

April 2011

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COMMITTEE ON COMMODITY PROBLEMS

INTERGOVERNMENTAL GROUP ON BANANAS AND TROPICAL FRUITS

FIFTH SESSION

Yaoundé, Cameroon, 3 – 5 May 2011

**FUNDING APPLICATION TO THE COMMON FUND FOR
COMMODITIES: PARTICIPATORY DISSEMINATION AND
PROMOTION OF MANAGEMENT TECHNOLOGIES FOR
BACTROCERA INVADENS, *CERATITIS* FRUIT FLIES AND MANGO
SEED WEEVIL THAT CONSTRAIN PRODUCTION AND EXPORT
OF MANGO AND AVOCADO IN EAST AFRICA**

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF AGRICULTURE FOOD SECURITY AND COOPERATIVE

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Ref. No. AB.348/437/01

Dr. Kaison Chang
Commodities and Trade Division
Food and Agriculture Organization (FAO) of the UN
Viale Delle Terme Di Caralla 00100
Rome, Italy

Dear Chang:

Funding application to the Common Fund for Commodities (CFC): Participatory Dissemination and Promotion of Management Technologies for *Bactrocera invadens*, *Ceratitis* Fruit Flies and Mango Seed Weevil that Constrain Production and Export of Mango and Avocado in East Africa

Following a series of teleconference between the Managing Director of CFC, the Director General of the International Centre of Insect Physiology and Ecology (*icipe*), the Technical Officials at the Fund and the issues raised by the Project Appraisal Committee (PAC) of the CFC (see Annex 1) and responses provided by *icipe* on behalf of the partner institutions (see Annex 2), the fruit fly project document earlier submitted in March 2010 has been revised.

Please find attached the revised version of the proposal entitled "*Participatory Dissemination and Promotion of Management Technologies for Bactrocera invadens, Ceratitis Fruit Flies and Mango Seed Weevil that Constrain Production and Export of Mango and Avocado in East Africa*" for submission to the Common Funds for Commodities (CFC) through the Intergovernmental sub-Group (IGG) for funding consideration.

The Ministry of Agriculture, Food Security and Cooperative (MAFSC) of the Government of Tanzania wish to make this submission on behalf of the government and national partners from Eastern Africa - Kenya, Tanzania, Uganda; the International Centre of Insect Physiology and Ecology (*icipe*); the Food and Agriculture Organization (FAO) of the United Nations and other partners.

It is our hope that this application receives your kind attention.

Sincerely yours


C. KIRUMBI
For PERMANENT SECRETARY
31.03.11

Participatory Dissemination and Promotion of Management Technologies for *Bactrocera invadens*, *Ceratitis* Fruit Flies and Mango Seed Weevil that Constrain Production and Export of Mango and Avocado in East Africa

A project proposal submitted to the
COMMON FUND FOR COMMODITIES (CFC)
By
Ministry of Agriculture, Food Security & Cooperatives
(MAFSC) of the Republic of Tanzania



On behalf of:

Kenya Plant Health Inspectorate Service (KEPHIS), Nairobi;
Kenya Agricultural Research Institute (KARI), Nairobi; Ministry of
Agriculture & Food Security, Plant Health Service (MAFSC),
Dar es Salaam; Mikochei Agricultural Research Institute (MARI),
Dar es Salaam; Ministry of Agriculture, Animal Industries & Fisheries
(MAAIF), Kampala; National Crops Resources Research Institute
(NaCRRI), Kampala; International Centre of
Insect Physiology and Ecology (*icipe*), Food and Agriculture
Organization (FAO) of the UN and other partners

Submitting Institution Lead Scientist:

Dr. F. Katagira (Email: pps@kilimo.go.tz)

Project Executing Agency (PEA):

International Centre of Insect Physiology and Ecology (*icipe*)

PEA Lead Scientist:

Dr. S. Ekesi (Email: sekesi@icipe.org)

Date: March 31, 2011

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ACRONYMS AND ABBREVIATIONS

ACIAR	Australian Centre for International Agricultural Research
AFFP	African Fruit Fly Programme (of <i>icipe</i>)
ARI	agricultural research institutes
ARPPIS	African Regional Postgraduate Programme in Insect Science
BC	biological control
BMZ	German Federal Ministry for Economic Cooperation and Development
CABI	CAB International
CFC	Common Fund for Commodities
DRIP	Dissertation Research Internship Programme
EF	entomopathogenic fungi
EU	European Union
FAO	Food and Agriculture Organization of the UN
FAO-IGSGTF	Intergovernmental Sub-Group on Tropical Fruits (of FAO)
FAO-TCP	Technical Cooperation Programme (of FAO)
FFS	Farmers Field School
GTZ	Gesellschaft für Technische Zusammenarbeit
HCDA	Horticultural Crops Development Authority (Kenya)
IAEA	International Atomic Energy Agency
IARC	international agricultural research centre
<i>icipe</i>	International Centre of Insect Physiology and Ecology
IFAD	International Fund for Agricultural Development (Italy)
IITA	International Institute of Tropical Agriculture
IPM	integrated pest management
IPPC	International Plant Protection Convention
MAT	male annihilation technique
MDG	millennium development goal
MoA	Ministry of Agriculture (Kenya)
MRL	maximum residue levels
MSW	mango seed weevil
NARS	national agricultural research systems
NPPO	National Plant Protection Organisation
PCC	Programme Coordination Committee
PEA	project-executing agency
POP	persistent organic pollutant
PRA	pest risk analysis
PSB	Project Supervisory Body
PSC	Project Steering Committee
PSDA	Promotion of Private Sector Development in Agriculture (of GTZ)
R&D	research and development
SADDC	Currently SADC [Southern Africa Development Community countries]
SAAGA	South African Avocado Growers Association
SIT	sterile insect technique
SSA	sub-Saharan Africa
TAC	Technical Advisory Committee
TCDC	Technical Cooperation Between Developing Countries (FAO unit)
UNEP	United Nations Environment Programme

PART I: PROJECT LOGICAL FRAMEWORK			
PART 1: OVERALL PROJECT GOAL, PURPOSE AND OUTPUTS			
Narrative Summary	Verifiable Indicators	Means of Verification	Assumptions and Risks
<p>Goal: To enhance food and nutritional security, improve income generation capacity and livelihood of fruit and vegetable growers in East Africa.</p>	<p>Increase in food production and income generation capacity of smallholder farmers in targeted countries.</p>	<p>National fruit sale statistics, publications.</p>	<p>Political commitment to horticulture improvement remains the same.</p>
<p>Purpose: To implement and disseminate, in collaboration with international and national partners, effective approaches (that are based on baiting technology, biopesticides, parasitoids, trapping, orchard sanitation and post harvest treatments) that lead to reduction of fruit losses due to fruit flies and mango seed weevil (MSW) infestation leading to quality production to meet the needs of both the domestic and export markets.</p>	<p>(1) Reduced fruit infestation in all project benchmark sites; (2) increased income, purchasing power, and seasonal labour; (3) availability of new baits and biological control agents and soft pesticides for management of fruit flies and MSW; (4) availability of post harvest management parameters for damaging fruit flies; (5) reduced incidence of rejection in export markets and increased access to markets; (6) availability and uptake in knowledge on pest diagnosis and phytosanitary information management; (7) increased knowledge by NPPOs and NARS in surveillance to guard against invasion by alien species; (8) increased knowledge of NARS, NPPOs and growers in partner countries on fruit flies and MSW IPM technologies.</p>	<p>Production and survey records; number of NARS, NPPOs and growers trained; parasitoids establishment records; post harvest treatment data; databases; training materials; interviews with growers; publications and reports.</p>	<p>Demand for quality fruit continues; security situation and extreme weather in target areas does not prevent or interrupt project activities.</p>
<p>Component 1: New technologies, exotic natural enemies and other existing management tools for controlling <i>B. invadens</i> and mango seed weevil assembled, demonstrated in multi-locational sites and disseminated.</p>	<p>(1) IPM package that is based on baiting, biological control, spot application of soft pesticides and orchard sanitation demonstrated and disseminated to at least 1000 growers by mid 2014; (2) at least 40% of growers at each benchmark site adopt and participate in use of at least 2 IPM packages by 2014; (3) during years of average seasonal conditions, at least 30% of growers reduce fruit flies and MSW densities by 70% leading to at least 20% yield increment; (4) parasitoid established at release sites by mid 2014 resulting in 20% financial savings by 40% of growers due to limited pesticide use; (5) cover spray application of pesticides reduced in benchmark sites by at least 20%; (6) pesticide load in fruits produced by at least 20% of growers at benchmark sites reduced to internationally acceptable level; (7) fruit rejection by export markets at benchmark site reduced by 70% by 2014; (8) at least 500 family members benefiting from additional seasonal labour.</p>	<p>Reports, publication records, direct opinion of end users.</p>	<p>No crop failure; NARS, NPPOs and growers cooperate; security situation and extreme weather events in target areas does not prevent or interrupt project activities</p>
<p>Component 2: Cold and hot water post-harvest disinfestations trials completed and validated for <i>B. invadens</i> on avocado and mango, respectively</p>	<p>(1) Vibrant colonies of <i>B. invadens</i> established by 2012; (2) the most cold and heat tolerant stages determined by 2012; (3) post harvest treatment regimes validated on a large-scale for mango and avocado by end of 2014 and parameters made available to commercial companies.</p>	<p>Reports and publication records.</p>	<p>Data are taken regularly; private sector take up data and established facility for treatment</p>
<p>Component 3: Surveillance, identification and mitigation measures to avert the threats</p>	<p>(1) At least 500 permanent trapping stations established by mid 2012; (2) a relational database established for each country by 2013; (3) quarantine detection materials in</p>	<p>Reports and publication records, voucher specimens,</p>	<p>Access to trapping stations</p>

of other exotic fruit flies that may impact on the management strategy and the industry	place in target countries by 2013.	databases.	granted by owners; NARS, NPPOs and growers cooperate
Component 4: Enhanced technical capacity at various levels of competency to support and sustain the project	(1) At least 120 NPPOs and NARS (trainers) trained and acquire new skills, approaches and methodologies related to surveillance and pre-harvest management of target pests by 2014; (2) at least 6 farmer field schools (FFS) established by 2013; (3) at least 9 field days/farm visits conducted by 2014; (4) post harvest treatment capacity impact on 15 members of the private sector; (5) at least 5000 training materials (leaflets, posters, manual and CD-based information tools) printed and distributed to NPPOs, NARS and growers.	Reports and publication records, FFSs, number of experts and private sector staff trained, availability of training materials, interview with growers and beneficiaries.	Need for capacity development exists; NARS, NPPOs and growers cooperate.

PART II: ACTIVITIES AND INPUTS RELATED TO THE OUTPUTS, MEANS AND COSTS

Component 1 - Pre-Harvest Management Measures: New technologies, exotic natural enemies and other existing management tools for controlling *B. invadens* and mango seed weevil assembled, demonstrated in multi-localational sites and disseminated.

ACTIVITIES

- (1) Assembling and large-scale demonstration, adaptation and dissemination of IPM package for fruit flies based on baiting, male annihilation, use of fungal pathogens, ant technology, orchard sanitation and assessing impact using farmer field schools (FFS) and technology learning sites in each participating country (**CFC funded for Kenya, Tanzania, Uganda; BMZ co-financing for Kenya, Tanzania**).
- (2) Conduct on-farm demonstration, adaptation and dissemination of trunk application of soft pesticides and fungal pathogens against MSW using FFS and technology learning sites in each country (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania**).
- (3) Large-scale releases of fruit fly parasitoids (*F. arisanus* and *Diachasmimorpha longicaudata*) and monitoring for establishment and impact (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania; Biovision co-financing for Kenya**)

MEANS/PROCEDURES

- (1) Selection, procurement and distribution of appropriate materials (baits, traps, fungus, etc.);
- (2) development of criteria (with inputs from local collaborators) for site and grower selection and participation; (3) identification of sites/farms, meeting with growers, interviews, developing collaborative agreements; (4) establishment of a mass rearing facility for parasitoids; (5) preparing experimental design for package demonstration, adaptation and dissemination jointly with growers, NARS and NPPOs; (6) training farmers on application and implementation; (7) on-farm assessment of pests infestation, identification and yield losses; and (8) data analysis, report writing and conclusions on technical viability and post experiment meeting with growers for feedback.

COST TO CFC & DURATION

Total project costs for all activities (in Kenya, Tanzania and Uganda) for 3 years: US\$ 265,000.

RISK AND ASSUMPTIONS

Financial disbursement is timely; collaborators provide effective contribution; security situation and extreme weather events in target areas does not prevent or interrupt project activities; NARS, NPPOs and growers are cooperative; access to farms granted by growers.

Component 2 - Post-Harvest Treatments: Cold and hot water post-harvest disinfestations trials completed and validated for *B. invadens* on mango and avocado.

Specific activities

- (1) Maintain colonies of *B. invadens* for heat and/or cold tolerance testing (**BMZ co-financing**).

- (1) Procurement of appropriate materials (water bath, thermocouples, data loggers, refrigerators etc.); (2) fruit disinfestation, data collection; and (3) sharing

Total project costs for all activities for 3 years:

Financial disbursement is timely; insect

<p>(2) Determination of the most cold-tolerant stage of <i>B. invadens</i> on avocado (SAAGA funded).</p> <p>(3) Determination of the most hot-tolerant stage of <i>B. invadens</i> on mango (CFC funded; BMZ co-financing).</p> <p>(4) Large-scale validation trials on avocado (cold treatment) (SAAGA funded).</p> <p>(5) Large-scale validation trials on mango (heat treatment) (CFC funded; BMZ co-financing).</p> <p>(1)</p>	<p>data with public-private.</p>	<p>US\$98,000.</p>	<p>colonies are stable; all parameters are taken regularly.</p>
<p>Component 3 – Surveillance and preventative measures: Surveillance, identification and mitigation measures to avert the threats of other exotic fruit flies that may impact on the management strategy</p>			
<p>(1) Conduct systematic trapping, monitoring and detection for exotic fruit flies in fruit and vegetable growing regions and other strategic locations in target countries to guide the application of phytosanitary management. (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania).</p> <p>(1) Establish in each participating country a database for target pests for the management of surveillance data and information sharing among partner countries. (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania).</p>	<p>(1) Procurement and distribution of materials (baits, traps, computers for databasing etc.); (2) development of a protocol for trapping, monitoring and detection; (3) identification of strategic locations for traps installation (airports, border posts, fruit dumping sites etc.); (4) setting up fruit fly monitoring systems and continuous servicing; (5) inputting data into the databases and information sharing;</p>	<p>Total project costs for all activities for 3 years: US\$117,000.</p>	<p>Financial disbursement is timely; NARS and NPPO commitment remains favourable; access to sampling locations is granted.</p>
<p>Component 4 – Training and technology dissemination - Enhanced technical capacity at various levels of competency to support and sustain the project</p>			
<p>(1) Train NARS and NPPOs (training of trainers) on surveillance and pre-harvest management packages—baiting; male annihilation; use of fungal pathogens; parasitoid mass rearing techniques, quality control, release and evaluation of parasitism; and orchard sanitation. (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania).</p> <p>(2) Fruit fly and MSW IPM technology learning sites established through FFS, contact farmers, farmer groups, and national extension networks through hands-on training approaches on surveillance and all management packages and awareness campaigns on technology availability. (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya).</p> <p>(3) Facilitate training of representatives of industry partners in participating countries on use of post-harvest treatment. (CFC funded; BMZ co-financing for Kenya).</p> <p>Prepare and disseminate fruit fly and MSW IPM materials and guidelines with due regard to market requirements through project website, leaflets, posters, manuals, and radio and TV programmes to facilitate large-scale adoption and application of the recommended management tools (CFC funded; BMZ co-financing for Kenya).</p>	<p>(1) Development of criteria for selecting NARS, NPPOs and growers from participating countries for training; (2) designing FFS training curriculum and preparation of training materials; (3) participatory on-farm demonstration and dissemination of surveillance and management packages to NARS, NPPOs, and growers; (4) organise and conduct hands-on training on parasitoid rearing and impact evaluation in the field.</p>	<p>Total project costs for all activities for 3 years: US\$ 348,830.</p>	<p>Financial disbursement is timely, NARS and NPPO commitment remains favourable; access to media is granted; political situation in the countries is stable.</p>

Project Summary

Title:	Participatory Dissemination and Promotion of Management Technologies for <i>Bactrocera invadens</i> , <i>Ceratitis</i> Fruit Flies and Mango Seed Weevil that Constrain Production and Export of Mango and Avocado in East Africa
Duration:	Three years
Location:	Eastern Africa: Kenya, Tanzania and Uganda
Objective and Nature:	<p>Project rationale: In Africa, improvement of fruit and vegetable productivity and quality boosts food security, employment opportunities and the economy in pursuit of the UN millennium development goals (MDGs). Horticultural crops such as mango and avocado, in particular, are an invaluable instrument for agricultural development because of their high economic returns and nutritive value, and their ability to serve as an engine for agricultural and economic diversification especially for smallholders who can gear production to specific local, regional or export markets. While the horticultural sector presents many opportunities for rural economies and improving livelihood of smallholders, several factors constrain production and limit the potential for trade. Insect pests are generally regarded as the most important. Tephritid fruit flies (e.g. <i>Bactrocera invadens</i> and <i>Ceratitis cosyra</i>, and the mango seed weevil [MSW]) cause direct damage to these important export crops, leading to 40–80% losses depending on locality, variety and season. Quarantine restrictions on fruit fly- and MSW-infested fruits limit export to large lucrative markets in South Africa, Europe, the Middle East, Japan and USA, where the insects are quarantine pests. Pest infestations reduce revenues and profits of smallholder growers and traders, and cause increasingly high production costs to local and export markets.</p> <p>Goal: To enhance food and nutritional security, improve income generation capacity and livelihood of fruit growers in eastern African countries.</p> <p>Purpose: To implement and disseminate, in collaboration with international and national partners, effective approaches (that are based on baiting technology, biopesticides, parasitoids, trapping, orchard sanitation and post-harvest treatments) that lead to reduction of fruit and vegetable losses due to fruit flies and MSW infestation leading to quality production to meet the needs of both the domestic and export markets.</p> <p>Project objective: The broad objective of the project is to improve the productivity and quality of mango and avocado in eastern Africa (Kenya, Tanzania, and Uganda) thereby improving incomes and livelihood of smallholder growers and traders engaged in production and trade of the target crops.</p> <p>Project outputs/components: The above objective will be achieved through participatory demonstration, adaptation, dissemination and training of NARS, NPPOs and growers on environmentally sustainable and affordable technologies for the management of fruit flies and MSW using the following project outputs/components: Component 1 – Pre-harvest management measure: This component involves implementing proven technologies that are based on application of baiting and male annihilation techniques, biopesticides, ant technology, parasitoid releases and orchard sanitation for target pests to minimise the use of pesticides that lead to unwanted pesticide residues in fruits which would then facilitate compliance with standards required for both domestic and export markets.</p> <p>Component 2 – Post-Harvest treatments: To access quarantine sensitive markets, post-harvest treatment parameters based on cold (avocado) and hot water (mango) treatments will be developed for <i>B. invadens</i> jointly with the private sector for uptake by local entrepreneurs.</p>

Component 3 – Surveillance and preventative measures: This component will address surveillance, identification and mitigation measures through systematic trapping in project target countries to avert the threats of other exotic fruit flies that may impact on the management strategy and the industry.

Component 4 – Training and technology dissemination: To enhance technical capacity at various levels of competency to support and sustain the project, the project will build capacity of NARS, NPPOs and growers on the management of target pests through training of trainers and the farmer field school approach in addition to training on systematic trapping, monitoring and detection to prevent entry of exotic fruit flies into the countries. Several training materials (manuals, posters, leaflets and CD-ROMs) will also be produced and disseminated.

Benefits, beneficiaries and contribution to MDGs: The immediate beneficiaries of the project will be smallholder producers of the target crops in participating countries through increased production and access to export markets due to quality production of fruits in addition to improving their economic well being. There is also an added benefit, in the form of reduced costs and labour input, given that introduction of parasitoids comes at no cost to the farmer once they establish in the system. Benefits will also accrue to traders (both small- and large-scale) in terms of large sales volume and better margins in quality-conscious consumers' and marketing outlets. The proposed project will contribute to meeting several millennium development goals (MDGs), specifically, eradicate extreme poverty and hunger (MDG 1), ensure environmentally sustainability (MDG 7), and develop a global partnership for development (MDG 8).

Recipient of Grant:	FAO-Intergovernmental Sub-Group on Tropical Fruits (FAO-IGSGTF)
Recipient of Loan:	0
Total project cost:	US\$ 1,431,375
CFC-financing:	US\$ 1,000,000
Mode of Financing:	
Grant:	US\$ 1,000,000
Loan:	US\$ 0
Co-financier:	
BMZ	US\$ 296,000
BioVision	US\$ 30,375
SAAGA	US\$ 5,000
Counterpart contribution:	US\$ 100,000
Project Executing Agency:	<i>icipe</i> – African Insect Science for Food and Health
Supervisory body:	FAO-IGSGTF
Starting date:	October 2011

Background

The Region

In Africa, agriculture remains the foundation of the society and food security forms the basis for economic development and stability. A large proportion of the population is engaged in farming, and production of fresh fruits and vegetables plays an important role in achieving food and nutritional security both at the household and national levels, offering increased opportunity for trade and employment. Horticultural crops are an especially invaluable instrument for agricultural development, and trade in fruit and vegetable provides an important opportunity for economic growth in pursuit of the UN millennium development goals (MDGs) (GHI, 2006). Economically, horticulture is one of the most attractive sectors owing to the relatively high value of the products involved. For example in Kenya, horticulture generated US\$1 billion in foreign exchange from exported commodities and over US\$ 650 million domestically in 2008 and directly and indirectly employed 4 million people (HCDA, 2009), making it the most important sector of the Kenyan economy, surpassing tourism and tea and coffee. Locally grown fruits such as mango and avocado are, therefore, an important source of income and foreign exchange in Africa (Dolan et al., 1999), in addition to gaining recognition as major sources of vitamins and other important nutrients. Promotion of consumption of fruits and vegetables has been included in national nutrition programmes of many countries because of the increasing awareness of the nutritive value of the crops (<http://www.fao.org/ag/magazine/FAO-WHO-FV>). The increasing purchasing power of local populations has also resulted in increased domestic demand for these produce. Additionally, the demand for quality tropical fruit in Europe, the Middle East, America and Japan is on the increase. The above factors, combined with increasing globalisation of trade have created new and lucrative production and trade opportunities in SSA.

The Role of Horticulture in Achieving the Millennium Development Goals (MDGs)

Horticultural crops have an important role to play in achieving the millennium development goals (MDGs) (GHI, 2006). A strengthened horticultural sector can have a positive impact on all of the eight MDGs because the sector can directly contribute to poverty reduction and food security issues (**MDG1**) in rural economies of Africa where the highest production of fruits and vegetables takes place. Horticultural crops are known to generate more jobs per hectare, on-farm and off-farm, than staple based agricultural enterprises (Ali et al., 2002) and they can generate higher profits than staple-based crops especially when land is relatively scarce and labour is abundant. This greatly benefits farmers and landless labourers in rural settings by providing income that is used to alleviate hunger and reduce poverty (**MDG1**). Fruits and vegetables are the most important sources of micronutrients. Improvement in diet can increase the productivity of the rural farmers (**MDG1**) and their children to achieve universal primary education (**MDG2**), reduce health care related costs and increase incomes. Women are the major producers of horticultural crops in Africa and they are also involved in value-addition activities from production to marketing and their involvement in horticulture promotes gender equality and empowerment (**MDG3**). The absence of essential micronutrients exacerbates poor children's vulnerability to disease. Improving access to fruits and vegetables reduces mortality and morbidity of infants and children under the age of five (**MDG4**), particularly in rural areas as well as improving maternal health (von Braun et al., 2004) (**MDG5**). A healthy diet rich in fruits and vegetables bolsters the body's immune system, helping it to resist HIV/AIDS, malaria and other infectious diseases that are rampant in Africa (FAO/ILSI, 1997) (**MDG6**). Fruits and vegetables are also recognised by FAO and WHO as the primary nutritional tools to prevent non-communicable and micronutrient related diseases (WHO-FAO, 2005). These two major UN organisations recently launched the campaign that every individual should consume 400 g of fruits and vegetables a day (excluding starchy tubers such as potatoes) to combat micronutrient deficiencies (<http://www.fao.org/ag/magazine/FAO-WHO-FV>). Perennial fruit trees such as mango can conserve and protect the soil in hilly and in high rainfall regions ensuring environmental sustainability (**MDG7**). The collaborative effort across many national and international agricultural centres and the private sector across Africa, Asia, Europe and the US in this project represents a global partnership for development to help the rural economies of Africa (**MDG8**).

The Target Commodities—Mango and Avocado

Mango is one of the four major commodities of concern to the FAO-Intergovernmental Sub-Group on Tropical Fruits and is the second most internationally traded tropical fruit after pineapple (<http://www.fao.org/>). World production of mango was at 32 million tons in 2006 and showed a slight increase to 33 million tons in 2007 (<http://www.fao.org/>). Mango production in Africa has been relatively stable at 2 million tons since 2003 (<http://www.fao.org/>). The total area

under production in the three project target countries in Africa stands at 52,000 ha (FAOSTAT, 2007) and it represents an important export crop for all the countries. According to data presented at the FAO Inter-Governmental Sub-Group on Tropical Fruits held in Australia in 1999 and Costa Rica in 2001, mango exports from Africa were estimated at 35–40,000 tons annually and were worth over US\$ 42 million (Lux et al., 2003). This value has gradually eroded as a result of import bans by several countries due to the invasion of *B. invadens* (Ekesi, 2010; Otieno et al., 2010).

Avocado production globally was estimated at 3 million tons in 2007 with America producing 80% of the world avocados, and the rest of the world accounting for the remaining 20%. In Africa, total production in 2007 was at 364,000 tons. Only 10% (200,000 tons) of avocado production is traded internationally. With the huge expansion in production areas of the Hass cultivar in many countries including Africa, the volume that is being traded internationally is likely to increase (Toerien, 1999).

For both target crops, and as with all other horticultural produce, the European Union (EU) is the largest destination market for African countries. Huge volumes are traded among African nationals although the exact figures are unknown. In the 3 target project countries, the export of fruits and vegetables is increasing at an annual rate of 15–20% and this trend is likely to continue with horticulture employing over 4 million people, mostly women and the youth in the production, transport, processing and trade sectors. Over 80% of the produce comes from smallholders who produce for the local and export markets to obtain the much-needed cash income for improving household food and nutritional security. However, despite substantial increases in exports in recent years, the share of all African suppliers of mango and avocado to lucrative markets abroad remains below 25%. With the current liberalisation in trade, increasing growth in consumption patterns and addressing of factors that afflict production such as fruit flies, opportunities exist for increasing the export of these commodities.

Constraints

Two of the major obstacles to increased fruit production in East Africa are infestation by fruit flies (mainly the exotic *Bactrocera invadens* and native *Ceratitis* species) and the mango seed weevil (*Sternochetus mangiferae*) (Mwangi, 1985; Lux et al., 2003; Ekesi et al., 2009; Ekesi, 2010).

Female fruit flies lay eggs under the skin of fruits and vegetables causing direct losses. The eggs hatch into larvae that feed in the decaying flesh of the crop. Infested fruits and vegetables quickly rot and become inedible or drop to the ground. In addition to this direct loss, major indirect losses result from quarantine restrictions that are imposed by importing countries to prevent entry and establishment of unwanted fruit flies. For example, in the case of *B. invadens* exports of mango and avocado from Kenya, Tanzania and Uganda are already banned in Seychelles, Mauritius and South Africa (KHDP, 2008; Ravry, 2008; Guichard, 2009). Trade of several horticultural produce between Africa and the US has been severely hampered by the recently issued Federal Order to ban importation of several cultivated fruits and vegetables from African countries where *B. invadens* has been reported (USDA-APHIS, 2008). These restrictions have severely hampered free trade to important lucrative markets abroad.

The Target Pests

(1) *Bactrocera invadens*: This new invasive fruit fly pest is believed to have invaded Africa from the Asian subcontinent and was discovered in Sri Lanka soon after it was reported from Africa (Drew et al., 2005). Since first detection in March 2003 in Kenya, the insect has rapidly spread across tropical Africa and is now known from over 28 countries and the Comoros Islands and Cape Verde (Drew et al., 2005; French, 2005; Ekesi and Billah, 2007; De Meyer et al., 2010). The Inter-African Phytosanitary Council has described it as a “devastating quarantine pest” (Drew et al., 2005; French, 2005). Damage to mango (its primary host plant) has increased to between 40–80% especially in lowland areas where it is now the dominant fruit fly pest (Ekesi et al., 2006b; Rwomushana et al., 2009; Mwatawala et al., 2009). Ongoing host range studies across Africa have shown that the pest attacks other cultivated crops such as cucurbits, tomatoes, citrus, avocado and banana but the primary host plant is clearly mango compounding the existing problem on the crop. With grants from IFAD, BMZ and core support from *icipe*, studies on the bioecology of the exotic fruit fly, its response to improved attractants, bait sprays, male annihilation, fungal pathogens, efficacy of the indigenous weaver ant (*Oecophylla longinoda*) (Ekesi et al., 2007, 2009; Ekesi, 2010; Van Mele et al., 2007; Rwomushana et al., 2009; Ouna, 2010), and efficacy of two introduced natural enemies (*Fopius arisanus* and *Diachasmimorpha longicaudata*) from Hawaii have been completed (Mohamed et al., 2008; 2010). These technologies are therefore ready for demonstration, promotion and dissemination among growers to minimize the impact of the pest on fruits and vegetables.

(2) *Indigenous Ceratitis Fruit Flies*: A varying combination of five indigenous fruit fly species including *Ceratitidis cosyra*, *C. fasciventris*, *C. rosa*, *C. anonae* and *C. capitata* attack mango. Out of the five species the most damaging is *C. cosyra*. Traditionally, yield loss on mango due to native fruit flies can range between 30–70% depending on the locality, season and variety (Lux et al., 2003). Baseline ecological data relevant to the application of management strategies is currently available for these indigenous fruit fly species and their response to food attractants and susceptibility to fungal pathogens has been quantified (Manrakhan, 2005; Ekesi et al., 2005; Ekesi et al., 2006a, b) and ready for dissemination.

(3) *Mango Seed Weevil (MSW)*: Like fruit flies, mango seed weevils cause direct losses to the mango fruit. MSW is responsible for premature fruit drop, direct damage to fruit pulp, and reduced seed germination (Hansen; 1993; Peña et al., 1998; Verghese et al., 2005). It is also a major quarantine pest in many countries (CABI, 2000). Adult weevils insert their eggs into mango fruitlets and initially cause small, dark marks on the skin. The larvae develop inside the seed and the emerging adults cause substantial internal damage to the fruit pulp, while their exit holes provide entry to pathogens that accelerate the deterioration of the infested fruit (Joubert, 1998). Infestation by MSW in East Africa can vary between 25–68% depending on the variety, locality and season (Mwangi, 1985; Ekesi, 2010). Like fruit flies, indirect loss is associated with quarantine restrictions. As in the case of fruit flies, some smallholders practice cover-spray application at fruit set while a large majority does nothing and consequently suffer heavy losses especially for exports targeting the Middle East. Those that apply cover sprays apply insecticides that are not MRL compliant. Potent isolates of the entomopathogenic fungi and *soft* pesticides have been identified in the laboratory by *icipe* and there is an urgent need for large-scale on-farm promotion and dissemination of these control approaches jointly with farmers.

Proposed Management Strategies for Project Target Pests

(1) *IPM for fruit flies*: Previous experience with exotic and native fruit fly species in Africa and with other species in similar agroecologies in Latin America and the South Pacific has shown that management of a complex of fruit fly species is unlikely to be successful if based on a single management technique (Aluja et al., 1996; Allwood and Drew, 1997; Lux et al., 2003). An integrated pest management (IPM) approach offers the best method to improve the economies of the production system by reducing yield losses and enabling growers to comply with stringent quality on the export market (Aluja et al., 1996; Allwood and Drew, 1997; Lux et al., 2003).

icipe, and various partner institutions through several research project grants from donors such as IFAD, FAO and IAEA, has identified and developed a number of fruit fly management options against the target exotic and native fruit flies (*Bactrocera invadens*, *B. cucurbitae*, *Ceratitidis cosyra*, *C. fasciventris*, *C. rosa*, *C. anonae*, and *C. capitata*). These include several management products that are based on baiting techniques, male annihilation technique (MAT), mass trapping, use of the entomopathogenic fungus (*Metarhizium anisopliae*), conservation of natural enemies and orchard sanitation using the Augmentorium (Lux et al., 2003; Ekesi et al., 2005; Ekesi and Billah, 2007; Ekesi et al., 2006 a, b., Ekesi et al., 2007; Van Mele et al, 2007; Vayssières et al, 2009; Ekesi, 2010). On-farm trial results obtained with both the native and exotic species have been encouraging and the management toolbox is ready for large-scale application, adaptation, dissemination and promotion. In addition to the various management packages above, studies on the efficacy of two introduced natural enemies (*Fopius arisanus* and *Diachasmimorpha longicaudata*) from Hawaii have been completed against *B. invadens* (Mohamed et al., 2008). With regard to *F. arisanus*, limited field releases of the parasitoid have begun in Kenya and Tanzania following issuance of permits from the various government authorities and large-scale releases across the major mango and avocado production locales are planned if approval is granted for this project.

(2) *IPM for MSW*: The importance of field sanitation as an effective tool for reducing infestation by MSW has been stressed and is strongly advocated in South Africa (Joubert, 1998). This technique will be promoted in this project. Recent important findings have shown that mango seed weevils hibernate in huge numbers on the trunk of the mango tree. Unknowingly, growers apply control agents on the mango canopy rather than the trunk. Several *soft* pesticides such as spinosad, imidacloprid and thiamethoxam have been identified as valuable tools as drench application against the MSW. MSW is also highly susceptible to fungal pathogens and because adult weevils spend a substantial part of their time in the soil at the base of the mango trees in addition to the trunk, the potent fungus that has been identified will become a valuable tool for management of the insect. Any management approach for MSW that is based on a single tactic is less likely to provide a sustainable solution (Hansen, 1993) and an IPM strategy based on the use of orchard sanitation, entomopathogens and *soft* pesticides will be promoted and disseminated.

(3) *Post-harvest treatment for B. invadens*: Regulatory measures such as post-harvest quarantine treatments usually applied before export of fruits and vegetables will be important in the current project particularly for the devastating *B. invadens*. Currently, outside of the Republic of South Africa, there is no facility available for post-harvest treatment in sub-Saharan Africa and parameters for treatment must be established which will be given high priority in the project. Without such post-harvest treatments to provide quarantine security, quarantine restrictions will limit available markets for fruits and vegetables from East Africa. Available quarantine treatment options include using irradiation, chemicals, physical treatments and controlled atmosphere. Prohibition on the use of chemicals such as ethylene dibromide and methyl bromide as post-harvest quarantine fumigants, the expensive nature of irradiation and the fact that controlled atmosphere is mainly directed at dried fruits means that the use of cold and heat treatments may be an appropriate option for avocado and mango, respectively in the proposed project. There is, therefore, the need to identify effective cold and hot treatment regimes that are not harmful to the fruits, yet cost effective and suitable to the smallholder farmer. In this regard, the project will target mango for hot water treatment and avocado for cold disinfestations. Effective parameters will be established in close collaboration with industry partners, NARS and NPPOs for both fruits against *B. invadens*.

(4) *Monitoring and detection*: A sound quarantine system to reduce the risk of entry, establishment, spread and in general survival of a pest that is not already endemic to a country is important as it can minimise the severity of the pest problem. In many African countries, however, the concept of a sound quarantine system is not routine and is often viewed as difficult. Indeed, quarantine problems are often compounded not only by rapid expansion of international trade in fruit and vegetables but also by international passenger traffic, uncontrolled movement of fruits and poor surveillance practices. According to Armstrong and Jang (1997) there may actually be more risk for introduction of exotic pest species from contraband fruits smuggled by airline passengers than commercial shipments of fruits. The need to train quarantine specialists at quarantine barriers on detection, monitoring and taxonomy of fruit flies and MSW is therefore crucial and will be vigorously pursued in this project. Indeed an efficient quarantine system in Africa may also limit the spread of these devastating pests from Africa to other parts of the world. For example, in Australia, the implementation of an effective IPM programme for fruit flies and better regional control efforts in Southeast Asia have led to fewer fruit flies being 'exported' to other countries. Additionally, correct identification of a wide range of fruit species was found to reduce the probability of misidentification of an incursion into Australia and saved unnecessary expenditure of further surveillance, containments and eradication (www.aciar.gov.au).

Although our target pests and particularly the fruit fly species attack numerous tropical fruits and vegetables, the project shall focus on mango and avocado. These target crops represent important smallholder products for both domestic and export markets.

PROJECT JUSTIFICATION

In East Africa, production of fruits and vegetables is recognised as a major source of income and has been accorded high priority in the national development plans of most of the countries in the region. This is also reflected in the region's agricultural sector priorities in which enhancement of horticultural production for income generation figures prominently (HCDA, 2004, 2009; Mugenyi, 2004; Sonko et al., 2005). In Kenya, horticulture including flower production overtook tourism in 2008 contributing up to US\$ 1 billion in foreign exchange and over US\$ 650 million domestically (HCDA, 2009). Out of this, fruits and vegetable exports alone were estimated to be worth US\$ 460 million in 2008 (KRA, 2008; HCDA, 2006, 2009). In Tanzania, horticulture earned the country US\$ 9.2 million in 2003 (Mugenyi, 2004). In Uganda, in 2003 alone, export of fruits and vegetables contributed US\$ 12.5 million to the national economy, which was equivalent to 4% of the country's total export value (E. Niyibigira et al., unpublished data). The export of fruits and vegetables in the three African countries—Kenya, Tanzania, and Uganda—is increasing at an annual rate of 15–20% and this trend is likely to continue with horticulture employing over 4 million people, mostly women and the youth in the production, transport, processing and trade sectors. Over 80% of the produce comes from smallholders who produce for the local and export markets to obtain the much-needed cash income for improving household food security and livelihood.

In this region, however, one of the major problems afflicting production of quality fruits and vegetables is infestation by fruit flies, especially the invasive species, *B. invadens*. Assessment made by *icipe*-led African Fruit Fly Programme in 1999 showed that, out of 90,000 tons of mango produced annually in Kenya about 40% is lost to native fruit fly infestation (Lux et al., 2003). With the arrival of *B. invadens* from the Asian sub-continent, damage to mango in Kenya, Tanzania and Uganda has risen to between 40 to 80% (Seguni and Mwaiko, 2005; Ekesi et al., 2006b; Ekesi et al.,

2009). Besides causing these extensive direct losses in the field, fruit flies greatly restrict the trade and export of fruits and vegetables to large and lucrative markets abroad where they are regarded as major quarantine pests (Barnes, 2004). For example, exports of potential host species of *B. invadens* such as mango, avocado and cucurbits from Kenya are already banned in Seychelles, Mauritius and South Africa. Trade of several horticultural produce between Africa and the US has been severely hampered by recently issued Federal Order by US banning importation of several cultivated fruits and vegetables from African countries where *B. invadens* has been reported (USDA-APHIS, 2008). In the case of avocado, Kenya lost US\$ 1.9 million in 2008 due to *B. invadens* quarantine restriction imposed by South Africa. Ugandan exports of banana have been severely affected due to quarantine restrictions on *B. invadens* despite it not normally being associated with this crop.

The mango seed weevil (MSW) on the other hand causes direct damage to mango fruit pulp and up to 68% infestation has been recorded in coastal Kenya and Tanzania (Mwangi, 1985; Z. Seguni, unpublished data). Aside from direct losses, MSW is also a serious quarantine pest like fruit flies and indirect losses result from quarantine restrictions imposed by importing countries to prevent entry and establishment of the pest (CABI, 2000).

Considerable losses due to fruit flies and MSW reduce the profits of smallholder growers and traders and contribute to high production costs. Some farmers frequently control these pests by spray application of broad-spectrum pesticides like malathion and diazinon, most of which are listed as candidate persistent organic pollutants (POPs) by UNEP (www.unep.org/thematic/chemicals). These pesticides often contribute to high pesticide residues on fruits and vegetables and rejection by export markets. Other growers who cannot afford available pesticides suffer considerable losses due to high levels of fruit fly and MSW infestations. When available to rural farmers, pesticides are often applied too ineffectively to significantly affect pest incidence (MoA, 2003). Furthermore, there is often little regard for human and environmental safety when these pesticides are applied. Because of lack of basic knowledge about the biology and ecology of fruit flies, some smallholders practice early harvest as a strategy to evade infestations. This often does not help as some fruit fly species like *B. invadens*, *C. cosyra* and *C. rosa* attack green immature and mature mango fruits (S. Ekesi *et al.*, unpublished data). Additionally, the quality of early harvested fruits is inferior to tree-matured fruits. This control action is, therefore, ineffective. The recently introduced uniform and strict quarantine regulations and maximum residue levels (MRLs) by the EU compound the problem and jeopardise the lucrative export and trade in fruits and vegetables from Africa to Europe. Consequently, the success of fruit and vegetable production in Kenya, Tanzania and Uganda, whether it is for the rapidly expanding domestic market or for export, will largely depend on sound management of fruit flies and MSW. So, there is a critical need to demonstrate, adapt and disseminate proven IPM programmes based on baiting technique, male annihilation, use of biopesticides, parasitoids and orchard sanitation that promote alternatives to broad-spectrum insecticides. The proposed strategy in the technology transfer to the grower community is to involve them directly in the demonstration of the technologies, adaptation and dissemination through Farmer Field Schools (FFS) in several benchmark sites in the participating countries. Experience in the development of the various management options to date shows that several farmers are interested in the technological package and rapid uptake is anticipated especially given the ever-increasing loss at the export market. If losses caused by fruit flies and MSW can be reduced, food self-sufficiency will be increased and the livelihood of the farming community will be enhanced and the economy will improve.

Equally important for the transfer of appropriate pre-harvest technologies for combating the native and invasive fruit flies is the need for regulatory measures such as post-harvest quarantine treatments (usually applied before export of fruits and vegetables). There is no facility available for post-harvest treatment in the four target countries. Parameters for treatment must be established. Without treatments to provide quarantine security, quarantine restrictions will limit available markets for fruits and vegetables from the region. There is, therefore, the need to identify effective post-harvest treatments that are not harmful. In this regard, parameters for hot water treatment for mango and cold treatment for avocado will be developed jointly with industry partners/growers, NARS and NPPOs and aptly transferred to relevant authority. It is believed that investment in post-harvest treatment plant in the region could improve export of fruits and vegetables from East Africa by up to 50% (R. Ntoyai, Kenya Plant Health Inspectorate Service, pers. commun.). Phytosanitary measures that reduce the risk of entry, establishment, spread and general survival of a pest that is not already endemic to a country are imperative to prevention and exclusion of the invasive species. Adequate training of inspectors to respond to unknown insects through surveillance is an important activity. The above will also be pursued in the project.

The project shall build on the vast experience of *icipe* and FAO on IPM and previous knowledge with dealing with invasive pests and particularly *B. invadens* with the aim of enabling effective management of all target fruit flies and MSW in East Africa.

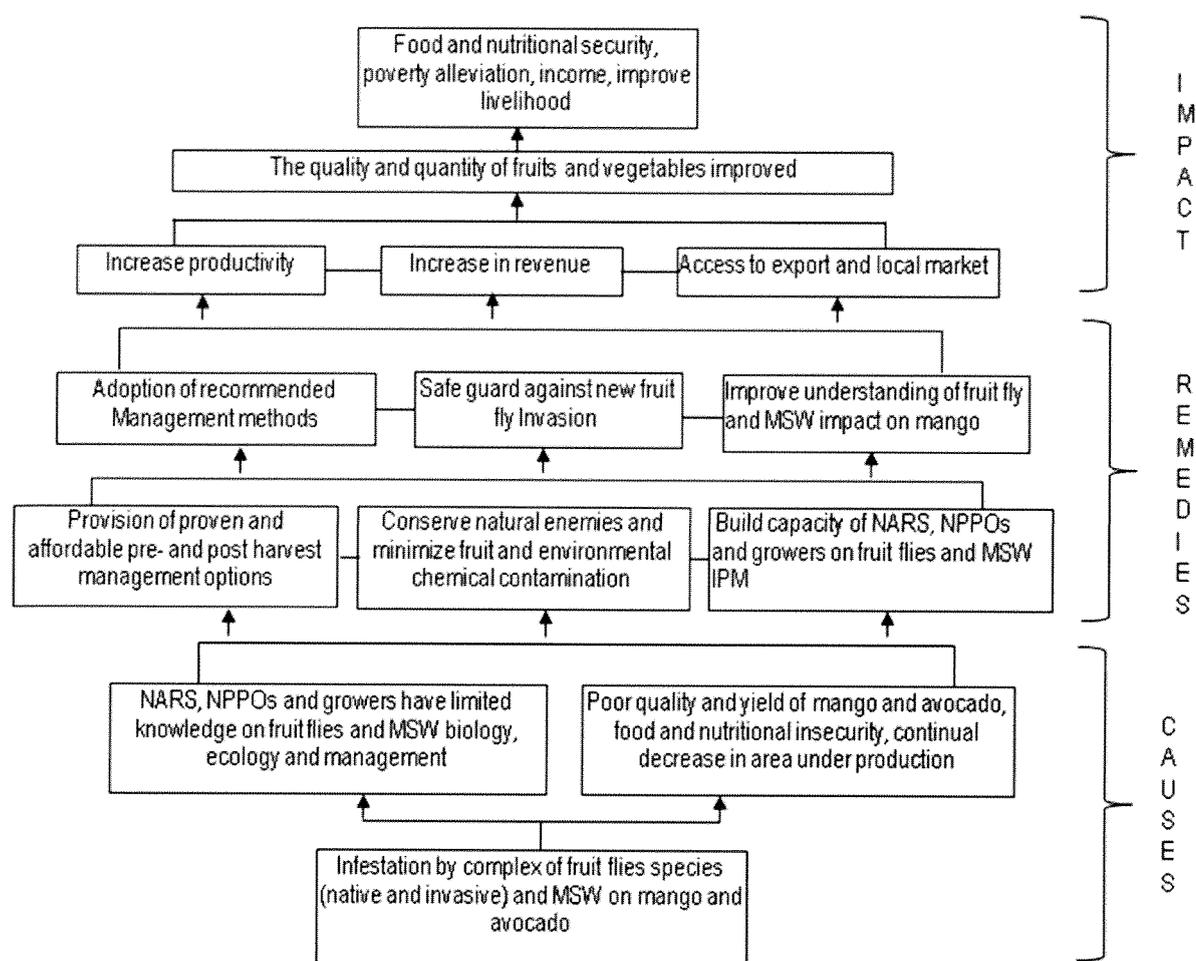


Figure 1. Project objective tree: Causes, remedies and impact

CONSULTATION WITH STAKEHOLDERS

In the development of this project document several consultations were held with stakeholders. The resources provided by IFAD, FAO, IAEA and BMZ to the *icipe*-led African Fruit Fly Programme (AFFP) has allowed for consultative meetings with stakeholders in East and southern Africa that included fruit and vegetable growers, NARS and NPPOs and governments of participating countries on the problems related to fruit flies and MSW in the region and to design a project document for long-term management of these insects. The AFFP, through its various regional stakeholders' meetings since November 2005 to date, has had an extensive consultation with regional partners on the tactics for dealing with fruit flies in Africa. The GIZ (formerly GTZ) with participation of *icipe* also held a series of stakeholder workshops on mango value chain and identified fruit flies and MSW as the major obstacles limiting increased fruit and vegetable production in Kenya. Following these various stakeholder meetings, the FAO in August 2006 and April 2009 sponsored task force meetings with broad participation of government officials of Kenya, Tanzania (mainland and Zanzibar) and Uganda to develop a long-term strategy for management of both fruit flies and MSW in the region. **On May 25, 2010, the World Bank organised a video conference in Nairobi to lobby funding support to the fruit fly menace in Africa (www.globalhort.org).** During the Sub-Regional Contingency Planning and Transboundary Emergency Plant Pests (EPP) Preparedness Workshop organised by FAO in October 2010 in Zambia, fruit flies and especially *B. invadens*, were listed as EPP that require urgent attention and donor support in Africa. The current proposal provides a comprehensive view of the outcome of the various stakeholder meetings and if approved would go a long way in ameliorating the fruit fly and MSW related problems in the region thereby increasing food and nutritional security, income generation capacity and livelihood of the East African countries.

PROJECT DESCRIPTION

Project Vision: The proposed project is a collaborative joint initiative of FAO with *icipe* and national institutions in East Africa with the broad objective of improving the income and nutrition of smallholder families and increase the export earnings of the target countries by improving yield and quality of mango and avocado through the introduction of sustainable IPM programmes and post-harvest treatment tools for fruit flies and MSW.

Project Mission Statement: The project shall build on existing experience of the collaborating institutions and provide management tools to growers by demonstrating new and existing technologies combining them into an IPM package and disseminating the management tools to smallholder farming communities in the targeted countries. The project also plans to provide post-harvest management tools to allow for export of fruits to quarantine-sensitive markets. Training at various levels of competence will be a fundamental component of the project, and capacity of NARS and NPPOs in surveillance, pest diagnostics and phytosanitary information management will be improved. The proposed project builds on several consultations with stakeholders in the fruit and vegetable industries, local authorities of the target countries, international fruit fly experts and donor agencies following completion of a FAO-TCP project on surveillance of *B. invadens* in East Africa that revealed serious economic problems associated with the invasion of the insect.

Goal: To enhance food and nutritional security, improve income generation capacity and livelihood of fruit and vegetable growers in eastern African countries.

Purpose: To implement and disseminate, in collaboration with international and national partners, effective approaches (that are based on baiting technology, biopesticides, parasitoids, trapping, orchard sanitation and post-harvest treatments) that lead to reduction of fruit and vegetable losses due to fruit flies and MSW infestation leading to quality production to meet the needs of both the domestic and export markets.

Collaborating Institutions, NARS and ARO: Kenya: (1) Ministry of Agric., Nairobi (MoA-N)—Dr W. Songa and Mr N. Ticha; (2) Kenya Plant Health Inspectorate Service (KEPHIS)—Dr W. Otieno and Mr S. Muchemi; (3) Kenya Agricultural Research Institute (KARI)—Dr M. Waiganjo; (4) International Centre of Insect Physiology and Ecology (*icipe*)—Drs S. Ekesi and S. Mohamed. **Tanzania:** (1) Mikochei Agricultural Research Institute (MARI)—Dr Z. Seguni; (2) Ministry of Agriculture & Food Security, Plant Health Service (MAFS)—Dr. F. Katagira, Mr G. Kirenga, Ms J. Muganyizi and Ms B. Pallangyo. **Uganda:** (1) National Crops Resources Research Institute (NaCRRI) and Ministry of Agric. Animal Industries & Fisheries, Kampala (MoA-U)—Dr I. Rwomushana and F. Okullowany. **FAO**—Dr A. Peralta. Responsibilities of all project partners are as listed in Annex 1. At project inception meeting, partners will identify relevant farmer groups at project benchmark sites and key private sectors for project implementation and operations.

PROJECT COMPONENTS

Four project components are proposed. These are listed below with the respective envisaged activities per component.

Component 1 – Pre-Harvest Management Measures: New technologies, exotic natural enemies and other existing management tools for controlling *B. invadens* and mango seed weevil assembled, demonstrated in multi-locational sites and disseminated.

Specific activities

- (1) Assembling and large-scale demonstration, adaptation and dissemination of IPM package for fruit flies based on baiting, male annihilation, use of fungal pathogens, ant technology, orchard sanitation and assessing impact using farmer field schools (FFS) and technology learning sites in each participating country (**CFC funded for Kenya, Tanzania, Uganda; BMZ co-financing for Kenya, Tanzania**).
- (2) Conduct on-farm demonstration, adaptation and dissemination of trunk application of soft pesticides and fungal pathogens against MSW using FFS and technology learning sites in each country (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania**).
- (3) Large-scale releases of fruit fly parasitoids (*F. arisanus* and *Diachasmimorpha longicaudata*) and monitoring for establishment and impact (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania; Biovision co-financing for Kenya**).

Component 2 – Post-Harvest Treatments: Cold and hot water post-harvest disinfestations trials completed and validated for *B. invadens* on avocado and mango, respectively.

Specific activities

- (1) Maintain colonies of *B. invadens* for heat and/or cold tolerance testing (**BMZ co-financing**).
- (2) Determination of the most cold-tolerant stage of *B. invadens* on avocado (**SAAGA funded**).
- (3) Determination of the most heat-tolerant stage of *B. invadens* on mango (**CFC funded; BMZ co-financing**).
- (4) Large-scale validation trials on avocado (cold treatment) (**SAAGA funded**).
- (5) Large-scale validation trials on mango (heat treatment) (**CFC funded; BMZ co-financing**).

Component 3 – Surveillance and Preventative Measures: Surveillance, identification and mitigation measures to avert the threats of other exotic fruit flies that may impact on the management strategy and the industry.

Specific activities

- (1) Conduct systematic trapping, monitoring and detection for exotic fruit flies in fruit and vegetable growing regions and other strategic locations in target countries to guide the application of phytosanitary management. (**CFC funded for Kenya, Tanzania, Uganda; BMZ co-financing for Kenya, Tanzania**).
- (2) Establish in each participating country a database for target pests for the management of surveillance data and information sharing among partner countries. (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania**).

Component 4 – Training and Technology Dissemination: Enhanced technical capacity at various levels of competency to support and sustain the project.

Specific activities

- (1) Train NARS and NPPOs (training of trainers) on surveillance and pre-harvest management packages—baiting; male annihilation; use of fungal pathogens; parasitoid mass rearing techniques, quality control, release and evaluation of parasitism; and orchard sanitation. (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania**).
- (2) Fruit fly and MSW IPM technology learning sites established through FFS, contact farmers, farmer groups, and national extension networks through hands-on training approaches on surveillance and all management packages and awareness campaigns on technology availability. (**CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya**).
- (3) Facilitate training of representatives of industry partners in participating countries on use of post-harvest treatment. (**CFC funded; BMZ co-financing**).
- (4) Prepare and disseminate fruit fly and MSW IPM materials and guidelines with due regard to market requirements through project website, leaflets, posters, manuals, and radio and TV programmes to facilitate large-scale adoption and application of the recommended management tools (**CFC funded; BMZ co-financing**).

COMPONENT 1

PRE-HARVEST MANAGEMENT MEASURES:

New technologies, exotic natural enemies and other existing management tools for controlling *B. invadens* and mango seed weevil assembled, demonstrated in multi-locational sites and disseminated

Background

Under this component, the project intends to achieve the objectives through participatory on-farm demonstration, adaptation and dissemination of technologies based on baiting technology, use of male annihilation, entomopathogenic fungus (*Metarhizium anisopliae*), releases of parasitoids (*Fopius arisanus* and *Psytalia fletcheri*), promotion and conservation of the weaver ant (*Oecophylla longinoda*), and orchard sanitation through the use of the Augmentorium (Ekesi et al., 2005; Ekesi and Billah, 2007; Ekesi et al., 2006 a b; Ekesi et al., 2007; Van Mele et al., 2007; Vayssières et al., 2009; Hanna et al., unpublished). This IPM package will therefore consist of a 'menu' of management options suitable for different species and ecologies and also depending on pests' severity/levels of damage in the various localities. The effectiveness and feasibility of the package will be tested with full participation of growers, NARS and

NPPOs in all the target countries. A pilot production facility for locally developed bait, fungus and traps will be established for demonstration to potential entrepreneurs that may take up production while at the same time producing materials for field suppression activities in all the target countries. The specific activities and methodological approach envisaged under this component are briefly described below.

Activity 1: Assembling and large-scale demonstration, adaptation and dissemination of IPM package for fruit flies based on baiting, male annihilation, use of fungal pathogens, ant technology, orchard sanitation and assessing impact using farmer field schools (FFS) and IPM technology learning sites in each participating country (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania)

Traditionally, the use of food attractants consisting of hydrolysed protein or ammonia-based mimics such as NuLure, combined with relatively small amounts of insecticides, has been the major control method for fruit flies (Roessler, 1989). The food baits containing pesticidal toxicant are applied locally to 1-m² spots of tree canopy or trunk, avoiding contact with fruits. Adult fruit flies are attracted to the spot from a distance where they ingest the toxicant and are killed. *icipe* has identified powerful commercial attractants such as GF-120, Mazoferm, methyl eugenol and terpenyl acetate that could be utilised both as liquid baits, solid bait stations and killer blocks for management of *B. invadens* and native *Ceratitidis* species (Ekesi, 2010; Hanna et al., 2008). The entomopathogenic fungus *M. anisopliae* has been developed for both adults and pupariating larvae of the different fruit flies (Ekesi, 2010; Ouna, 2010). Candidate isolates will be employed both for soil inoculation against all target pests, and whenever possible, as killing agents in baiting stations/biodegradable spheres. The weaver ant *O. longinoda* has been shown to effectively suppress fruit flies on mango in Benin, West Africa (Van Mele et al., 2007). The efficacy of this technology is yet to be tested in eastern and southern Africa and this technology will be integrated into the IPM package being proposed for the region. Sound crop sanitation that involves the collection and destruction of all fallen fruits will be strongly advocated. A new technique that involves the use of the Augmentorium® (Klungness et al., 2005) developed by Hawaiian entomologists will be employed. The Augmentorium serves the double purpose of field sanitation and conservation of natural enemies of fruit flies. It is a tent-like structure that sequesters fruit flies that emerge from fallen rotten fruits that are collected from the field and deposited in the structure while at the same time conserving their natural enemies by allowing parasitoids to escape from the structure through a fine mesh at the top of the tent.

The components of the IPM package will, therefore, include the following elements: (1) fruit fly monitoring using simple trapping system; (2) fruit fly suppression using baiting technology either as canopy bait spray or solid bait station combined with appropriate toxicant (insecticides or the identified fungal pathogen); (3) male annihilation with methyl eugenol as perimeter trapping; (4) soil inoculation with candidate entomopathogenic fungus to kill pupariating fruit fly larvae; (5) ant technology through promotion and conservation in the orchard; and (5) orchard sanitation (by collecting and deposition of fruits in an Augmentorium). The package will therefore include a 'menu' containing several complementary techniques. NARS and NPPO collaborators in consultation with growers and *icipe* will choose a combination of elements from the package, which are locally feasible and applicable. Such 'custom tailored' variants of the package will be demonstrated and promoted in each of the participating countries. Implementation of this activity will be closely linked with training and technology dissemination operations of the project (*see component 4 below*). In each country, 2–3 FFS/IPM technology learning sites will be established from among farmer groups and/or role model farmers. Depending on the consultation with the growers, packages suitable for different species and ecologies and pests' severity/levels of damage in the various localities will be chosen and applied. Treatments proposed for demonstration must consist of: (i) custom tailored IPM package, (ii) farmers' methods of control and (iii) untreated control whenever possible. The IPM package treatment will also represent the FFS or IPM technology demonstration and learning sites. In most African communities, growers frequently meet at a model farmer's compound for various community development initiatives. Therefore, locating the FFS or IPM technology learning sites in the model farmers' fields offers easy access to the technology demonstration sites, facilitating farmers' observation and comparison of the technologies with their own trials. Fruit flies technology Starter Packs will be distributed to at least 1000 growers for them to compare performance of demonstration trials with their own experiments. Growers, NARS and *icipe* staff will monitor demonstration plots and collect data from the 3 treatments above. Efficiency of treatments shall be monitored by number of fruit flies caught on each plot using appropriate food bait during the season and by the actual fruit infestation by fruit fly larvae at harvest time.

Performance indicators/Measurable outputs:

- IPM package that is based on baiting and male annihilation techniques, use of fungal biopesticides, predatory ants and orchard sanitation demonstrated, adapted and disseminated to at least 1000 growers by mid 2014.

- At least 40% of growers at each project benchmark site adopt and participate in use of at least 2 IPM components by 2014.
- During years of average seasonal conditions, at least 40% of growers reduce fruit flies densities on mango by 70% leading to 30% yield increment translating to US\$ 1,440/ha (9 t/ha) representing additional income of US\$ 640/ha by 2014.
- Cover sprays pesticide application reduced by 30% at benchmark sites.
- Pesticide load in fruits that are produced by 30% of growers at benchmark sites reduced to internationally acceptable level.
- Export markets fruit rejection at benchmark site reduced by 70% by 2014.
- At least 600 family members benefiting from additional seasonal labour.

Activity 2: Conduct on-farm demonstration, adaptation and dissemination of trunk application of soft pesticides and fungal pathogens against MSW using FFS and technology learning sites in each country (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania).

Several soft pesticides such as spinosad, imidacloprid, and thiametoxam were recently identified by *icipe* for management of the MSW. Similarly, the entomopathogenic fungus, *M. anisopliae* has also been found to be a useful tool in the IPM package for MSW. Different formulations of the fungus have been tested and an oil-based formulation has been found suitable for field application based on long persistence in the field and amenability to mass production. Orchard sanitation, which has proven to be an effective tool for managing MSW in Hawaii, will also form an important component of the management package. In this activity we, therefore, propose to conduct a large-scale field testing and validation of the technologies based on soft pesticide application, trunk application of fungal pathogen and orchard sanitation as a means of managing MSW on mango. Proposed package for demonstration at the FFS/technology learning sites will include the following elements: (1) IPM based on suppression with soft pesticides and orchard sanitation, (2) IPM based on suppression with the fungus (*M. anisopliae*) and orchard sanitation (suitable for organic production), (3) farmer method and (4) untreated orchard whenever possible. Treatments 1 and 2 will represent our FFS demonstration trials and all other protocols will be similar to that described in Activity 1. MSW IPM Starter Packs will be distributed to at least 1000 growers and efficiency of treatments shall be monitored by number of MSW in mango fruit at harvest time.

Performance indicators/Measurable outputs:

- Trunk application of appropriate soft pesticides, entomopathogenic fungus and orchard sanitation demonstrated and disseminated to at least 1000 growers by mid 2014.
- At least 30% of growers at each benchmark site adopt and participate in use of at least two IPM packages by 2014.
- Direct economic benefits to growers are expected to be similar to activity 1 given that the farmer would be implementing all management options on one crop.
- At least 20% financial savings by 50% of the farmers adopting the IPM practices as a result of limited use of pesticides through spot application on trunk.
- At least 600 family members benefiting from additional seasonal labour (e.g. orchard sanitation, harvesting etc.).
- Pesticide residue in fruits that are produced by 30% of growers at benchmark sites reduced to internationally acceptable level.
- Export markets fruit rejection at benchmark site reduced by 70% by 2014.

Activity 3: Large-scale releases of fruit fly parasitoids (*F. arisanus* and *Diachasmimorpha longicaudata*) and monitoring for establishment and impact (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania; Biovision co-financing for Kenya)

The efficacy of two introduced natural enemies (*F. arisanus* and *D. longicaudata*) from Hawaii has been completed and ready for field releases (Mohamed et al., 2008, 2010). Limited field releases of *F. arisanus* have been carried out in Kenya and Tanzania following issuance of permits from the various government authorities. Large-scale release of the parasitoids is proposed in all target countries. **For clarity and based on the CFC Project Appraisal Committee comments to an earlier version of the proposal, we would like to state that classical biological control is NOT the same as sterile insect technique (SIT).** Given the fact that *B. invadens* is an exotic fruit fly species of South Asian origin that was accidentally introduced to Africa, *icipe* has imported effective biological control agents (in this case parasitoid natural enemies) to re-unite the natural enemy with the pest through mass releases in the

***B. invadens* affected countries. Once the parasitoid/natural enemy has established in the new environments, no further releases are required, as it will continue to control the pest naturally at no additional cost to the growers.** Parasitoids will be released: (1) at project target and non-target crops (mango, citrus, zucchini, cucumber, bitter melon and watermelon) at project benchmark sites; (2) at selected farm sites and urban settings containing garden and ornamental trees that are host to target fruit flies (e.g. *Terminalia catappa* for *B. invadens*); (3) in wholesale and retail fruit dumping sites with a variety of host fruits; and (4) in managed and unmanaged refugia consisting of unsprayed annual or perennial plant hosts suitable for development of the fruit flies and parasitoids. Adult parasitoids will mostly be targeted for releases. However, whenever possible, the parasitoid-preferred host fruits (*Sclerocarya birrea*; *T. catappa*) will be field-collected, exposed to fruit fly adults and then parasitoids in the laboratory, and later released back to the field in an Augmentorium.

The international partners and participating NARS that were trained in mass rearing, handling and release of the parasitoids will evaluate parasitoid dispersal and impact after releases in the countries. To document the establishment, dispersal and impact of the introduced parasitoids in the ecosystem and to monitor for evidence of non-target impacts on beneficial fruit flies, surveys will be conducted along a predetermined distance in the target countries. Different host fruit species for target pests as well as fruits, flowers and galls, which might be hosting beneficial fruit flies will be examined for fruit fly infestation. Various urban and farm site ornamental fruits will also be collected and processed to assess for establishment. At all localities, samples will be collected at various times throughout the year rather than strict specificity to a particular period. Radius from the nearest location of release point will also be measured. Post-release evaluations will be conducted at intervals appropriate for each host/parasitoid system at release sites and at distances with intervals depending on the spread potential of the parasitoids. Fruits will be collected at various locations where releases have been conducted, incubated in the laboratory until fruit flies and parasitoid emergence and parasitism index and impact on target as well as the non target hosts will be assessed. One Augmentorium shall also be installed in each of the project demonstration plots to preserve parasitoids in the orchards while contributing to orchard sanitation. Additionally, at least 100 augmentoria shall be distributed to growers in the surrounding villages around the release sites for preservation of parasitoids and orchard sanitation.

Implementation of this activity will be closely linked with training and technology dissemination operations of the project (see component 4 below).

Performance indicators/Measurable outputs:

- Parasitoids established at release sites by mid 2014 resulting in 20% financial savings by 40% of the farmers due to limited use of pesticides.
- Cover sprays pesticide application reduced by 30% at benchmark sites.
- Pesticide load in fruits that are produced by 30% of growers at benchmark sites reduced to internationally acceptable level.

COMPONENT 2

POST-HARVEST TREATMENTS MEASURES:

Cold and hot water post-harvest disinfestations trials completed and validated for *B. invadens* on avocado and mango, respectively

Background

In today's global horticultural economy, the application of IPM tools and classical biological control methods alone may not be an acceptable option for assessing quarantine-sensitive markets. Post-harvest treatments are, therefore, needed to maintain the flow of export commodities through lucrative marketing channels from Africa. The need to research and develop efficacious quarantine treatments to move fruits and vegetables through quarantine barriers becomes crucial. Post-harvest quarantine treatments include fumigation with toxic compounds, irradiation, and non-host status and regulatory inspection protocols. Not all of these measures are applicable under the African setting. For example, fumigation is currently banned, irradiation may be too expensive, non-host status is applicable to commodities that are not host to fruit flies while systems approach will probably require years of intensive biological and host/plants studies. Research efforts in the current project will, therefore, be directed at physical disinfestation treatments such as heat or cold treatment. **Again for the purpose of the CFC PAC comment, it is important to clarify that because of the novelty status of *B. invadens*, no post-harvest treatment measures have been developed for this insect pest on**

mango and avocado. Recently, the USDA/APHIS and FAO/IAEA have also embarked on post-harvest treatment research for *B. invadens* on apple, orange and plum, at the Insect Pest Control Laboratory at Seibersdorf but no results are available as yet (IPPC, 2011). Even if results become available, they will be specific for apple, orange and plum. In this project we propose to conduct post-harvest treatment research exclusively on *B. invadens* on mango (heat treatment) and avocado (cold treatment) for sole reason that **there is no parameter available globally for this pest and that** these two crops have significantly been affected by quarantine restrictions due to *B. invadens* across the target countries.

There are 4 phases in the development of heat and cold treatment: (1) establishment and maintenance of the insect colony, (2) investigation of the larval development in the target crop, (3) determination of the most heat or cold tolerant stage and (4) large-scale trial using the most heat or cold tolerant stage. Colonies of *B. invadens* already exist at *icipe* and only require maintenance for continuous supply of the insect for the activity. Studies on the development of *B. invadens* on avocado and mango have been completed through *icipe* core research support. In this component, the project has set realistic objectives of availing data, information and whenever possible, materials after completion of the above trials that can facilitate development of post-harvest treatment facility rather than establishing a facility itself. Establishment of a facility cannot be met within the proposed project resources. However, once appropriate data have been generated and the data are disseminated to the industry, rapid uptake is anticipated from the industries that are willing to recoup lost export market. The activities required to accomplish this component are, therefore, determination of the most cold tolerant stages and large-scale validation trials that will contribute towards lifting of major trade barriers. In this regard, the following actions are envisaged:

Activity 1: Maintain colonies of *B. invadens* for heat and/or cold tolerance testing (BMZ co-financing activity)

To conduct experiments of post-harvest treatment for the target fruit flies, a regular supply of good quality insects of pre-determined reproductive stages and age is crucial. *icipe* has developed standard rearing methodologies for all the target fruit fly species (Ekesi et al., 2007). This activity will be conducted mainly at *icipe* with funds from BMZ and FAO and will also benefit mass rearing of parasitoids for field releases since the host insects are necessary for the rearing of the natural enemies.

Performance indicators/Measurable outputs:

- Vibrant colonies of *B. invadens* established by mid 2012.

Activity 2: Determination of the coldest tolerant stage of *B. invadens* on avocado (SAAGA funded)

This test will be conducted using the most internationally accepted methodology of Jessup (1994). Fruit for each stage to be tested will be infested at differing times relative to the development so that treatment of all stages could be carried out at the same time. When the stages are reached, they will be checked by dissecting a small additional sample and infested fruit placed in fridge at 2 °C. Sample of approximately 20 fruits will be removed daily for 7–12 days after cold treatment and held over sand in incubation rooms set at 29 °C and 70% RH until all larvae have left. Sand will be sieved over a period of 4 weeks to collect puparia and for comparison of treatments. For each cultivar, the resulting survivors from each life stage will be recorded to enable computation of LT₅₀ (time in minutes that is lethal to 50% of the insects). The effect of treatment on fruit quality will also be assessed.

Performance indicators/Measurable outputs:

- The most cold-tolerant stage of *B. invadens* on avocado determined by end of 2012.

Activity 3: Determination of the most heat-tolerant stage of *B. invadens* on mango (CFC funded; BMZ co-financing)

This test will be conducted using the most internationally accepted methodology of Sharp et al. (1989ab) and Armstrong et al. (1995). Treatment of all stages will be carried out at the same time as in avocado. When the stages are reached, they will be checked by dissecting a small additional sample and the infested fruit placed in a water bath or metal containers and propane gas operated burners set at 45 °C. Sample of approximately 20 fruits will be removed at 20, 25, 30, 35, 40, 45, 50 and 55 min after heat treatment and held over sand in incubation rooms set at 29 °C and 70% RH until all larvae have left. Sand will be sieved over a period of 4 weeks to collect puparia and for comparison of treatments. For each cultivar, the resulting survivors from each life stage will be recorded to enable computation of LT₅₀ (time in minutes that is lethal to 50% of the insects). The effect of treatment on fruit quality will also be assessed (Sharp et al., 1989ab). Mangoes will not be accepted if they show any shriveling, different colour, scalding and flavour, and unusual aroma compared with untreated control.

Performance indicators/Measurable outputs:

- The most heat-tolerant stage of *B. invadens* on mango established by end of 2012.

Activity 4: Large-scale validation trials on avocado (SAAGA funded)

In this trial, fruit inoculated with eggs and allowed to develop to the most cold-tolerant life stage identified in Activity 2 will be used. The fruit will be placed in cold storage and then inspected according to the procedures in Activity 2, except that 3000–5000 individuals of the most tolerant life stage will be tested for survival. Appropriate dose response curves (e.g. Probit analysis with Abbott's correction) will be used to determine the lethal time of exposure needed to achieve >99% mortality with 95% confidence.

Performance indicators/Measurable outputs:

- Large-scale validation trials on avocado completed by end of 2013 and parameters made available to the private sector and growers.
- By the end of 2014 and depending on availability of treatment facility, at least 2 lost export markets due to *B. invadens* regained by avocado growers in project partner countries.

Activity 5: Large-scale validation trials on mango (CFC funded; BMZ co-financing)

In this trial, fruit inoculated with eggs and allowed to develop to the most heat-tolerant life stage identified in Activity 3 will be used. The fruit will be immersed in hot water and then inspected according to the procedures in Activity 3, except that 3000–5000 individuals of the most tolerant life stage will be tested for survival. Appropriate dose response curves (e.g. Probit analysis with Abbott's correction) will be used to determine the lethal time of exposure needed to achieve >99% mortality with 95% confidence.

Performance indicators/Measurable outputs:

- Large-scale validation trials on mango completed by end of 2013 and parameters made available to the private sector and growers.
- By the end of 2014 and depending on availability of treatment facility, at least 2 lost export markets due to *B. invadens* regained by mango growers in project partner countries.

COMPONENT 3

SURVEILLANCE AND PREVENTATIVE MEASURES:

Surveillance, identification and mitigation measures to avert the threats of other exotic fruit flies that may impact on the management strategy and the industry

Background

As part of globalisation in trade in fruits and vegetables, trade between the targeted eastern African countries, their neighbouring countries and importing countries will be gradually liberalised thus increasing the chances of inadvertently translocating fruit flies that constrain horticulture among these countries. Generally, in addition to increases in trade, the cultural ties and customs of bearing gifts (such as host fruits) by visitors and travelers among African countries will obviously lead to exchange of fruit flies. Mechanisms must be found to minimise this problem and pest surveillance activities and training of NPPOs in all countries will be essential. Knowledge of existence of certain species of fruit flies in neighbouring countries will ensure that NPPOs of eastern and southern African countries and their trading partner countries respond quickly to emergencies arising from pest invasions and develop appropriate measures to manage and minimise incursions. In this regard, the following activities are proposed for this project component:

Activity 1: Conduct systematic trapping, monitoring and detection for exotic fruit flies in fruit and vegetable growing regions and other strategic locations in target countries to guide the application of phytosanitary management.

To prevent entry of other exotic fruit flies into the countries, NPPOs of the participating countries must enforce a systematic trapping and monitoring system. This can be achieved by establishing an extensive grid of attractants such as methyl eugenol (ME), Cuelure (CUE) and Trimedlure traps round the countries including all the major ports of call for immigration, trade and fruit dumping sites. This should provide early warning against entry of a range of exotic fruit fly species and incursions of indigenous flies into current or previously uninfested areas and this activity will be vigorously

pursued in the current project. Survey methodology will follow the guidelines developed by IAEA (2003) and Ekesi and Billah (2007).

Performance indicators/Measurable outputs:

- Five hundred permanent trapping stations established in strategic locations in the three target countries for fruit fly monitoring and detection by mid 2012.
- Identity of trapped insects confirmed and curated.
- A multi-stakeholder platform for joint trapping is operational across all target countries by 2012.

Activity 2: Establish in each participating country a database for fruit fly species for the management of surveillance data and information sharing among partner countries.

To ensure management of surveillance data and identification of possible pathways for introductions, a database for all fruit fly species will be established in each participating country. It is anticipated that information gathered on fruit fly fauna, their pathways for introduction and effective management options to prevent further spread will be shared among participating countries and other interested fruits and vegetable importing countries.

Performance indicators/Measurable outputs:

- A one-stop information resource based on a relational database model established in each country to accrue and coordinate data on specimens, host plants, distribution, taxonomy, attractants and literature pertaining to target pest by 2013.
- A multi-stakeholder platform for knowledge and information sharing operational across all target countries is active by 2013.

COMPONENT 4

**TRAINING AND TECHNOLOGY DISSEMINATION:
Enhanced technical capacity at various levels of competency to support and
sustain the project and dissemination of technological
packages to stakeholders**

Background

The project will have several levels of scientific training, interactions and technology dissemination. The activities with NARS/NPPOs and growers and their direct involvement in evaluation of IPM technologies, surveillance, preventative measures and post-harvest treatment will enhance their ability to manage the target pests, which will also translate into capacity for managing other insect pests on other crops. Farmer Field School (FFS) is a component of fundamental importance in the project and should allow direct interaction with the growers, providing feedbacks on the technologies and refinement as necessary.

Regional meetings/workshops will be combined with training on fruit fly taxonomy, surveillance and management. This should allow country experts to meet with global experts in IPM and post-harvest treatment and discuss adoption of the results of the project in their countries. *icipe* and FAO have been involved in the training of community-based groups and extension personnel in several IPM related activities across the globe and have immense experience on fruit fly R&D carried out jointly with the IAEA. Such experience and expertise will be valuable in the proposed project. Training on product inspection at ports will be provided in addition to routine surveillance activity to quarantine personnel. Most of this training, particularly the group training, shall be in-country and combined with on-farm demonstrations and local awareness campaigns on the IPM technologies and application of post-harvest treatment. These groups of trainees will be expected to promote these control packages and disseminate this information widely among small-scale producers in their countries with technical backstopping from FAO and *icipe*. The proposed awareness campaigns will be organised and conducted by NARS, NPPOs and partner international organisations through government extension agencies, radio and TV broadcasts, on-farm open days, manuals, posters and leaflets. Specific activities in this component are outlined below:

Activity 1: Train NARS and NPPOs (training of trainers) on surveillance and pre-harvest management packages—baiting; male annihilation; use of fungal pathogens; parasitoid mass rearing techniques, quality

control, release and evaluation of parasitism; and orchard sanitation. (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania)

Since expertise and capabilities in fruit fly and MSW management are fairly uniformly absent among participating countries, a common training strategy will be adopted beginning with the training of trainers of NARS and NPPOs from partner institutions. In this regard, 3–5 experts will be drawn from collaborating institutions and bodies with close link to the fruit and vegetable sector (producers, grower associations, etc.) and trained specifically in all aspects of control systems (baiting; male annihilation; use of fungal pathogens; ant technology; parasitoid mass rearing techniques, quality control, release and evaluation of parasitism; and orchard sanitation). Selection of individuals for the training of trainers will be based on criteria that place a heavy emphasis on involvement and expertise in the horticultural sector and on the likelihood that individuals will remain closely associated with the sector. Training will be hands-on and field-based at project benchmark sites where suppression trials are ongoing to allow for technology demonstration, promotion and dissemination of the control packages on-farm. In addition to surveillance, training in measures to prevent or detect infested products through inspection, warning to travelling public, detector dogs at airports and mail exchanges, luggage searches and trapping will be provided to quarantine personnel.

Performance indicators/Measurable outputs:

- At least 100 NARS and NPPOs (trainers) trained in all aspects of surveillance and pre-harvest management packages for target pests acquired new skills, approaches and methodologies related to the 4 project components.
- At least 40% of relevant target organisations/institutions have increased capacities to develop and promote mango and avocado pest management solutions for wealth creation.

Activity 2: Fruit fly and MSW IPM technology learning sites established through FFS, contact farmers, farmer groups, and national extension networks through hands-on training approaches and field days on surveillance and all management packages and awareness campaigns on technology availability. (CFC funded for Kenya, Tanzania, Uganda; BMZ co-financing for Kenya)

The NARS and NPPOs that have been trained in Activity 1 (training of trainers) will together with *icipe* carry out FFS hands-on training activities on surveillance and all management packages directly at selected demonstration sites (2–3 per country). As in Activity 1, training will be hands-on and allow for technology demonstration of all the control packages outlined in Component 1, its promotion and dissemination on-farm at the project benchmark sites but as with all FFS trainings, with heavy involvement of growers. This training will be combined with local awareness campaigns on the impact of fruit flies on fruit and vegetable production and availability of management tools.

Researchers and NARS will organise field days to demonstrate the performance of the new technologies in the demonstration trials. The field days will involve trial farmers that have received IPM Starter Packs as well as other growers from the surrounding villages. At the FFS and during field days, *icipe* as technology provider and NARS will describe the on-farm demonstrations, lead discussions, and answer farmers' questions. The field day is also expected to provide an opportunity for farmers hosting their own trials to compare the performance of FFS demonstration trials with their own "baby" experiments. In addition to field days, mid-season evaluation meetings with farmers hosting their own trials will be organised, to discuss trial performance. These meetings should provide an opportunity for farmers to make an early assessment of the technologies, and discuss possible adaptations they might want to make in subsequent trials.

Performance indicators/Measurable outputs:

- At least 8 farmer field schools (FFS) demonstration plots established by 2012 to conduct experimentation and evaluate technologies (baiting, orchard sanitation, biopesticide application etc.) for improving productivity and profitability.
- Over 4000 fruit fly and MSW IPM Starter Packs distributed to over 4000 growers in the target countries by 2013.
- At least 10 field days/farm visits conducted by 2014.

Activity 3: Facilitate training of representatives of industries in participating countries on use of post-harvest treatment (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania)

To facilitate uptake of the post-harvest treatment parameters and establishment of facilities, the project proposes to train entrepreneurs, representatives of the horticultural industries, NARS/NPPOs and growers of the participating countries on the operation and usefulness of post-harvest treatment. Private construction through loan concession from CFC by participating countries can also be facilitated by consultations with government and industries on the possibility and modalities of establishing and operating such commercial ventures in the countries.

Performance indicators/Measurable outputs:

- Capacity in post-harvest treatment technology impacted on at least 50 members from the private sector, NARS/NPPOs and growers by 2014.
- By 2014, the project will have promoted more effective public–private partnerships and new institutional arrangements for market access.

Activity 4: Prepare and disseminate fruit fly and MSW IPM materials and guidelines with due regard to market requirements through project website, leaflets, posters, manuals, and radio and TV programmes to facilitate large-scale adoption and application of the recommended management tools (CFC funded for Kenya, Tanzania and Uganda; BMZ co-financing for Kenya, Tanzania).

Effective public awareness campaigns will be essential to the success of the fruit fly and MSW management strategy that is being proposed. As part of this component, the project shall seek to update the farming community and local media (TV, radio, newspaper) on all aspects of the project through a project website that will be regularly updated. Additional public materials such as manuals, posters, leaflets, t-shirts and fruit fly and MSW quarantine materials will be developed and distributed to government departments, the general public and school children on recommended management options to fast track information up-take. The goal will be to have a more informed public on the risks associated with fruit flies, MSW and movement of quarantine items.

Performance indicators/Measurable outputs:

- An operational project website that is regularly updated with information on the application and relevance of management tools.
- By 2013, at least 8000 leaflets, posters and manuals are printed and distributed on all aspect of surveillance and management; and at least two radio or TV programmes aired to promote awareness on monitoring management packages.

BENEFITS AND BENEFICIARIES

The immediate beneficiaries of the project will be smallholder producers of the target crops in participating countries. Smallholders will benefit from increased production and access to export markets due to quality production of fruits and economic well being of the growers. There are also added benefits in the form of reduced costs and labour input given that introduction of parasitoids (if they establish) comes at no cost to the farmer and the use of localised spot applications of baits for fruit flies and trunk application for MSW entails minimal application of inputs compared to the current cover spraying of the entire canopy. There are environmental and health benefits since spraying often exposes both the fruits and labourers to danger from toxic compounds. The lost export market will be recouped and this will lead to improved livelihood, economic benefits and increase in foreign exchange to countries affected by the ban due to *B. invadens* and other fruit flies.

Producers who are aware of and have been attempting to access niche markets for organic production of both fruits may be attracted to packages such as application of baiting technologies that incorporate entomopathogens rather than insecticides. Producers growing target fruits for own consumption and local sales will benefit from quality fruits for own consumption and to varying degrees additional income from sales depending upon local market circumstances. Benefits will also accrue to traders (both small and large scale) in terms of large sales volume and better margins in quality conscious consumers' and marketing outlets.

Introduction of IPM technologies, improved biological control (classical and inundative) and knowledge on post-harvest treatment plant(s) will improve the export capacity of the eastern African countries. Training on IPM, surveillance and phytosanitary information management will benefit extension personnel, agricultural officers, quarantine specialists and growers in all countries in increasing their capacity in pest management. NARS and NPPOs will improve their capacity in coordinating research, disseminating technical information and providing relevant training to the project.

PROJECT COSTING AND FINANCING

The costs of the activities under this project are estimated to be US\$ 1,431,375 of which the CFC is expected to contribute the equivalent of US\$ 1,000,000. The BMZ is co-financing the project to the equivalent of US\$ 296,000. BioVision Switzerland will contribute US\$ 30,375. SAAGA will contribute US\$ 5,000. Total co-financing amounts to US\$

331,375. Counterpart contribution is equivalent to US\$ 100,000 from the proposed PEA-*icipe* and participating countries.

WORK PLAN AND PROJECT ACTIVITIES

Details of the project work plan for each component are provided in Annex 1. Project activities are highlighted in the project logical framework and the components above.

PROJECT MANAGEMENT, MONITORING AND SUPERVISION

The Food and Agriculture Organization (FAO) of the UN through the Intergovernmental Sub-Group on Tropical Fruits (IGSGTF) and International Plant Protection Convention (IPPC) shall be the Project Supervisory Body (PSB) in close collaboration with the Fund. The Project Executing Agency (PEA) shall be responsible for the day-to-day monitoring and management coordination of the project in liaison with the participating partner institutions. The PSB and the Fund will examine all information submitted by the PEA.

The PEA shall appoint a Project Steering Committee (PSC) to provide technical oversight of the activities and operations that have direct bearing to the technical effectiveness and efficiency of the overall project. The PSC will monitor and evaluate implementation of the project objectives and also suggest and periodically review priorities of the project. The PSC shall also develop and supervise the implementation of annual work plans within the framework of the project. The structure of the committee will be decided and regularly reviewed by a regional stakeholders' forum (which shall be the policy and priority setting body of the project) to ensure adequate representation of the member countries as well as categories of stakeholders that have a vested interest in fruit fly and MSW management. The Chair of the PSC shall rotate among the participating countries on an annual basis. Each year, the PSC shall elect a Vice-chair who will assume the position of Chair in the following year.

At each participating country, there shall be a National Project Leader (NPL) who shall supervise project implementation and assure project quality and performance. The NPL shall on behalf of government, receive, manage and account for resources allocated to the country for project execution. The NPL shall also prepare technical and financial reports and annual work plans and budgets according to donor procedures.

The project will be subject to regular annual reviews including at mid-term by the CFC to assess overall progress, the continuing relevance of the project activities and allocated budgets, to approve annual work plans and to propose any modifications as required. The project is to be evaluated after its completion, to assess project achievements against objectives, with a view to deriving lessons for other projects and assessing its impact.

JUSTIFICATION AND QUALIFICATION OF PROJECT EXECUTING AGENCY (PEA) - *icipe*

icipe works to improve the well-being of the peoples of the tropics through research and capacity building in insect science and its application. This institutional focus has resulted from the realisation that the incidence of pests is invariably linked to the vicious cycle of poverty and underdevelopment. *icipe's* overall goal is stabilising food production by reducing quantitative and qualitative pre- and post-harvest yield losses due to insect pests, mites, weeds and mycotoxin-producing fungi by contributing to the development of economically viable production systems that are less reliant on external inputs, in particular pesticides, and thus environmentally friendly and sustainable. Having the unique advantage of being an African institution, based in Africa, and mandated to address pest problems at the foundation of poverty, especially in terms of food security and health, *icipe* designs interventions based on a pro-poor set of values that contribute to the achievement of the Millennium Development Goals (MDGs). **The institute's work on fruit flies started in 1999 and represents the first active fruit fly research and management effort in sub-Saharan Africa culminating in the establishment of the African Fruit Fly Initiative (AFFI).** AFFI was renamed African Fruit Fly Programme (AFFP) in 2008. With funds from IFAD, FAO, BMZ and IAEA the programme was established with the main objective of developing and introducing environmentally friendly and affordable technologies for management of fruit flies in Africa. The grants obtained over the years has permitted the establishment of extensive network of collaborators interested in fruit fly research in Africa and linking the initiative with other fruit fly programmes in the world. Major accomplishments of the AFFP include a comprehensive assessment of the fruit fly complex attacking key horticultural crops such as mango, various cucurbits, citrus and avocado and responses of these complex fruit fly species to attractants and their susceptibility to killing agents. The AFFP was responsible for the first detection of *B. invadens* in

Africa in 2003, which is now arguably the most damaging fruit fly species in the continent. Two exotic natural enemies (*F. arisanus* and *D. longicaudata*) have been introduced from Hawaii by AFFP and pre-release studies against the major fruit fly species have been completed and experimental releases started in Kenya, Tanzania and Benin and with request for releases from several other African countries. The programme has developed user-friendly taxonomic tools for easy identification of the fruit fly species that will support implementation activities. AFFP have also developed a database of fruit flies that includes several fruit fly collections from Africa. With funds from the IAEA, colonies of the most damaging fruit fly species including *B. invadens* have been established for testing of their response to food attractants, susceptibility to entomopathogens, classical biological control and the planned post-harvest related activities. Capacity building is at the core of the programme activities of AFFP and it has trained and will continue to train PhD and MSc students, agricultural officers, extension personnel and quarantine officers in various aspects of fruit fly biology, ecology and management, detection and monitoring. Currently, the Leader of the AFFP at *icipe*, Dr S. Ekesi serves as a member of the International Fruit Fly Steering Committee (IFFSC) that is chaired by Prof. Aldo Malavasi, Leader of the Moscamed Program in Brazil (malavasi@moscamed.org.br).

icipe is funded by a consortium of donors known as the Sponsoring Group for *icipe* (SGI), and other private charitable organisations, United Nations organisations and governmental aid agencies. It collaborate widely with sister bodies within the Consultative Group on International Agricultural Research (CGIAR). With such a pan-Tropical mandate on arthropod pests, *icipe* is in a good position to act as a PEA of the current project. Additional information about the organisation is available from www.icipe.org.

ASSUMPTIONS AND RISKS

Although the project is designed in a sufficiently robust way to ensure that a good level of results will be achieved even in worst-case scenarios, some risks and assumptions are anticipated. Bait-based technologies, especially those based on food attractants are well developed and relatively easy to use. However, since farmers across SSA have never used this technology, full adoption cannot be guaranteed.

Most farmers are aware of the environmental and health hazards associated with chemical pesticides (Maiga et al., 1999) and for that reason the risk associated with the use of natural enemies (*F. arisanus*, *D. longicaudata*, *O. longinoda* and *M. anisopliae*) is minimal. Although recoveries of *F. arisanus* following field releases are already documented from Kenya, there is, however, no guarantee that the parasitoid will establish in all agroecologies across the target countries. There is also risk of negative interaction with *O. longinoda*, which may limit their impact on the fruit flies. Although there is an increasing interest in the use of biopesticides for management of fruit flies, there is always the risk that few farmers may take up such a novel biocontrol technology even if commercial suppliers make the product available. Application of the ant technology is likely to be successful. Farmer perception of the Hemiptera, their transport to the field as well as aggression to humans may limit adoption. For both *F. arisanus* and *O. longinoda*, a prerequisite for them to flourish in the agroecosystem is a careful use of selective and *soft* pesticide. This cannot be guaranteed and may jeopardise their efficacy in the field.

During the various trainings that will be provided for extension agents, quarantine personnel, and growers, the project will generate a team of experts in fruit fly management. There is always the danger that trained personnel are lost to the project, especially if attracted by greener pastures outside the country or institution involved in the project.

Marketing risks may arise if there is rapid adoption of technologies and this could result in overproduction, glut in supplies and potential downward pressure on prices. While this is possible, the scale of the project in target countries is unlikely to lead to falling prices. On the international markets, the aim of the project is to recoup lost market due to *B. invadens* invasion as well as expand market share but international markets are characterised by up and downward trends in demand.

Outlined activities evidently seem to be beyond the scope of the project resources, but co-financing funds from other ongoing projects (e.g. BMZ) and possibly other donors that may join the project at a later date should enable successful execution of specified project activities.

SUSTAINABILITY AND EXIT STRATEGY

The project has been conceived with active participation of NARS and NPPOs and key to the sustainability of the knowledge base and management packages proposed for the target pests is stakeholder involvement and feedback. The success of the project activities will depend largely on how well end-users understand and combine knowledge of fruit fly and MSW IPM with their own farming experiences to produce quality fruits for domestic use and export. The participatory nature in the project activities should promote project sustainability. Community-based feedback mechanisms that enables participating NARS and NPPOs to re-define the research agenda in a bottom-up manner and to respond to emerging issues from the farmers' field experiences will promote the sustainability of the programme. The programme will also actively advocate and lobby policy support from government authorities to ensure that proper attention is given to improving horticulture production through fruit fly and MSW management and especially development of efficient quarantine systems and overall success of the project. The approach of demonstrating technologies on-farm, encouragement in adaptation and appropriate awareness campaigns that will be developed should allow for wide adoption and sustainable impact of the management strategies.

Educational activities and local research capacity building through NARS, NPPOs and growers training will be pivotal to the project exit strategy. Exit strategy will involve proactive encouragement of NARS, NPPOs and development partners to aggressively embark on resource mobilisation for follow-up action plans in the testing and sharing of the IPM knowledge and post-harvest treatment technologies with several fruit and vegetable production groups within and beyond project benchmark sites that may require similar assistance with minimal (supervisory) input from external technical agencies.. Horticulture producers and other relevant actors within the region will be encouraged to integrate the IPM and post-harvest treatment experiences into fruit and vegetable crop development activities for sustainable impact.

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BUDGET

Table 1: Summary - Total project cost by category of expenditure

Budget Category	Budget Requested From CFC										Contribution by				TOTAL BUDGET
	KN	TZ	UG	FAO	icipe	Total	BMZ	Biovision	SAAGA	PEA-NARS					
Vehicles, machinery and equipment	25,000	25,000	25,000	-	60,000	135,000	10,000	-	-	-	145,000				
Civil Works	-	-	-	-	-	-	-	-	-	-	-				
Materials and Supplies	30,000	30,000	30,000	-	45,000	135,000	100,000	10,000	5,000	-	250,000				
Personnel /Technical assistance/Consultancy	30,000	30,000	30,000	-	99,000	189,000	50,000	-	-	100,000	339,000				
Duty travel	9,000	9,000	9,000	15,000	15,000	57,000	-	-	-	-	57,000				
Dissemination and training	48,000	48,000	48,000	-	-	144,000	40,000	-	-	-	184,000				
Operational Costs	30,000	30,000	30,000	-	48,830	138,830	90,000	20,000	-	-	248,830				
Monitoring/evaluation (FAO & CFC)	-	-	-	30,000	-	30,000	-	-	-	-	30,000				
Loan component	-	-	-	-	-	-	-	-	-	-	-				
Subtotal - Direct project cost	172,000	172,000	172,000	45,000	267,830	828,830	290,000	30,000	5,000	100,000	1,253,830				
Contingency 5% of direct cost	8,600	8,600	8,600	2,250	13,392	41,442	-	-	-	-	41,442				
Total direct project cost	180,600	180,600	180,600	47,250	281,222	870,272	290,000	30,000	5,000	100,000	1,295,272				
Administrative cost	18,060	18,060	18,060	10,868	64,681	129,728	6,000	375	-	-	136,103				
Total cost	198,660	198,660	198,660	58,118	345,902	1,000,000	296,000	30,375	5,000	100,000	1,431,375				

Table 2. Summary - Total project cost by year

Budget Category	YEAR 1					YEAR 2					YEAR 3							
	KN	TZ	UG	FAO	icipe	Total	KEN	TZ	UG	FAO	icipe	Total	KEN	TZ	UG	FAO	icipe	Total
Vehicles, machinery and equipment	25,000	25,000	25,000	-	60,000	135,000												
Civil Works	-	-	-	-	-	-												
Materials and Supplies	10,000	10,000	10,000	-	15,000	45,000	10,000	10,000	10,000	-	15,000	45,000	10,000	10,000	10,000	-	15,000	45,000
Personnel/Tech. assis./Consultancy	10,000	10,000	10,000	-	33,000	63,000	10,000	10,000	10,000	-	33,000	63,000	10,000	10,000	10,000	-	33,000	63,000
Duty travel	3,000	3,000	3,000	5,000	5,000	19,000	3,000	3,000	3,000	5,000	5,000	19,000	3,000	3,000	3,000	5,000	5,000	19,000
Dissemination and training	16,000	16,000	16,000	-	-	48,000	16,000	16,000	16,000	-	-	48,000	16,000	16,000	16,000	-	-	48,000
Operational Costs	10,000	10,000	10,000	-	16,300	46,300	10,000	10,000	10,000	-	16,300	46,300	10,000	10,000	10,000	-	16,300	46,300
Monitoring/evaluation (FAO & CFC)	-	-	-	10,000	-	10,000	-	-	-	10,000	-	10,000	-	-	-	10,000	-	10,000
Subtotal - Direct project cost	74,000	74,000	74,000	15,000	129,300	366,300	49,000	49,000	49,000	15,000	69,300	231,300	49,000	49,000	49,000	15,000	69,300	231,300
Contingency 5% of direct cost	3,700	3,700	3,700	750	6,465	18,315	2,450	2,450	2,450	750	3,465	11,565	2,450	2,450	2,450	750	3,462	11,562
Total direct project cost	77,700	77,700	77,700	15,750	135,765	384,615	51,450	51,450	51,450	15,750	72,765	242,865	51,450	51,450	51,450	15,750	72,692	242,792
Administrative cost	7,770	7,770	7,770	3,623	31,226	58,158	5,145	5,145	5,145	3,623	16,736	35,793	5,145	5,145	5,145	3,623	16,719	35,777
Total cost	85,470	85,470	85,470	19,373	166,991	442,773	56,595	56,595	56,595	19,373	89,501	278,658	56,595	56,595	56,595	19,373	89,411	278,568

Grand Total (Years 1-3)					
KEN	TZ	UG	FAO	icipe	Total
25,000	25,000	25,000	0	60,000	135,000
0	0	0	0	0	0
30,000	30,000	30,000	0	45,000	135,000
30,000	30,000	30,000	0	99,000	189,000
9,000	9,000	9,000	15,000	15,000	57,000
48,000	48,000	48,000	0	0	144,000
30,000	30,000	30,000	0	48,830	138,830
0	0	0	30,000	0	30,000
172,000	172,000	172,000	45,000	267,830	828,830
8,600	8,600	8,600	2,250	13,392	41,442
180,600	180,600	180,600	47,250	281,222	870,272
18,060	18,060	18,060	10,868	64,681	129,728
198,660	198,660	198,660	58,118	345,902	1,000,000

Table 4. Complete cost of operation for Kenya

KENYA						
Unit	Unit price	Estimated cost			Total Cost	
		Year1	Year2	Year3		
Inputs						
Component 1 - Pre-Harvest Management Measures						
1.0 Vehicles, machinery and equipment						
1.1. Vehicle						
1.2 Computer, printer, GPS	25,000	25,000	-	-	25,000	
2.0 Materials and supplies						
2.1. Trap, baits, fungus, rearing, cages, vials etc.	1,500	1,500			1,500	
3.0 Personnel/Technical Assistance/Consultancy						
3.1 Secretarial services (1% of technical time/year)		150	150	150	450	
3.2 Tech. assistance (3% of icipe scientist time/year)	111,700	3,351	3,351	3,351	10,053	
4.0 Operational Cost						
4.1. Monitoring, traps services, fuel, vehicle repairs, spares etc.	-	1,000	1,500	1,500	4,000	
5.0 Duty travel						
5.1 Local travel for traps services, per diems, accommodation etc.		1,000	2,000	2,000	5,000	
Total cost		35,000	10,000	10,000	55,000	
Component 2 – Post-harvest treatment						
1.0 Materials and supplies						
1. Insect culture and maintenance (diet, cages, fruits, vials, etc.)	0	0	0	0	0	
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (0% of technical time/country/year)	15,000	0	0	0	0	
2.2 Tech. assistance (0% of icipe scientist time/year)	111,700	0	0	0	0	
2.3 Tech. assistance (0% of icipe technician time/year)	20,000	0	0	0	0	
3.0 Operational Cost						
3.1 Fruit dissection, logger monitoring, vehicle repairs, spares	0	0	0	0	0	
Total cost		-	-	-	0	
Component 3 - Surveillance and Preventative Measures						
1.0 Materials and supplies						
2.1. Trap, baits, fungus, rearing, cages, vials etc.		5,000	5,000	5,000	15,000	
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (1% of technician time/year)	15,000	150	150	150	450	

2.2 Tech. assistance (3% of <i>icipe</i> scientist time/year)	Average scientist salary	111,700	3,351	3,351	3,351	10,053
3.0 Operational Cost						-
4.1. Monitoring, traps services, fuel, vehicle repairs, spares etc.			1,499	1,499	1,499	4,497
5.0 Duty travel						-
5.1 Local travel for traps services, per diems, accommodation etc.			3,000	3,000	3,000	9,000
Total cost			13,000	13,000	13,000	39,000
Component 4 - Training and Technology Dissemination						
1.0 Materials and supplies						
1.1 Stationery, training materials, photocopying, printing, CDs etc.	Lump per year		2,000	2,000	2,000	6,000
2.0 Personnel/Technical Assistance/Consultancy						-
2.1 Secretarial services (1% of <i>icipe</i> technician time/year)	Average secretary salary	15,000	150	150	150	450
2.2 Tech. assistance (7.9% of <i>icipe</i> scientist time/year)	Average scientist salary	111,700	8,851	8,851	8,851	26,553
3.0 Dissemination and Training						
3.1 Standard training course fee per participant (training of trainers; 4 participants) covering the cost of training materials, books, subsistence and accommodation of trainees, air return ticket, local field travel during training, conference room etc.	Lump per year		7,000	7,000	7,000	21,000
3.2 Awareness campaign course fee for approximately 30 participants comprising of printing of awareness materials, allowances for participants, fee for meeting room etc.	Lump per year		4,000	4,000	4,000	12,000
3.3 Training of representatives of industries (4) on post-harvest treatment	Lump per year		2,499	2,499	2,499	7,497
4.0 Duty travel						-
Local field travel by NARS conducting awareness campaign	Lump per year		1,500	1,500	1,500	4,500
Total cost			26,000	26,000	26,000	78,000
Grand total (Direct operational cost)			74,000	49,000	49,000	172,000
GRAND TOTAL - COMPLETE COST OF OPERATION FOR KENYA						
Pre-Harvest Management Measures			35,000	10,000	10,000	55,000
Post-Harvest Treatments			-	-	-	-
Surveillance and preventative measures			13,000	13,000	13,000	39,000
Training and technology dissemination			26,000	26,000	26,000	78,000
Subtotal - Direct project cost			74,000	49,000	49,000	172,000
Contingency 5% of direct cost			3,700	2,450	2,450	8,600
Total direct project cost			77,700	51,450	51,450	180,600
Administrative cost			7,770	5,145	5,145	18,060
Total cost			85,470	56,595	56,595	198,660

Table 5. Complete cost of operation for Tanzania

TANZANIA						
Inputs	Unit	Unit price	Estimated cost			Total Cost
			Year1	Year2	Year3	
Component 1 - Pre-Harvest Management Measures						
1.0 Vehicles, machinery and equipment						
1.1. Vehicle	Lump per year	25,000	25,000	-	-	25,000
1.2 Computer, printer, GPS			1,500			1,500
2.0 Materials and supplies						
2.1. Trap, baits, fungus, rearing cages, vials etc.	Lump per year		2,999	2,999	2,999	8,997
3.0 Personnel/Technical Assistance/Consultancy						
3.1 Secretarial services (1% of technical time/country/year)	Average secretary salary	15,000	150	150	150	450
3.2 Tech. assistance (3% of icipe scientist time/year)	Average scientist salary	111,700	3,351	3,351	3,351	10,053
4.0 Operational Cost						
4.1. Monitoring, traps services, fuel, vehicle repairs, spares etc.	Lump per year	-	1,000	1,500	1,500	4,000
5.0 Duty travel						
5.1 Local travel for traps services, per diems, accommodation etc.			1,000	2,000	2,000	5,000
Total cost			35,000	10,000	10,000	55,000
Component 2 – Post-harvest treatment						
1.0 Materials and supplies						
1. Insect culture and maintenance (diet, cages, fruits, vials, etc.)	Lump per year	0	0	0	0	0
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (0% of technical time/country/year)	Average secretary salary	15,000	0	0	0	0
2.2 Tech. assistance (0% of icipe scientist time/year)	Average scientist salary	111,700	0	0	0	0
2.3 Tech. assistance (0% of icipe technician time/year)	Average technician salary	20,000	0	0	0	0
3.0 Operational Cost						
3.1 Fruit dissection, logger monitoring, vehicle repairs, spares		0	0	0	0	0
Total cost			-	-	-	0
Component 3 - Surveillance and Preventative Measures						
1.0 Materials and supplies						
2.1. Trap, baits, fungus, rearing cages, vials etc.	Lump per country		5,000	5,000	5,000	15,000
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (1% of technical time)	Average secretary salary	15,000	150	150	150	450
2.2 Tech. assistance (3% of icipe scientist time/year)	Average scientist salary	111,700	3,351	3,351	3,351	10,053

3.0 Operational Cost										
4.1. Monitoring, traps services, fuel, vehicle repairs, spares etc.							1,499	1,499	1,499	4,497
5.0 Duty travel										
5.1 Local travel for traps services, per diems, accommodation etc.							3,000	3,000	3,000	9,000
Total cost							13,000	13,000	13,000	39,000
Component 4 - Training and Technology Dissemination										
1.0 Materials and supplies										
1.1 Stationery, training materials, photocopying, printing, CDs etc.							2,000	2,000	2,000	6,000
2.0 Personnel/Technical Assistance/Consultancy										
2.1 Secretarial services (1% of technical time)						15,000	150	150	150	450
2.2 Tech. assistance (7.92% of icipe scientist time/year)						111,700	8,851	8,851	8,851	26,553
3.0 Dissemination and Training										
3.1 Standard training course fee per participant (training of trainers; 4 participants) covering the cost of training materials, books, subsistence and accommodation of trainees, air return ticket, local field travel during training, conference room etc.							7,000	7,000	7,000	21,000
3.2 Awareness campaign course fee for approximately 30 participants comprising of printing of awareness materials, allowances for participants, fee for meeting room etc.							4,000	4,000	4,000	12,000
3.3 Training of representatives of industries (4) on post-harvest treatment							2,499	2,499	2,499	7,497
4.0 Duty travel										
Local field travel by NARS conducting awareness campaign							1,500	1,500	1,500	4,500
Total cost							26,000	26,000	26,000	78,000
Grand total (Direct operational cost)							74,000	49,000	49,000	172,000
GRAND TOTAL - COMPLETE COST OF OPERATION FOR TANZANIA										
Pre-Harvest Management Measures							35,000	10,000	10,000	55,000
Post-Harvest Treatments							-	-	-	-
Surveillance and preventative measures							13,000	13,000	13,000	39,000
Training and technology dissemination							26,000	26,000	26,000	78,000
Subtotal - Direct project cost							74,000	49,000	49,000	172,000
Contingency 5% of direct cost							3,700	2,450	2,450	8,600
Total direct project cost							77,700	51,450	51,450	180,600
Administrative cost							7,770	5,145	5,145	18,060
Total cost							85,470	56,595	56,595	198,660

Table 6. Complete cost of operation for Uganda

UGANDA						
Inputs	Unit	Unit price	Estimated cost			Total Cost
			Year1	Year2	Year3	
Component 1 - Pre-Harvest Management Measures						
1.0 Vehicles, machinery and equipment						
1.1. Vehicle	Lump per year	25,000	25,000	-	-	25,000
1.2 Computer, printer, GPS			1,500			1,500
2.0 Materials and supplies						
2.1. Trap, baits, fungus, rearing cages, vials etc.	Lump per year		2,999	2,999	2,999	8,997
3.0 Personnel/Technical Assistance/Consultancy						
3.1 Secretarial services (1% of technical time/year)	Average secretary salary	15,000	150	150	150	450
3.2 Tech. assistance (3% of <i>icipe</i> scientist time/year)	Average scientist salary	111,700	3,351	3,351	3,351	10,053
4.0 Operational Cost						
4.1. Monitoring, traps services, fuel, vehicle repairs, spares etc.	Lump per year	-	1,000	1,500	1,500	4,000
5.0 Duty travel						
5.1 Local travel for traps services, per diems, accommodation etc.			1,000	2,000	2,000	5,000
Total cost			35,000	10,000	10,000	55,000
Component 2 - Post harvest treatment						
1.0 Materials and supplies						
1. Insect culture and maintenance (diet, cages, fruits, vials, etc.)	Lump per year	0	0	0	0	0
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (0% of technical time/year)	Lump per year	0	0	0	0	0
2.2 Tech. assistance (0% of <i>icipe</i> scientist time/year)	Average secretary salary	15,000	0	0	0	0
	Average scientist salary	111,700	0	0	0	0
2.3 Tech. assistance (0% of <i>icipe</i> technician time/year)	Average technician salary	20,000	0	0	0	0
3.0 Operational Cost						
3.1 Fruit dissection, logger monitoring, vehicle repairs, spares		0	0	0	0	0
Total cost			-	-	-	0
Component 3 - Surveillance and Preventative Measures						
1.0 Materials and supplies						
2.1. Trap, baits, fungus, rearing cages, vials etc.	Lump per country		5,000	5,000	5,000	15,000
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (1% of technical time)	Average secretary salary	15,000	150	150	150	450

2.2 Tech. assistance (3% of icipe scientist time/year)	Average scientist salary	111,700	3,351	3,351	3,351	10,053
3.0 Operational Cost						
4.1. Monitoring, traps services, fuel, vehicle repairs, spares etc.			1,499	1,499	1,499	4,497
5.0 Duty travel						
5.1 Local travel for traps services, per diems, accommodation etc.			3,000	3,000	3,000	9,000
Total cost			13,000	13,000	13,000	39,000
Component 4 - Training and Technology Dissemination						
1.0 Materials and supplies						
1.1 Paper, training materials, photocopying, printing, CD etc.	Lump per year		2,000	2,000	2,000	6,000
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (1% of technical time)	Average secretary salary	15,000	150	150	150	450
2.2 Tech. assistance (7.92% of icipe scientist time/year)	Average scientist salary	111,700	8,851	8,851	8,851	26,553
3.0 Dissemination and Training						
3.1 Standard training course fee per participant (training of trainers; 4 participants) covering the cost of training materials, books, subsistence and accommodation of trainees, air return ticket, local field travel during training, conference room etc.	Lump per year		7,000	7,000	7,000	21,000
3.2 Awareness campaign course fee for approximately 30 participants comprising of printing of awareness materials, allowances for participants, fee for meeting room etc.	Lump per year		4,000	4,000	4,000	12,000
3.3 Training of representatives of industries (4) on post-harvest treatment	Lump per year		2,499	2,499	2,499	7,497
4.0 Duty travel						
Local field travel by NARS conducting awareness campaign	Lump per year		1,500	1,500	1,500	4,500
Total cost			26,000	26,000	26,000	78,000
Grand total (Direct operational cost)			74,000	49,000	49,000	172,000
GRAND TOTAL - COMPLETE COST OF OPERATION FOR UGANDA						
Pre-Harvest Management Measures			35,000	10,000	10,000	55,000
Post-Harvest Treatments			-	-	-	-
Surveillance and preventative measures			13,000	13,000	13,000	39,000
Training and technology dissemination			26,000	26,000	26,000	78,000
Subtotal - Direct project cost			74,000	49,000	49,000	172,000
Contingency 5% of direct cost			3,700	2,450	2,450	8,600
Total direct project cost			77,700	51,450	51,450	180,600
Administrative cost			7,770	5,145	5,145	18,060
Total cost			85,470	56,595	56,595	198,660

Table 7. Complete cost of operation for FAO and CFC

FAO & CFC						
Inputs	Unit	Unit price	Estimated cost			Total Cost
			Year1	Year2	Year3	
Monitoring and evaluation						
Project evaluation and monitoring	Lump per year	10,000	10,000	10,000	10,000	30,000
Total cost			10,000	10,000	10,000	30,000
Component 1 - Pre-Harvest Management Measures						
Pre-harvest management						
Total cost						
Component 2 – Post-harvest treatment						
Post-harvest treatment						
Total cost						
Component 3 - Surveillance and Preventative Measures						
1.0 Materials and supplies						
1.1 Paper, training materials, photocopying, printing, CDs etc.						
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (0% of technical time)	Average secretary salary					
2.2 Technical assistance	Average technical salary					
4.0 Duty travel						
4.1 International travel	Lump per year		5,000	5,000	5,000	15,000
Total cost			5,000	5,000	5,000	15,000
Component 4 - Training and Technology Dissemination						
Training and technology dissemination	Lump per year					
Total cost						
Grand total direct cost of operation						
			15,000	15,000	15,000	45,000
GRAND TOTAL - COMPLETE COST OF OPERATION FOR FAO & CFC						
Monitoring and evaluation			10,000	10,000	10,000	30,000
Pre-Harvest Management Measures						
Post-Harvest Treatments						
Surveillance and preventative measures			5,000	5,000	5,000	15,000
Training and technology dissemination						

Subtotal - Direct project cost		15,000	15,000	15,000	15,000	45,000
Contingency 5% of direct cost		750	750	750	750	2,250
Total direct project cost		15,750	15,750	15,750	15,750	47,250
Administrative cost		3,623	3,623	3,623	3,623	10,868
Total cost		19,373	19,373	19,373	19,373	58,118

Table 8. Complete cost of operation for *icipe*

<i>icipe</i>						
	Unit	Unit price	Estimated cost			Total Cost
			Year1	Year2	Year3	
Inputs						
Project coordination and management (across all components)						
Project coordination time (<i>icipe</i> scientist at 29.5% per year)	Average scientist, salary	111,700	33,000	33,000	33,000	99,000
Total cost			33,000	33,000	33,000	99,000
Component 1 - Pre-Harvest Management Measures						
1.0 Vehicles, machinery, equipment, consumables						
1.1 Consumables (bait, fungus, trap etc.)	Lump		3,000	2000	900	5,900
1.2 Vehicle	Lump		25,000			25,000
1.3 Computer, printer	Lump		3,000			3,000
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (0.15% of technical time/year)	Average secretary salary/year	15,000	2,300	2,300	2,300	6,900
2.2 Tech. assistance (0% of technician time responsible for bait, fungus and traps production)	Average technician salary/year	15,000				
3.0 Duty travel						
3.1 International travel			3,000	3,000	3,000	9,000
Total cost			36,300	7,300	6,200	49,800
Component 2 - Post-harvest treatment						
1.0 Vehicles, machinery, equipment, consumables						
1. Cold rooms, water bath, insects, diet, cages, fruits, vials, etc.	Lump per year		30,500	9,000	9,000	48,500
2.0 Personnel/Technical Assistance/Consultancy						
2.1 Secretarial services (0.3% of technical time/year)	Average scientist salary	15,000	4,500			4,500

Annex 1. Project workplans, implementation schedules and responsibilities

Work Breakdown Schedule	Total months	Year 1	Year 2	Year 3	Partners responsible*	Expected Output
1.0	COMPONENT 1: PRE-HARVEST MEASURES					
1.1	36				icipe, MoA-N, KARI, KEPHIS, MARI, MAFS, MoA-U, NaCRRRI, Farmers' groups	IPM package assembled, demonstrated, adapted and disseminated in the target countries
1.2	24				icipe, MoA-N, KARI, KEPHIS, MARI, MAFS, MoA-U, NaCRRRI, Farmers' groups	IPM package for MSW demonstrated, adapted and disseminated in the target countries
1.3	36				icipe, FAO, MoA-N, KARI, KEPHIS, MARI, MAFS, MoA-U, NaCRRRI, Farmers' groups	Fruit fly parasitoids establish and contribute to the suppression of fruit flies
2.0	COMPONENT 2: POST-HARVEST MEASURES					
2.1	36				icipe	Colonies of <i>B. invadens</i> are maintained for post-harvest work
2.2	9				icipe	The most cold-tolerant stage of <i>B. invadens</i> on avocado determined
2.3	9				icipe	The most heat-tolerant stage of <i>B. invadens</i> on mango determined
2.4	24				icipe, KEPHIS, private sector	Large-scale validation trials on avocado completed

Annex 1

From: Nianjun Shen [mailto:APO@common-fund.org]
Sent: Wednesday, December 01, 2010 2:41 PM
To: Ekesi, Sunday
Cc: C. Borgemeister - ICIPE
Subject: RE: Fruit fly proposal

Dear Dr. Sunday,

I am now sending to you the comments. Should you have any questions, please contact me.

"1) "West African Fruit Fly Initiative: A Strategy for Promoting Mango Value Chain and Exports"

AND

2) "Participatory Validation and Dissemination of Management Technologies for *Bactrocera Invadens* and other Major Pests that Constrain Production and Export of Fruits and Vegetables in East and Southern Africa"

The two above submitted proposals were submitted by IITA and ICIPE (under the auspices of the Ministry of Agriculture of Tanzania), respectively. These proposals were discussed together as they focus on the same problem and have similar goals and objectives. Both proposals address problems associated with various insects collectively referred to as fruit flies that lead to production and post harvest losses, and restrict export of fruits such as Mangoes to the EU, USA and other markets due to quarantine issues.

The PAC agreed that the fruit fly is indeed an important constraint to fruit exports of African countries. It was however mentioned that numerous donors have already provided considerable development funds into measures that assist in control and management of the fruit fly on various levels (from on-farm pest management to phytosanitary post harvest operations). However there seems to be little impact on country or regional level and therefore donors like Worldbank, IFAD and EU are now pulling out of financing further fruit fly projects. Relatively successful continuous support operations, like provided by USAID/USDA for Central American countries (release of predator insects by air on a year by year basis) is neither within CFC's mandate nor scope.

PAC members recalled that many of the activities proposed in both project proposals have in fact already been undertaken and that the results of many proposed activities (such as effective and efficient IPM measures and post harvest protocols for exports) are proven and readily available. Countries such as Senegal, Sudan and India were mentioned by PAC members as examples of fruit (mango) export countries that successfully manage the fruit fly and fulfill phytosanitary requirements in major export markets - contrary to the statement of the proposal submitted by ICIPE, protocol and the required post harvest processes are successfully in place in a number of African countries. Also PAC members remarked that hot water vaporizing machinery for phytosanitary export treatment were readily available on the world market. The PAC agreed that a serious attempt by the private and/or public sector in both West and East Africa should therefore make fruit export to lucrative markets such as US, EU and Japan possible, despite the presence of the Fruit Fly.

The PAC concluded that both projects did not provide any innovative approaches or solutions to fruit fly control. Together with a strong research bias and no apparent (export) market and value chain orientation an engagement of the CFC would not be justified.

The Project Appraisal Committee is of the opinion that both projects are not supportable by the CFC and recommends to inform both proponents accordingly.

For your information, we may finance a workshop to be held in Nigeria next year for the development of tropical fruits in West Africa, and if that workshop is approved, we will ask them to make a thorough discussion on the FF issue on that occasion, particularly the practical way to forward.

Regards,

Nianjun Shen
Associate Project Manager
Common Fund for Commodities(CFC)
Stadhouderskade 55
1072 AB Amsterdam
The Netherlands
Tel: 0031-20-575-4952
Fax: 0031-20-676-0231
Email: apo@common-fund.org
Web: www.common-fund.org

Annex 2

December 8, 2010

Dr. Nianjun Shen
Associate Project Manager
Common Fund for Commodities (CFC)
Stadhouderskade 55
1072 AB Amsterdam
The Netherlands

Dear Dr. Shen

RE: “1) “West African Fruit Fly Initiative: A Strategy for Promoting Mango Value Chain and Exports” AND 2) “Participatory Validation and Dissemination of Management Technologies for Bactrocera Invadens and other Major Pests that Constrain Production and Export of Fruits and Vegetables in East and Southern Africa”

Thank you very much for sharing the comments of the CFC Project Appraisal Committee (PAC) with us. I have taken the time to discuss the content of the review with the project partners and there was a general consensus among the project partners that *icipe* as the project executing agency (PEA) should send a response to the CFC. In this regard, you will find below a point-by-point response to the issues raised by the CFC PAC.

PAC comment: The two above submitted proposals were submitted by IITA and ICIPE (under the auspices of the Ministry of Agriculture of Tanzania), respectively. These proposals were discussed together as they focus on the same problem and have similar goals and objectives. Both proposals address problems associated with various insects collectively referred to as fruit flies that leads to production and post harvest losses, and restrict export of fruits such as Mangoes to the EU, USA and other markets due to quarantine issues.

The PAC agreed that the fruit fly is indeed an important constraint to fruit exports of African countries. It was however mentioned that numerous donors have already provided considerable development funds into measures that assist in control and management of the fruit fly on various levels (from on-farm pest management to phytosanitary post harvest operations). However there seems to be little impact on country or regional level and therefore donors like Worldbank, IFAD and EU are now pulling out of financing further fruit fly projects. Relatively successful continuous support operations, like provided by USAID/USDA for Central American countries (release of predator insects by air on a year by year basis) is neither within CFC's mandate nor scope.

PEA and partners response: The assertion that numerous donors have already provided development funds for fruit fly activities in Africa is erroneous. The first and major contributor to fruit fly R&D in Africa was IFAD and most recently the German Ministry for Economic Cooperation and Development (BMZ). These were mainly research grants to understand African fruit fly bio-ecology and develop management tools for their control. Within the framework of the IFAD grant (which was made to *icipe*), a co-funding arrangement was negotiated and agreed between CFC and IFAD. In this context CFC was to handle aspects of the project that were related to technology dissemination and promotion. A project document was developed by *icipe* in 2000/2001 for CFC. After several rounds of negotiations lasting from 2001-2004 that resulted in 11 revisions of the project document and the final appraisal by CFC in late 2004, the CFC eventually turned down the proposal for reasons that *icipe* and its partners did not understand. Ever since this rejection, both *icipe* and IITA have made various attempts to convince different donors to fund the technology dissemination and promotion components of the original IFAD/ CFC fruit fly proposal,

especially because the management packages are now in place; unfortunately both Centers have been so far rather unsuccessful. *icipe* revived its discussion with the CFC about 2 years ago and a visit by the *icipe* DG (Prof. C. Borgemeister) to the CFC Headquarters in Amsterdam ensued followed by the current proposal. The proposal was fully endorsed by the FAO-IGG and later submitted to CFC but result is what we are discussing now.

In West Africa, the STDF has provided limited funding for pilot project activities and a donor meeting was held in September 19-25, 2009 in Mali to rally donor support for fruit flies in Africa. Despite the fact that several donors including the CFC, the World Bank, EU, USAID, DFID etc. were present and appreciated the magnitude of the problem, it has been more of a lip service to the problem than concrete commitment. Hence we were rather surprised by the assessment of the PAC that donors such as the World Bank, IFAD and EU are pulling out of funding solutions to the fruit fly problem in Africa when in fact it was the World Bank that championed the said donor meeting in West Africa in September 2009. The World Bank also organized a Video Conference in Nairobi on May 25, 2010 to lobby funding support to the fruit fly menace in Africa. Again we have difficulties in understanding the assessment of PAC regarding donor interest in the fruit fly problem in Africa.

We are also aware that a successful continuous support operations like the one provided by USAID/USDA for Central American countries is neither within CFC's mandate nor scope. It is important to note that the action of the USAID/USDA is not a release of predatory insects by air on a year by year basis BUT sterile insect technique (SIT) which is based on the aerial releases of mass-produced sterile males (not predators) to mate with wild females. We are very much familiar with this technique and aware that huge amount of resources are required to implement such an approach at the initial stage of development. It is exactly because of the same reason that we did not propose this management approach in our proposal. What we are proposing is the *classical biological control approach* and not SIT. Given the fact that *Bactrocera invadens* is an exotic fruit fly species, possibly of South Asian origin that was accidentally introduced to Africa, *icipe* has imported an effective biological control agent (a parasitoid) to re-unite the natural enemy with the pest through mass releases in the *Bactrocera invadens* affected countries. Once the parasitoid/ natural enemy has established in the new environments, no further releases are required as it will continue to control the pest naturally at no additional cost to the growers.

PAC comment: PAC members recalled that many of the activities proposed in both project proposals have in fact already been undertaken and that the results of many proposed activities (such as effective and efficient IPM measures and post harvest protocols for exports) are proven and readily available. Countries such as Senegal, Sudan and India were mentioned by PAC members as examples of fruit (mango) export countries that successfully manage the fruit fly and fulfill phytosanitary requirements in major export markets - contrary to the statement of the proposal submitted by ICIPE, protocol and the required post harvest processes are successfully in place in a number of African countries.

PEA and partner response: There is no doubt that the technologies have proven efficacy and as mentioned above, they were developed by *icipe* and partners. But the technologies require large-scale dissemination and promotion. For example, the natural enemy (parasitoid) that was imported by *icipe* from USDA Hawaii for the management of *Bactrocera invadens* requires mass production to enable mass releases in the affected African countries to assure the establishment of the natural enemy. So far only pilot releases have been made in three of the 29 *Bactrocera invadens* countries in Africa, namely in Kenya, Tanzania and Benin. If the growers were already aware of the management methods, we believe that the attention that the fruit fly problem has received over the last couple of years would be difficult to explain. In the opening statement of PAC comment it was acknowledged that "...fruit fly is indeed an important constraint to fruit exports of African countries." Senegal and Sudan are mentioned as countries that successfully manage fruit fly and fulfill phytosanitary requirements in major export markets. This is far from the truth. USAID in collaboration with the USDA recently held a training meeting at *icipe* from May 3-9, 2010 for plant protection officials from the Francophone African countries to create awareness on the fruit fly problem and lobby support for funding. This meeting brought together important dignitaries from the Ministries of Agriculture of several West African countries including Senegal. During the said meeting it was reported that mango export rejections from Senegal and other Francophone African countries are on the rise. For further information, especially on the topic of

fruit rejections in Senegal, we suggest you contact Dr. Dennis Hannapel (dhannapel@usaid.gov) the convener of the workshop and USDA SPS Advisor for Senegal. In addition, Sudan recently contacted the International Atomic Energy Agency (IAEA) for assistance on fruit fly management because mango and other fruits and vegetables attacked by *Bactrocera invadens* can no longer be exported. Dr. Jorge Hendrichs (j.hendrichs@iaea.org), the Head of IAEA's Insect Pest Control Section can provide you with more information on this. In summary it is hence difficult for us to understand how PAC reached such conclusions on the fruit fly management status in Africa.

PAC comment: Also PAC members remarked that hot water vaporizing machinery for phytosanitary export treatment were readily available on the world market. The PAC agreed that a serious attempt by the private and/or public sector in both West and East Africa should therefore make fruit export to lucrative markets such as US, EU and Japan possible, despite the presence of the Fruit Fly.

PEA and partner response: The issue with hot water treatment is that parameters that have been developed for one particular kind of fruit fly species do not necessarily work for another and this is the only researchable aspect that the East African CFC proposal was seeking to address. *Bactrocera invadens* is a fruit fly pest that is completely new to science (first described in 2005). There are NO HEAT TREATMENT PARAMETERS available for this pest anywhere in the world! Precisely because of this calamity *icipe* was recently approached by Citrus Research International (CRI) of South Africa to assist them in the development of cold treatment parameters for citrus against *Bactrocera invadens*. A similar request has come from the South African Avocado Growers Association. While these activities will allow for export of citrus and avocado to lucrative markets abroad, we still do not have such data for mango. Thus our intentions to develop a post harvest treatment in the context of the East African CFC proposal. We agree with the PAC assessment that the machinery is proven; however, the parameters, i.e. the appropriate temperature regimes for treatment, urgently need to be developed.

PAC comment: The PAC concluded that both projects did not provide any innovative approaches or solutions to fruit fly control. Together with a strong research bias and no apparent (export) market and value chain orientation an engagement of the CFC would not be justified.

PEA and partner response: It is not clear to us which of the two projects are biased towards research because the East African CFC proposal is focusing largely on implementation/dissemination apart from the mentioned generation of post harvest treatment parameters, which are presently the most important prerequisites for export of mangoes from *Bactrocera invadens* affected countries in Africa. The proposed activities address the fruit fly problem right from the field to post harvest and basically work along the mango value chain, addressing interests of growers, traders, processors and consumers.

Sincerely yours,

Dr. Sunday Ekesi
For PEA (*icipe*) and on behalf of project partners