil	-	Nil	-	Nil	-	Nil	-
Travel										
Return fare for trainees	36 trainees/ Centre x 6 zones x 30,000Tshs return ticket/person	4,207.79	Nil	-	Nil	-	Nil	-	Nil	-
Field allowances (fruits collection)	14 days x 3 seasons x 10 Centre points x 32,500Tshs/ day	2,532.47	14 days x 3 seasons x 10 Centre points x 32,500Tshs/ day	2,532.47	14 days x 3 seasons x 10 Centre points x 32,500Tshs/ day	2,532.47	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
fuel										
Fuel delimiting surveys	16,200Kms x 1/6L x Fuel price	4,032.47	Nil	-	Nil	-	2700Liters	4050.00	Nil	-
Training sessions	11,800Kms x 1/6L x Fuel price	2,937.23	Nil	-	Nil	-	Nil	-	Nil	-
Fuel fruits collection	400 kms/ Centre x 10 Centres x 1/6L x Fuel price	995.67	400 kms/ Centre x 10 Centres x 1/6L x Fuel price	995.67	400 kms/ Centre x 10 Centres x 1/6L x Fuel price	995.67				
Training sessions (venue, projector)	Conference hire charge/day x 3 days x 7 zones	2,727.27	Nil	-	Nil	-	Nil	-	Nil	-
MATERIALS										
Traps (Tephri traps/ McPhail traps)	5 traps/location x 100 Locations x 20USD/trap	10,000.00	Nil	-	Nil	-	5 traps/location x 100 Locations x 20USD/trap	10,000.00	Nil	-
Attractants (lures and batts)	Assorted	6,000.00	Nil	-	Nil	-	5 attractants/tree x 100 locations	6,000.00	Nil	-
Stationeries (papers, pens, pencils, files, cartridges)	Assorted	162.34	Assorted	-	Assorted	162.34	Assorted	162.34	Assorted	162.34
rearing containers	4000 containers x 2500Tshs/ container	6,493.51	1000 containers	-	1000 containers	6,493.51	1000 containers	6,493.51	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Rearing cages	10 Cages x 10 stations x 250,000TShs/cage	16,233.77	Nil	-	Nil	-	Nil	-	Nil	-
Consummables (alcohol, gloves, pins, scissors, bags)	Assorted	2,597.40	Assorted	-	Assorted	-	Assorted	2,597.40	Nil	-
rearing buckets	100 buckets/stations 10 stations x 6000Tshs/ bucket	3,896.10	100 buckets/ stations 10 stations x 6000Tshs/ bucket	-	100 buckets/ stations 10 stations x 6000Tshs/ bucket	3,896.10	100 buckets/ stations 10 stations x 6000Tshs/ bucket	3,896.10	Nil	-
EQUIPMENT										
PCs	10 x 1600USD/ per PC	16,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Printers	10 x 500USD/printer	8,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Weighing balances	10 x 150USD/ weighing balance	1,500.00	Nil	-	Nil	-	Nil	-	Nil	-
Sub-Total for activity		169410.17		8,838.14		26,240.09		60,990.65		7,012.34
6.1.2. Monitoring surveys in selected localities, representing the different agro-ecological zones, in order to gather data on population dynamics, phenology and economic status of fruit fly pests.										
HUMAN RESOURCES										
Full time senior	1 senior personnel x 10 stations	N/A	10	-	10	-	10	-	10	-
Full time junior	5 personnel/ station (including driver) x 10 stations	N/A	30	-	30	-	30	-	30	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
WORKING COSTS										
Mileage										
Mileage monitoring surveys	120 kilometers/ trip x 2 trips/ month x 12 months x 0.45USD	1,296.00	120 kilometers/ trip x 2 trips/ month x 12 months x 0.45USD	1,296.00	120 kilometers/ trip x 2 trips/ month x 12 months x 0.45USD	1,296.00	Nil	-	Nil	-
Per diems										
Per diems monitoring surveys	6 personnel/ station x 10 stations x 2 trips/ month x 12 months x Per diem	78,805.19	6 personnel/ station x 10 stations x 2 trips/ month x 12 months x Per diem	78,805.19	6 personnel/ station x 10 stations x 2 trips/ month x 12 months x Per diem	78,805.19	Nil	-	Nil	-
6.1.2. Monitoring surveys in selected localities, representing the different agro-ecological zones, in order to gather data on population dynamics, phenology and economic status of fruit fly pests.										
Fuel										
Monitoring surveys	120kms x 2 trips x 12months x 1/6L x Fuel Price	716.88	120kms x 2 trips x 12months x 1/6L x Fuel Price	716.88	120kms x 2 trips x 12months x 1/6L x Fuel Price	716.88	Nil	-	Nil	-
MATERIALS										
Traps (Tephri traps/ McPhail traps)	50 traps x 20USD/trap	1,000.00	50 traps x 20USD/trap	1,000.00	50 traps x 20USD/trap	1,000.00	Nil	-	Nil	-

Appendices

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Lures (methyl eugenol, trimedlure, cue lure, Terpinyl acetate, ego lure, protein bait	Assorted	1,000.00	Assorted	1,000.00	Assorted	1,000.00	Nil	-	Nil	-
Stationeries (papers, pens, pencils, files, cartridges)	Assorted	779.22	Assorted	779.22	Assorted	779.22	Assorted	1,500.00	Assorted	1,500.00
Consummables (alcohol, gloves, pins, scissors, bags)	Assorted	1,168.83	Assorted	1,168.83	Assorted	1,168.83	Assorted	2,500.00	Assorted	2,500.00
Sub-Total for activity		80,766.13		80,766.13		80,766.13		4,000.00		4,000.00
Total for target		250,176.30		89,604.27		107,006.22		64,990.65		11,012.34

6.2. Assessing the economic impact of fruit flies on the horticultural industry nationwide

6.2.1 Repeated sampling of the major commercially grown fruits in the country

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
HUMAN RESOURCES										
Full time senior	1 senior staff/ station x 10 stations	-	1 senior staff/ station x 10 stations	-	1 senior staff/ station x 10 stations	-	1 senior staff/ station x 10 stations	-	1 senior staff/ station x 10 stations	-
Full time junior	2 junior staff/ station x 10 stations	-	2 junior staff/ station x 10 stations	-	2 junior staff/ station x 10 stations	-	2 junior staff/ station x 10 stations	-	2 junior staff/ station x 10 stations	-
Casual labour	4 casual labours/ station x 10 stations	-	4 casual labours/ station x 10 stations	-	4 casual labours/ station x 10 stations	-	4 casual labours/ station x 10 stations	-	4 casual labours/ station x 10 stations	-
WORKING COSTS										
Mileage										
Mileage fruit collection	120 kilometers/ trip x 14 trips / season x 2 seasons x 10 locations x 0.45	15,120.00	120 kilometers/ trip x 14 trips / season x 2 seasons x 10 locations x 0.45	15,120.00	120 kilometers/ trip x 14 trips / season x 2 seasons x 10 locations x 0.45	15,120.00	Nil	15,120.00	Nil	-
per diem										
Per diems fruit collection	5 persons x 10 zones x 14 days/season x 2 seasons x Per diem	72,727.27	5 persons x 10 zones x 14 days/season x 2 seasons x Per diem	72,727.27	5 persons x 10 zones x 14 days/season x 2 seasons x Per diem	72,727.27	Nil	72,727.27	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Fuel										
Sampling	120kms/ trip x 14 trips/ season x 2 seasons x 10 Locations x 1/6L x Fuel price	8,363.38	120kms/ trip x 14 trips/ season x 2 seasons x 10 Locations x 1/6L x Fuel price	8,363.38	120kms/ trip x 14 trips/ season x 2 seasons x 10 Locations x 1/6L x Fuel price	8,363.38	Nil	-	Nil	-
Stationeries (papers, pens, pencils, files, cartridges)	Assorted	1,623.38	Assorted	1,638.38	Assorted	1,623.38	Assorted	1,623.38	Assorted	1,623.38
MATERIALS										
Rearing containers	4000 containers x 2,500TShs/ container	649.35	1500 containers x 2,500TShs/ container	2,435.06	1000 containers x 2,500TShs/ container/	649.35	Nil	-	Nil	-
Consummables (alcohol, gloves, pins, scissors, bags)	Assorted	2,597.40	Assorted	2,500.00	Assorted	2,500.00	Nil	-	Nil	-
Sub-Total for activity		101,081.04		102,769.35		100,963.64		1,623.38		1,623.38
6.2.2. Economic loss assessment, across the agro-ecological zones										
HUMAN RESOURCES										
Full time senior	1	N/A	1	N/A	1	N/A	1	N/A	1	N/A
Full time junior	2	N/A	2	N/A	2	N/A	2	N/A	2	N/A
Consultants										
Per diems	300USD x 7 days	2,100.00	Nil	-	Nil	-	300USD x 7 days	2,100.00	300USD x 7 days	2,100.00

Appendices

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Allowance	250USD x 7 days	1,750.00	Nil	-	Nil	-	250USD x 7 days	1,750.00	250USD x 7 days	1,750.00
Travel	Return ticket and local travel	3,000.00	Nil	-	Nil	-	Return ticket and local travel	3,000.00	Return ticket and local travel	3,000.00
Stationeries (papers, pens, pencils, files, cartridges)	Assorted	1,038.96	Assorted	1,038.96	Assorted	1,038.96	Assorted	1,038.96	Assorted	1,038.96
Sub-Total for activity		7,888.96		1,038.96		1,038.96		7,891.96		7,891.96
Total for target		108,970.00		103,808.31		102,022.60		9,515.34		9,515.34

6.3 Evaluating available mechanism for fruit fly control

6.3.1 Testing of developed IPM components under area-wide strategy

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
HUMAN RESOURCES										
Full time senior	1 senior x 3 locations	-	1 senior x 3 locations	-	1 senior x 3 locations	-	1 senior x 3 locations	-	1 senior x 3 locations	-
Full time junior	2 junior x 10 farms x 3 locations	-	2 junior x 10 farms x 3 locations	-	2 junior x 10 farms x 3 locations	-	2 junior x 10 farms x 3 locations	-	2 junior x 10 farms x 3 locations	-
Casual labor	3 casual labours x 10 farms x 3 locations	-	3 casual labours x 10 farms x 3 locations	-	3 casual labours x 10 farms x 3 locations	-	3 casual labours x 10 farms x 3 locations	-	3 casual labours x 10 farms x 3 locations	-
Consultants										
Per diems	300USD x 7 days	2,100.00	Nil	-	300USD x 7 days	2,100.00	Nil	-	300USD x 7 days	2,100.00
Allowance	250USD x 7 days	1,750.00	Nil	-	250USD x 7 days	1,750.00	Nil	-	250USD x 7 days	1,750.00
Travel	Return ticket and local travel	3,000.00	Nil	-	Return ticket and local travel	3,000.00	Nil	-	Return ticket and local travel	3,000.00

Appendices

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
WORKING COSTS										
Mileage										
Mileage surveys	4,100 kms x 0.45USD	1,845.00	Nil	-	Nil	-	Nil	-	Nil	-
Mileage: Field visits	12,600 kms x 0.45USD	5,670.00	12,600 kms x 0.45USD	5,670.00	12,600 kms x 0.45USD	5,670.00	12,600 kms x 0.45USD	5,670.00	12,600 kms x 0.45USD	5,670.00
Mileage local supervision	4,320 kms x 0.45USD	19,440.00	4,320 kms x 0.45USD	19,440.00	4,320 kms x 0.45USD	19,440.00	4,320 kms x 0.45USD	19,440.00	4,320 kms x 0.45USD	19,440
Mileage meeting	500 kms x 2 meetings x 0.45USD	450.00	500 kms x 2 meetings x 0.45USD	450.00	500 kms x 2 meetings x 0.45USD	450.00	500 kms x 2 meetings x 0.45USD	450.00	500 kms x 2 meetings x 0.45USD	450.00
Per diems										
Per diems surveys	4 persons x 7 days x 3 location x Per diem	4,363.00	Nil	-	Nil	-	Nil	-	Nil	-
Per diem field visits	4 staff x 4.5 days x 3 per season x Per diem	2,805.19	4 staff x 4.5 days x 3 per season x Per diem	2,805.19	4 staff x 4.5 days x 3 per season x Per diem	2,805.19	4 staff x 4.5 days x 3 per season x Per diem	2,805.19	4 staff x 4.5 days x 3 per season x Per diem	2,805.19

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Per diems local supervision	2 staff x 2 days/month x 3 months x Per diem + 2 staff x 2 days/month x 3 months (Muheza 2nd season)	2,805.19	2 staff x 2 days/month x 3 months x Per diem + 2 staff x 2 days/month x 3 months (Muheza 2nd season)	2,805.19	2 staff x 2 days/month x 3 months x Per diem + 2 staff x 3 months (Muheza 2nd season)	2,805.19	2 staff x 2 days/month x 3 months x Per diem + 2 staff x 2 days/month x 3 months (Muheza 2nd season)	2,805.19	2 staff x 2 days/month x 3 months x Per diem + 2 staff x 2 days/month x 3 months (Muheza 2nd season)	2,805.19
Per diems meetings	25 persons x 4.5days/ meeting x 2 meetings x Per diem	11,688.31	25 persons x 4.5days/ meeting x 2 meetings x Per diem	11,688.31	25 persons x 4.5days/ meeting x 2 meetings x Per diem	11,688.31	25 persons x 4.5days/ meeting x 2 meetings x Per diem	11,688.31	25 persons x 4.5days/ meeting x 2 meetings x Per diem	11,688.31
Fuel										
Fuel surveys	4,100 kms x 1/6L x Price	1,020.56	Nil	-	Nil	-	Nil	-	Nil	-
Fuel field visits	12,600 kms x 1/6L x Price	3,136.36	12,600 kms x 1/6L x Price	3,136.36	12,600 kms x 1/6L x Price	3,136.36	12,600 kms x 1/6L x Price	3,136.36	12,600 kms x 1/6L x Price	3,136.36
Fuel local supervision	4,320 kms x 1/6L x Price	720.00	4,320 kms x 1/6L x Price	720.00	4,320 kms x 1/6L x Price	720.00	4,320 kms x 1/6L x Price	720.00	4,320 kms x 1/6L x Price	720.00
Fuel meetings	500 kms x 1/6L x Price	124.46	500 kms x 1/6L x Price	124.46	500 kms x 1/6L x Price	124.46	500 kms x 1/6L x Price	124.46	500 kms x 1/6L x Price	124.46
Meetings	Venue hire charge/day x 3 days x 2 occasions/ year	779.22	Venue hire charge/day x 3 days x 2 occasions/ year	779.22	Venue hire charge/day x 3 days x 2 occasions/ year	779.22	Venue hire charge/day x 3 days x 2 occasions/ year	779.22	Venue hire charge/day x 3 days x 2 occasions/ year	779.22

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Community facilitation	Various	3,000.00	Various	3,000.00	Various	3,000.00	Various	3,000.00	Various	3,000.00
MATERIAL										
Mazoferm	500L (get a figure from AMAGRO)	3,000.00	500 L	2,564.10	250 L	1,282.05	Nil	-	Nil	-
Nulure	500 L	2,500.00			250 L	1,602.56	Nil	-	Nil	-
Male lures	Assorted	4,000.00	Assorted	4,000.00	Assorted	4,000.00	Assorted	4,000.00	Assorted	4,000.00
Amdro ant bait	100kg	2,500.00	Nil	-	100 kg	3,205.13	Nil	-	Nil	-
Ethyl alcohol	100L x 25,000Tshs/L	33,783.78	Nil	-	Nil	-	100L x 25,000Tshs/L	33,783.78	Nil	-
Methyl eugenol	100 L	4,500.00	Nil	-	Nil	-	Methyl eugenol	4,500.00	Nil	-
Insecticides	Assorted	1,500.00	Nil	-	Assorted	1,500.00	Nil	-	Nil	-
Spinosad	100L	10,000.00	Nil	-	100L	10,000.00	Nil	-	Nil	-
Assorted traps	2000	40,000.00	Nil	-	2000	40,000.00	Nil	-	Nil	-
Rearing containers and associated glassware	1000 containers x 2500TShs/container	33,873.78	Nil	-	1000 containers x 2500TShs/container	33,873.78	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Rearing cages	12 cages x 250,000TShs/cage	1,948.05	Nil	-	Nil	-	Nil	-	Nil	-
Muslin and mesh/netting materials	250m	3,896.10	Nil	-	Nil	-	Nil	-	Nil	-
PC laptops	2 x 1,600USD	3,200.00	Nil	-	Nil	-	Nil	-	Nil	-
Printer	2 x 500USD/printer	1,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Stereo microscope	2 x 2000USD/microscope	4,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Digital camera	2 x 800USD	1,600.00	Nil	-	Nil	-	Nil	-	Nil	-
Vials Assorted	Assorted	3,200.00	Nil	-	Nil	-	Nil	-	Nil	-
Knapsack sprayers	4 Motorised knapsack sprayers x 3 station x 500,000Tshs/sprayer	1,025.64	Nil	-	Nil	-	Nil	-	Nil	-
Protective gear	5 Kits x 300,000Tshs/Kit	961.54	Nil	-	Nil	-	5 Kits x 300,000Tshs/Kit	961.54	Nil	-
Lab Coats	20 Pairs x 30,000TShs/per pair	320.51	Nil	-	Nil	-	20 Pairs x 30,000TShs/per pair	320.51	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Dissecting kits	10 Units x 50,000Tshs/unit	320.51	Nil	-	Nil	-	10 Units x 50,000Tshs/unit	320.51	Nil	-
Gumboots	60 Pairs x 20,000Tshs/pair	779.22	Nil	-	Nil	-	60 Pairs x 20,000Tshs/pair	779.22	Nil	-
Stationaries	Assorted	649.35	Assorted	649.35	Assorted	649.35	Assorted	649.35	Assorted	649.35
Sub-Total for activity		223,166.44		57,832.20		153,491.61		80,790.81		63,239.89

6.3.2. Testing various post harvest treatment protocols

(a) Hot water treatment pilot plants:

Purchase of unit and shipment	Purchasing 2 units	-	Purchasing 2 units	20,000.00	Nil	-	Nil	-	Nil	-
Installation charges	Expert to install plants for 2 weeks	-	Purchasing 2 units	3,500.00	Nil	-	Nil	-	Nil	-
Casual labour charges	Various	-	Various	649.35	Nil	-	Nil	-	Nil	-

(b) Cold temperature treatment pilot units-

Purchase of unit and shipment	Purchasing 2 units	-	Purchasing 2 units	15,000.00	Nil	-	Nil	-	Nil	-
Installation costs	Expert to install plants for 2 weeks	-	Expert to install plants for 2 weeks	3,500.00	Nil	-	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Casual labour charges	Various	-	Various	649.35	Nil	-	Nil	-	Nil	-
(c) Maintenance and running costs										
Maintenance costs per month x 12 months	Various	-	Various	649.35	Various	649.35	Various	649.35	Various	649.35
(d) Training stakeholders										
Training operators										
Trainers costs										
Per diems	6 person x 14 days x Per diem	-	6 person x 14 days x Per diem	4,363.64	Nil	-	Nil	-	Nil	-
Return fare	80,000Tshs/ person x 6 persons	-	80,000Tshs/ person x 6 persons	311.69	Nil	-	Nil	-	Nil	-
Fuel	Fuel for field visits	-	Fuel for field visits	129.87	Nil	-	Nil	-	Nil	-
Venue hire	200,000Tshs/ day x 14 days	-	200,000Tshs/ day x 14 days	1,818.18	Nil	-	Nil	-	Nil	-
Training focus groups										
Per diems	10 person x 14 days x Per diem	-	10 person x 14 days x Per diem	7,272.73	Nil	-	Nil	-	Nil	-
Return fare	10 persons x 80,000Tshs/ person	-	10 persons x 80,000Tshs/ person	519.48	Nil	-	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Fuel	Fuel for field visits	-	Fuel for field visits	129.87	Nil	-	Nil	-	Nil	-
Venue hire	200,000Tshs/ day x 14 days	-	200,000Tshs/ day x 14 days	1,818.18	Nil	-	Nil	-	Nil	-
Training exporters										
Per diems	15 person x 80,000Tshs x 7 days	-	15 person x 80,000Tshs x 7 days	779.22	Nil	-	Nil	-	Nil	-
Return fare	80,000Tshs/ person x 7 persons	-	80,000Tshs/ person x 7 persons	363.64	Nil	-	Nil	-	Nil	-
Fuel	Fuel for field visits	-	Fuel for field visits	129.87	Nil	-	Nil	-	Nil	-
Venue hire	200,000Tshs/ day x 7 days	-	200,000Tshs/ day x 7 days	909.09	Nil	-	Nil	-	Nil	-
Sub-Total for activity				62,463.51		649.35		649.35		649.35
6.3.3. Cost benefit analysis of control measures (ALL ACTIVITIES POOLED)										
Msc students										
Fees and stipend	5,520,000Tshs x 2 students	-	5,520,000Tshs x 2 students	3,584.42	Nil	-	Nil	-	Nil	-
Research work	Only course work in the first year	-	Only course work in the first year	2,922.08	Nil	-	Nil	-	Nil	-
Sub-Total for activity				6,506.49		-		-		-
Total for target		223,166.44		126,832.20		154,140.97		81,440.16		63,889.24

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
6.4 Formulating management program for mitigation of fruit fly problems in horticulture in Tanzania										
6.4.1. Establish guidelines and package for tailor made IPM programmes										
(i) Prepare IPM guidelines for community based fruit tree IPM- leaflets/pamphlets/posters/videos etc	Various	-	Nil	-	Various	6,000.00	Nil	-	Nil	-
(ii) Prepare guidelines for various horticultural crops eg cucurbits	Nil	-	Nil	-	Various	3,000.00	Various	-	Nil	-
(iii) Prepare Guidelines for- AW- IPM	Nil	-	Nil	-	various	3,205.13	Various	-	Nil	-
(iv) Prepare guidelines for fruit post harvest heat treatments etc	Nil	-	Nil	-	Various	1,923.08	Various	-	Nil	-
(v) Prepare guidelines for early harvesting procedure in relation to produce	Nil	-	Nil	-	Various	1,923.08	Various	-	Nil	-
Sub-Total for activity						16,051.28				
6.4.2. Design a surveillance program for fruit flies										
Materials			Nil	-	Various	-	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Attractants	6 lure types x 6 plugs/each lure x 12 months x 36 stations x 2USD/ plug x Exchange rate	31,104.00	6 lure types x 6 plugs/each lure x 12 months x 36 stations x 2USD/ plug x Exchange rate	31,104.00	6 lure types x 6 plugs/each lure x 12 months x 36 stations x 2USD/ plug x Exchange rate	31,104.00	6 lure types x 6 plugs/each lure x 12 months x 36 stations x 2USD/ plug x Exchange rate	31,104.00	6 lure types x 6 plugs/each lure x 12 months x 36 stations x 2USD/ plug x Exchange rate	31,104
Traps	6 traps x 36 stations x 20USD/ trap x Exchange rate	4,320.00	6 traps x 36 stations x 20USD/ trap x Exchange rate	4,320.00	6 traps x 36 stations x 20USD/ trap x Exchange rate	4,320.00	6 traps x 36 stations x 20USD/ trap x Exchange rate	4,320.00	6 traps x 36 stations x 20USD/ trap x Exchange rate	4,320.00
Gloves	2 boxes gloves x 36 stations x 7500Tshs/box	350.65	2 boxes gloves x 36 stations x 7500Tshs/box	350.65	2 boxes gloves x 36 stations x 7500Tshs/box	350.65	2 boxes gloves x 36 stations x 7500Tshs/box	350.65	2 boxes gloves x 36 stations x 7500Tshs/box	350.65
Ethanol	2 Liters alcohol x 36 stations x 25,000Tshs/Liter	1,168.83	2 Liters alcohol x 36 stations x 25,000Tshs/Liter	1,168.83	2 L alcohol x 36 stations x 25,000Tshs/ Liter	1,168.83	2 Liters alcohol x 36 stations x 25,000Tshs/ Liter	1,168.83	2 Liters alcohol x 36 stations x 25,000Tshs/ Liter	1,168.83
Vials	2 vials per lure x 6 lures x 36 locations x 12 months x 2USD/ vial x Exchange rate	15,484.68	2 vials per lure x 6 lures x 36 locations x 12 months x 2USD/ vial x Exchange rate	15,484.68	2 vials per lure x 6 lures x 36 locations x 12 months x 2USD/ vial x Exchange rate	15,484.68	2 vials per lure x 6 lures x 36 locations x 12 months x 2USD/ vial x Exchange rate	15,484.68	2 vials per lure x 6 lures x 36 locations x 12 months x 2USD/ vial x Exchange rate	15,484.68

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Stationaries	Assorted	9,350.65	Assorted	9,350.65	Assorted	9,350.65	Assorted	9,350.65	Assorted	9,350.65
Allowances	Field allowance x 2 personnel x 36 stations x 12 months	18,233.77	Field allowance x 2 personnel x 36 stations x 12 months	18,233.77	Field allowance x 2 personnel x 36 stations x 12 months	18,233.77	Field allowance x 2 personnel x 36 stations x 12 months	18,233.77	Field allowance x 2 personnel x 36 stations x 12 months	18,233.77
Fuel	Fuel for motorbike x 10 Liters x 36 stations x 12 months x Fuel price	6,451.95	Fuel for motorbike x 10 Liters x 36 stations x 12 months x Fuel price	6,451.95	Fuel for motorbike x 10 Liters x 36 stations x 12 months x Fuel price	6,451.95	Fuel for motorbike x 10 Liters x 36 stations x 12 months x Fuel price	6,451.95	Fuel for motorbike x 10 Liters x 36 stations x 12 months x Fuel price	6,451.95
Dissecting kits	Dissecting kits x 36 stations x 50,000Tshs/Kit	1,168.83	Nil	-	Nil	-	Nil	-	Dissecting kits x 36 stations x 50,000Tshs/Kit	1,168.83
Shipment	Shipment (including packaging)	3,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Laboratory costs (Taxonomic centres SUA, MARI)										
Allowances lab assistants	Lab allowances x 2 days x 2 laboratory assistants x 12 months	623.38	Lab allowances x 2 days x 2 laboratory assistants x 12 months	623.38	Lab allowances x 2 days x 2 laboratory assistants x 12 months	623.38	Lab allowances x 2 days x 2 laboratory assistants x 12 months	623.38	Lab allowances x 2 days x 2 laboratory assistants x 12 months	623.38

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Identification costs	Expert costs x 2 days x 2 experts x 12 months x 100,000Tshs/day	3,116.88	Expert costs x 2 days x 2 experts x 12 months x 100,000Tshs/day	3,116.88	Expert costs x 2 days x 2 experts x 12 months x 100,000Tshs/day	3,116.88	Expert costs x 2 days x 2 experts x 12 months x 100,000Tshs/day	3,116.88	Expert costs x 2 days x 2 experts x 12 months x 100,000Tshs/day	3,166.88
Consultants										
Per diems	300USD x 7 days	2,100.00	300USD x 7 days	2,100.00	300USD x 7 days	2,100.00	300USD x 7 days	2,100.00	300USD x 7 days	2,100.00
Allowance	250USD x 7 days	1,750.00	Nil	-	250USD x 7 days	1,750.00	250USD x 7 days	1,750.00	250USD x 7 days	1,750.00
Travel	Return ticket and local travel	3,000.00	Nil	-	Return ticket and local travel	3,000.00	Nil	-	Return ticket and local travel	3,000.00
Equipment										
Cupboards	Cupboards for voucher specimen x 2 stations	3,896.10	Nil	-	Nil	-	Nil	-	Nil	-
Microscope	1 Microscopes x 2 stations X 2000USD/microscope	4,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Communication	2 stations x 500,000Tshs/station	649.35	2 stations x 500,000Tshs/station	649.35	2 stations x 500,000Tshs/station	649.35	2 stations x 500,000Tshs/station	649.35	2 stations x 500,000Tshs/station	649.35

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Sub-Total for activity				90,854.13		129,806.69		90,854.13		98,872.96
6.4.3. Advisory role in formulation of subsidiary legislation										
(i) Identify possible fruit fly control legislation areas										
Transport	25 person x 80,000 Return fare	-	25 person x 80,000 Return fare	1,298.70	Nil	-	Nil	-	Nil	-
Per diems	25 person x 80,000Tshs/person x 2 days	-	25 person x 80,000Tshs/person x 2 days	2,597.40	Nil	-	Nil	-	Nil	-
Venue hire	2 days x Conference hire	-	2 days x Conference hire	259.74	Nil	-	Nil	-	Nil	-
Stationaries	Assorted	-	Assorted	259.74	Nil	-	Nil	-	Nil	-
Driks	100,000Tshs/day x 2 days	-	100,000Tshs/day x 2 days	129.87	Nil	-	Nil	-	Nil	-
(ii) Assist local government in possible areas of fruit fly control legislation										
Production of DVDs and CDs	5 Master copies x 300,000Tshs/copy	-	5 Master copies x 300,000Tshs/copy	974.03	Nil	-	Nil	-	Nil	-
Production of posters	100,000 posters x 1000Tshs/poster	-	100,000 posters x 1000Tshs/poster	6,493.51	Nil	-	Nil	-	Nil	-
Sub-Total for activity				12,012.99	Nil	-	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Establish a database of fruit flies control substances										
Transport	20 person 80,000Tshs/ person x 2 days	-	Nil	-	Nil	-	20 person 80,000Tshs/ person x 2 days	2,077.92	Nil	-
Per diems	20 person x 80,000Tshs/ person x 2 days	-	Nil	-	Nil	-	20 person x 80,000Tshs/ person x 2 days	2,077.92	Nil	-
Venue hire	2 days x Conference hire	-	Nil	-	Nil	-	2 days x Conference hire	259.74	Nil	-
Stationeries	Assorted	-	Nil	-	Nil	-	Assorted	259.74	Nil	-
Drinks	100,000Tshs x 2 days	-	Nil	-	Nil	-	100,000Tshs x 2 days	129.87	Nil	-
Communication	Various	-	Nil	-	Nil	-	Various	129.87	Nil	-
Facilitators allowance (including transport and per diems)	3 facilitators x 500,000Tshs/day x s2 days	-	Nil	-	Nil	-	3 facilitators x 500,000Tshs/ day x s2 days	1948.05	Nil	-
Sub-Total for activity		-		-		-				-

6.4.5. Design a framework for public private partnership (ALL ACTIVITIES POOLED)										
	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Transport	25 person 80,000Tshs/ person x 2 days	2,597.40	Nil	-	Nil	-	Nil	-	Nil	-
Per diems	25 person x 80,000Tshs/person x 2 days	2,597.40	Nil	-	Nil	-	Nil	-	Nil	-
Venue hire	2 days x Conference hire	259.74	Nil	-	Nil	-	Nil	-	Nil	-
Stationeris	Assorted	259.74	Nil	-	Nil	-	Nil	-	Nil	-
Drinks	100,000Tshs/day x 2 days	129.87	Nil	-	Nil	-	Nil	-	Nil	-
Communication	Various	129.87	Nil	-	Nil	-	Nil	-	Nil	-
Facilitators allowance (including transport and per diems)	3 facilitators x 500,000Tshs/day x s2 days	1948.05	Nil	-	Nil	-	Nil	-	Nil	-
Sub-Total for activity		7,922.08		-		-		-		-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
6.4.6. Formulate post-harvest treatment protocols for import and export (ALL ACTIVITIES POOLED)										
Consultancy										
Transport	25 person 80,000Tshs/ person x 2 days	-	Nil	-	Nil	-	25 person 80,000Tshs/ person x 2 days	2,597.40	Nil	-
Per diems	25 person x 80,000Tshs/person x 2 days	-	Nil	-	Nil	-	25 person x 80,000Tshs/ person x 2 days	2,597.40	Nil	-
Venue hire	2 days x Conference hire	-	Nil	-	Nil	-	2 days x Conference hire	259.74	Nil	-
Stationeris	Assorted	-	Nil	-	Nil	-	Assorted	259.74	Nil	-
Drinks	100,000Tshs/day x 2 days	-	Nil	-	Nil	-	100,000Tshs/ day x 2 days	129.87	Nil	-
Communication	Various	-	Nil	-	Nil	-	Various	129.87	Nil	-
Facilitators allowance	3 facilitators x 500,000Tshs/day x s2 days	-	Nil	-	Nil	-	3 facilitators x 500,000Tshs/ day x s2 days	1948.05	Nil	-
Sub-Total for activity								7,922.08	Nil	-
Total for target		117,691.14		102,867.12		145,857.98		98,776.21		98,872.96

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
6.5 . Re-enforcing long term awareness, capacity building and collaboration										
6.5.1. Organize training sessions for officers conducting surveys and inspection										
HUMAN RESOURCES										
Full time senior	2	-	2	-	Nil	-	Nil	-	Nil	-
Full time junior	Nil	-	Nil	-	Nil	-	Nil	-	Nil	-
Casual labor	Nil	-	Nil	-	Nil	-	Nil	-	Nil	-
Consultants	1	-	1	-	Nil	-	Nil	-	Nil	-
WORKING COSTS										
Mileage	100kms/ per site visit x 252 sites visits x 0.45USD/km x Exchange rate	11,340.00	100kms/ per site visit x 252 sites visits x 0.45USD/km x Exchange rate	11,340.00	Nil	-	Nil	-	Nil	-
Per diem	27 participants x 8 x Per diem	11,220.78	27 participants x 8 x Per diem	11,220.78	Nil	-	Nil	-	Nil	-
Fuel	100km/visit x 252 visits x 1/6Liter x Fuel price	6,272.73	100km/visit x 252 visits x 1/6Liter x Fuel price	6,272.73	Nil	-	Nil	-	Nil	-
Travel	27 participants x 25,000Tshs fare/ participant	438.31	27 participants x 25,000Tshs fare/ participant	438.31	Nil	-	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Breakfast/ lunch	40,000TShs/ participants x 27 participants x 7 days	4,909.09	40,000TShs/ participants x 27 participants x 7 days	4,909.09	Nil	-	Nil	-	Nil	-
Rental venue	7 days x 200,000TShs/per day	909.09	7 days x 200,000TShs/ per day	909.09	Nil	-	Nil	-	Nil	-
Printing costs	manual 27 copies x 25,000Tshs/ copy	438.31	manual 27 copies x 25,000Tshs/ copy	438.31	Nil	-	Nil	-	Nil	-
Consultancy										
Consultants			Nil	-						
Per diems	300USD x 7 days	2,100.00	Nil	-	300USD x 7 days	2,100.00	Nil	-	300USD x 7 days	2,100.00
Allowance	250USD x 7 days	1,750.00	Nil	-	250USD x 7 days	1,750.00	Nil	-	250USD x 7 days	1,750.00
Travel	Return ticket and local travel	3,000.00	Nil	-	Return ticket and local travel	3,000.00	Nil	-	Return ticket and local travel	3,000.00
MATERIAL										
Stationeries	required for one training session	649.35	Nil	-	Nil	-	Nil	-	Nil	-

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Training kits	25 kits x 50,000 Tshs/kit	324.68	Nil	-	Nil	-	Nil	-	Nil	-
EQUIPMENT	Nil	-	Nil	-	Nil	-	Nil	-	Nil	-
Rental audiovisual	7 days x 150,000Tshs/day	681.82	7 days x 150,000Tshs/day	681.82	Nil	-	Nil	-	Nil	-
Sub-Total for activity		44,034.16		36,210.13		6,850.00		6,850.00		6,850.00
6.5.2. Capacity building in fruit fly research: Personnel										
MSc/PhD students										
PhD student										
Fees and stipend	5,520,000 Tshs x 1 student	3,584.42	10,440,000 (Tshs)	10,440,000 (Tshs)	10,440,000 (Tshs)	10,440,000 (Tshs)	10,440,000 (Tshs)	10,440,000 (Tshs)	Nil	-
Research work	3,500,000 Tshs x 1 student	2,272.73	6,000,000Tshs x 1 student	3,896.10	6,000,000Tshs x 1 student	3,896.10	4,000,000Tshs x 1 students	2,597.40		
MSc students										
Fees and stipend	5,520,000Tshs x 2 students	1,540.00	5,420,000 Tshs/student x 2 students	7,038.96	Nil	-	Nil	-	Nil	-
Research work	Only course work in the first year	-	4,500,000Tshs / student x 2 students	5,848.16	Nil	-	Nil	-	Nil	-
Laboratory technicians										
Bench fee	daily working costs	1,000.00	daily working costs	1,000.00	daily working costs	1,000.00	daily working costs	1,000.00	daily working costs	1,000.00

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Training fees	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00
Stipend	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00
Travel (within East Africa)	2 people	500.00	2 people	500.00	2 people	500.00	2 people	500.00	2 people	500.00
Laboratory technicians										
Bench fee	daily working costs	1,000.00	daily working costs	1,000.00	daily working costs	1000.00	daily working costs	1,000.00	daily working costs	1,000.00
Training fees	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00	2 months x 2 people	4,000.00
Stipend	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00	2 months x 2 people	2,000.00
Travel (within East Africa)	2 people	500.00	2 people	500.00	2 people	500.00	2 people	500.00	2 people	500.00
Sub-Total for activity		22,397.14		12,895.39		18,896.10		17,597.40		15,000.00

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
6.5.3. An awareness campaign nationwide including mass media publications (posters, leaflets, brochures, etc.) on various aspects of fruit flies.										
HUMAN RESOURCES										
Full time senior	2	-	2	-	2	-	2	-	2	-
Full time junior	3 at 1 month each	-	3 at 1 month each	-	3 at 1 month each	-	3 at 1 month each	-	3 at 1 month each	-
Casual labor	Nil	-	Nil	-	Nil	-	Nil	-	Nil	-
Audiovisual company	promotional film	5,000.00	Nil	-	Nil	-	Nil	-	Nil	-
Radio programme	A radio programme	2,500.00	Nil	-	Nil	-	Nil	-	Nil	-
IT company	website development and maintenance	3,000.00	website development and maintenance	1,000.00	website development and maintenance	1,000.00	website development and maintenance	1,000.00	website development and maintenance	-
WORKING COSTS										
Mileage	100kms/ per site visit x 252 sites visits x 0.45USD/ km x Exchange rate	11,340.00	Nil	-	100kms/ per site visit x 252 sites visits x 0.45USD/ km x Exchange rate	11,340.00	Nil	-	100kms/ per site visit x 252 sites visits x 0.45USD/ km x Exchange rate	11,340.00
Per diem	37 participants x 8 x Per diem	15,379.62	Nil	-	37 participants x 8 x Per diem	15,379.62	Nil	-	37 participants x 8 x Per diem	15,379.62

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Fuel	100km/visit x 252 visits x 1/6Liter x Fuel price	6,272.73	Nil	-	100km/visit x 252 visits x 1/6Liter x Fuel price	6,272.73	Nil	-	100km/visit x 252 visits x 1/6Liter x Fuel price	6,272.73
Travel	37 participants x 25,000Tshs fare/participant	600.65	Nil	-	37 participants x 25,000Tshs fare/participant	600.65	Nil	-	37 participants x 25,000Tshs fare/participant	600.65
Rental venue	7 days x 200,000Tshs/day	909.09	Nil	-	7 days x 200,000Tshs/day	909.09	Nil	-	7 days x 200,000Tshs/day	909.09
Breakfast/ lunch	40,000Tshs/ participants x 37 participants x 7 days	6,727.27	40,000Tshs/ participants x 37 participants x 7 days	6,727.27	Nil	-	Nil	-	Nil	-
Printing costs posters	3 types @ 1000 copies	8,116.88	Nil	-	3 types @ 1000 copies	8,116.88	Nil	-	Nil	-
Printing costs brochures	2000 copies	1,623.38	Nil	-	2000 copies	1,623.38	Nil	-	Nil	-
Printing costs booklets	500 copies	4,870.13	Nil	-	500 copies	4,870.13	Nil	-	Nil	-
Distribution costs		-	Nil	-	Nil	-	Nil	-	Nil	-
Extension	1 day stakeholder meeting	3,896.10	Nil	-	1 day stakeholder meeting	3,896.10	Nil	-	1 day stakeholder meeting	3,896.10

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
MATERIAL										
Stationeries	required for one training session	1,948.05	Nil	-	required for one training session	1,948.05	Nil	-	required for one training session	1,948.05
EQUIPMENT										
Rental audiovisual	1 day rental	97.40	Nil	-	1 day rental	97.40	Nil	-	1 day rental	97.40
Sub-Total for activity		72,278.31		7,727.27		56,051.04		1,000.00		41,440.65
6.5.4. Strengthening of infrastructure related to fruit fly research and management										
EQUIPMENT										
PC	1 PC x 1,600USD/PC	1,600.00	Nil	-	Nil	-	Nil	-	Nil	-
Photocopy machine	1 photocopy machine x 500USD/machine	500.00	Nil	-	Nil	-	Nil	-	Nil	-
Printing machine	1 printer x 500,000Tshs/ printer	500.00	Nil	-	Nil	-	Nil	-	Nil	-
taxonomic unit equipment	1 unit (Use existing facilities)	6,000.00	Nil	-	Nil	-	Nil	-	Nil	-
molecular unit equipment	1 unit (Use existing facilities)	10,000.00	Nil	-	Nil	-	Nil	-	Nil	-
outpost units equipment	10 units (Use existing facilities)	20,000.00								
Sub-Total for activity		38,600.00								

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
6.5.5. Strengthening collaboration between the different actors and defining their respective roles										
HUMAN RESOURCES										
Full time senior	10	-	10	-	10	-	10	-	10	-
Full time junior	N/A	-	Nil	-	Nil	-	Nil	-	Nil	-
Consultants	5	-	5	-	5	-	5	-	5	-
WORKING COSTS										
Mileage	200kms/ per site visit x 252 sites visits x 0,45USD/ km	22,680.00	150km (pickup/site visits)	17,010.00	150km (pickup/site visits)	17,010	150km (pickup/site visits)	17,010.00	200km (pickup/ site visits)	22,680.00
Per diem (foreign)	5 participants	10,000.00	1 participants	2,000.00	1 participants	2,000.00	1 participants	2,000.00	5 participants	10,000.00
Per diem (domestic)	10 participants x 4 days x Per diem	2,077.92	10 participants	3,200.00	10 participants	3,200.00	10 participants	3,200.00	10 participants	3,200.00
Fuel	200km/visit x 252 visits x 1/6L.liter x Fuel price	12,545.45	150km (pickup/site visits)	9,450.00	150km (pickup/site visits)	9,450.00	150km (pickup/site visits)	9,450.00	200km (pickup/ site visits)	12,600.00
National travel	10 participants x 100,000Tshs retrun fare/participant	649.35	10	1,500.00	10	1,500.00	10	1,500.00	10	1,500.00
Breakfast/ lunch	40,000Tshs/ participant x 10 participants x 4 days	695.65	11 participants	1,155.00	11 participants	1,155.00	11 participants	1,155.00	15 participants	1,575.00

	YR1	Budget (USD)	YR2	Budget (USD)	YR3	Budget (USD)	YR4	Budget (USD)	YR5	Budget (USD)
Printing costs	handout documents 15 copies	1,200.00	handout documents 11 copies	825.00	handout documents 11 copies	825.00	handout documents 11 copies	825.00	handout documents 15 copies	1,125.00
Rental venue	3 day rental x 200,000Tshs/ day	389.61	1 day rental	200.00	1 day rental	200.00	1 day rental	200.00	3 day rental	600.00
MATERIAL										
Stationeries	required for one meeting	97.40	required for one meeting	55.00	required for one meeting	55.00	required for one meeting	55.00	required for one meeting	75.00
EQUIPMENT										
Rental audiovisual	3 day rental	194.81	1 day rental	100.00	1 day rental	100.00	1 day rental	100.00	3 day rental	300.00
Sub-Total for activity		80,530.20		41,495.00		41,495.00		41,495.00		83,655.00
Total for Target		235,942.67		85,932.40		104,896.04		42,995.00		132,445.65
Base calculations										
Exchange rate		1,540.00								
Fuel price (September 2012)		2,300.00								
Per diem		80,000.00								
Field allowance		32,500.00								
Conference hire charges per day		200,000.00								
Lab allowance		20,000.00								

Appendices

Activity	Institution	Y1												Y2														
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
6.1. Establishing the status of economically important fruit flies in Tanzania																												
6.1.1. A nationwide detection and delimiting survey of fruit flies in the different biogeographical and agro-ecological zones in the country	SUA/MAFC																											
6.1.2. Monitoring surveys in selected localities, representing the different agro-ecological zones	SUA/MAFC																											
6.2. Assessing the economic impact of fruit flies on the horticultural industry nationwide																												
6.2.1 Repeated sampling of the major commercially grown fruits in the country	SUA/MAFC																											
6.2.2 Economic loss assessment, across the agro-ecological zones	SUA/MAFC																											
6.3 Evaluating available mechanism for fruit fly control																												
6.3.1 Testing of developed IPM components under area-wide strategy	SUA/MAFC																											
6.3.2 Testing of various post-harvest treatment protocols	SUA/MAFC																											
6.3.3. Cost Benefit Analysis of control measures	SUA/MAFC																											
6.4 Formulating management program for mitigation of fruit fly problems in horticulture in Tanzania																												
6.4.1. Establish guidelines and package for tailor made IPM programmes	SUA/MAFC																											
6.4.2. Design a surveillance program for fruit flies	SUA/M...																											

Appendices

Activity	Institution																												
		Y1												Y2															
Year																													
Month		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
6.4.3 Advisory role in formulation of subsidiary legislation	SUA/MAFC																												
6.4.4. Provide data to facilitate registration of pest-control substances used in fruit fly management	SUA/MAFC																												
6.4.5. Design a framework for Public Private Partnership with regard to fruit fly management	SUA/MAFC																												
6.4.6. Formulate post-harvest treatment protocols for import and export.	SUA/MAFC																												
6.5. Re-enforcing long term awareness, capacity building and collaboration																													
6.5.1. Organize training sessions for officers conducting surveys and inspection	SUA/MAFC																												
6.5.2. Support formal training in fruit fly related topics	SUA/MAFC																												
6.5.3. An awareness campaign nationwide including mass media publications (posters, leaflets, brochures, etc.) on various aspects of fruit flies.	SUA/MAFC																												
6.5.4. Strengthening of infrastructure related to fruit fly research and management	SUA/MAFC																												
6.5.5. Strengthening collaboration between the different actors and defining their respective roles	SUA/M...																												

Narrative summary	Results	Activities	Objectively Verifiable Indicators	Means of verification
Goal				
To reduce losses due fruit flies				
Purpose				
To increase access of quality fruits to local and international markets				
Objectives				
6.1. Establishing the spatial and temporal distribution economically important fruit flies in Tanzania	Spatial and temporal distribution of economically important fruit flies established	6.1.1. A nationwide detection and delimiting survey of fruit flies in the different biogeographical and agro-ecological zones in the country	Distribution map of fruit flies	Journal publications and reports
		6.1.2. Monitoring surveys in selected localities, representing the different agro-ecological zones	Seasonal abundance curves of fruit flies	Journal publications and reports
6.2. Assessing the economic impact of fruit flies on the horticultural industry nationwide	Losses due to fruit flies established	6.2.1 Repeated sampling of the major commercially grown fruits in the country	Number of samples and sampling units	Journal publications and reports
		6.2.2 Economic loss assessment, across the agro-ecological zones	Incidence of fruit flies, infestation rates of fruit flies	Journal publications and reports
6.3 Evaluating available mechanism for fruit fly control	Effectiveness of IPM determined	6.3.1 Testing of developed IPM components under area-wide strategy	Incidence of fruit flies, infestation rates of fruit flies	Journal publications and reports
		6.3.2 Testing of various post-harvest treatment protocols.	Incidence of fruit flies, infestation rates of fruit flies	
		6.3.3. Cost benefit analysis of control measures	Cost benefit ratio	Journal publication and reports

Narrative summary	Results	Activities	Objectively Verifiable Indicators	Means of verification
6.4 Formulating management program for mitigation of fruit fly problems in horticulture in Tanzania	Management program of fruit flies formulated	6.4.1. Establish guidelines and package for tailor made IPM programmes	Number of guidelines and packages disseminated to farmers	Journal publication and reports
		6.4.2. Design a surveillance program for fruit flies	Number of entry points involved in surveillance program	Reports
		6.4.3 Advisory role in formulation of subsidiary legislation	Number of legislations formulated	Reports
		6.4.4. Provide data to facilitate registration of pest-control substances used in fruit fly management	Number of registered fruit flies control substances	Reports and actual publications
		6.4.5. Design a framework for public private partnership with regard to fruit fly management	Number of public-private-partnerships established	Reports
		6.4.6. Formulate post-harvest treatment protocols for import and export.	Quantities of fruits exported to international markets	Reports and published by laws
6.5. Re-enforcing long term awareness, capacity building and collaboration	Increase number of personnel knowledgeable on fruit flies management	6.5.1. Organize training sessions for officers conducting surveys and inspection	Number of trainees	Reports
		6.5.2. Support formal training in fruit fly related topics	Number of trainees	Reports
	Awareness of farmers on fruit flies improved	6.5.3. An awareness campaign nationwide including mass media publications (posters, leaflets, brochures, etc.) on various aspects of fruit flies.	Number of radio, TV programs and hard prints produced	Reports
	Infrastructures related to fruit flies research strengthened	6.5.4. Strengthening of infrastructure related to fruit fly research and management	Number of strengthened infrastructure	Reports
	Stakeholder networks established	6.5.5. Strengthening collaboration between the different actors and defining their respective roles	Number of established networks	Reports

ISBN 9987 640 35 4