Combating Fruit Flies in Eastern and Southern Africa (COFESA): Elements of a Strategy and Action Plan for a Regional Cooperation Program

An Issue Paper developed by

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For

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This issue paper was written by Dr. S. Ekesi (icipe) and commissioned by the World Bank. The views and opinions expressed in this report are those of the author and do not necessarily reflect those of the World Bank

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ABBREVIATIONS

AFFI	African Fruit Fly Initiative
AFFP	African Fruit Fly Program
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BMZ	German Ministry of Economic Cooperation and Development
CGIAR	Consultative Group on International Agricultural Research
COMESA	Common Market for Eastern and Southern Africa
CRI	Citrus Research International
CIRAD	International Institute of Tropical Agriculture-Centre de Coopération Internationale en Recherche Agronomique pour le Développement
DAAD	German Academic Exchange Service
EAC	East African Community
ESA	Eastern and Southern Africa
EU	European Union
FANR/SADC	Food, Agriculture and Natural Resource Directorate of the Southern African Development Community
FARA	Forum for Agricultural Research in Africa
FFS	Farmer Field School
FPEAK	Fresh Produce Exporters Association of Kenya
FSRP	Food Security Research Project
GHI	Global Horticulture Initiative
HCDA	Horticultural Crop Development Authority HVNSCP - High value non-staple crop program
HORTEXA	Horticultural Exporters Association of Uganda
icipe	International Centre of Insect Physiology and Ecology
IFAD	International Fund for Agricultural Research
IAEA	International Atomic Energy Agency
KARI	Kenya Agricultural Research Institute
KENFAP	Kenya National Federation of Agricultural Producers
KEPHIS	Kenya Plant Health Inspectorate Service
MDG	Millennium Development Goals
NaCRRI	National Crop Resources Research Institute
NGOs	Non-Governmental Organizations
NPPO	National Plant Protection Organization
ODI/DFID	Overseas Development Institutes/Department for International Development
SAAGA	South African Avocado Growers Association
SADC	Southern African Development Community
SAT	South Africa Tables Grapes
SIT	Sterile Insect Technique
SROs	Sub-regional organizations (SROs)
SSA	Sub-Saharan Africa
TAHA	Tanzania Horticultural Association
TCP	Technical Cooperation Program
USAID	United State Agency for International Development
USDA-APHIS	United States Department of Agriculture, Animal and Plant Health Inspection Service
USDA-ARS	United States Department of Agriculture, Agricultural Research Service
USDA-FAS	United States Department of Agriculture, Foreign Agricultural Service
UN	United Nations
WB	World Bank
ZEGA	Zambia Export Growers Association

EXECUTIVE SUMMARY

Context: In April 2010, the World Bank engaged the services of *icipe* and its Fruit Fly Program Leader Dr. S. Ekesi to develop an issue paper on combating fruit flies in Eastern and Southern Africa by providing a contextual assessment of the various stages and responses that the region has gone through with regard to the threat posed by *Bactrocera invadens*, outline on-going strategies and approach to manage the pest and offer perspectives with regard to a possible regional approach to tackling the *B. invadens* menace. The activities for the preparation of the issue paper consisted of a desk study and direct interaction and interviews with relevant staff of international organizations, national plant protection organizations (NPPOs), industry representatives and other interested groups or organizations. Based on the desk study and the interviews conducted, recommendations which are based on underlying principles are presented herein for a regional approach to managing fruit flies in Eastern and Southern Africa.

Background: Over the last two decades diversification into high value horticultural crop has been pushed as an economic development strategy for sub-Saharan Africa (SSA). Diversification into horticulture should contribute to poverty eradication by providing income to rural households and minimizing food insecurity while helping to restore the equilibrium in the balance of payments by increasing total export earnings for African countries. Horticulture offers one of the most important opportunities for, employment creation, affording access to education and health care and providing women with economic opportunities in rural economies where the highest production of fruits and vegetables takes place. For example, in 2008, the horticulture sub-sector industry generated US$ 1 billion in foreign exchange from exported commodities and over US$ 650 million domestically to Kenya; directly and indirectly employing over 4 million people. Across several of the Eastern and Southern African countries, a diversity of fruits and vegetables are grown both for domestic and export markets. The primary destination for export market is the EU, with the USA as an emerging market and a number of transactions also take place regionally among the countries. Several well-developed and dynamic private sector enterprises ensures monitoring of compliance with quality standards, access markets, improving industry's international image, enlisting government support and providing limited funding for research and development.

Constraints: Several types of insect pests afflict horticultural crops in the ESA region. However, none have garnered greater notoriety than Tephritid fruit flies. They are recognized worldwide as the most important threat to the horticultural industry. Female fruit flies that lay eggs under the skin of fruits and vegetables are responsible for direct damage. 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. Beside the direct damage to fruits, indirect losses is associated with quarantine restrictions that are imposed by importing countries to prevent the entry and establishment of unwanted fruit fly species. Sub-Saharan Africa (SSA) is the aboriginal home to 915 fruit fly species from 148 genera, out of which 299 species develop in either wild or cultivated fruit. They belong mainly to four genera: *Bactrocera, Ceratitis*, *Dacus,* and *Trirhithrum*. Most of the fruit fly species are highly polyphagous attacking several important fruits and vegetables. For example, on mango, the results of surveys across ESA shows the crop is attacked several native fruit fly species such *Ceratitis cosyra, C. quinaria, C. fasciventris, C. rosa, C. anonae* and *C. capitata* causing direct damage of 40–80% depending on locality, variety and season. On cucurbits and solanaceous crops, several native *Dacus* species (e.g. *D. ciliatus*, *D. puntatifrons*, etc) cause considerable losses to the crops. Although Africa is known to be the origin of several fruit fly introductions and establishments worldwide (the most notorious species being the Mediterranean fruit fly, *C. capitata*); with the intensification of fruit trade, the continent has also become highly vulnerable to introduction of alien invasive fruit fly species. Examples include the introduction of *Bactrocera zonata* into Egypt in 1997, the detection of *Bactrocera invadens* in Kenya in 2003 and the Solanum fruit fly *Bactrocera latifrons* in Tanzania in 2003. The

melon fly *Bactrocera cucurbitae* has also been in Africa for years without a clear date of introduction. Among all the fruit fly species listed here, one species, *B. invadens* is thought to be responsible for causing extensive economic losses to horticultural crops throughout Africa since its first detection in the continent in 2003. The rapid spread and devastating impact of *B. invadens* in SSA has been a matter of serious concern to the horticulture industry. For example, export of potential host species of *B. invadens* such as mango, avocado and cucurbits from Kenya, Tanzania and Uganda are already banned in Seychelles, Mauritius and South Africa. Trade of several horticultural produce between Africa and the USA has been severely hampered by recently issued Federal Order by the US banning importation of several cultivated fruits and vegetables from African countries where *B. invadens* has been reported The direct damage caused by *B. invadens* and the SSA-wide restrictions that are being imposed by importing countries seriously threatens the income, food security and livelihood of millions of families that produce and sell fresh fruit and vegetables across Africa.

Initial Action After Detection of *Bactrocera invadens*: Soon after the detection of *B. invadens* in Kenya, The Governments of Kenya, Tanzania and Uganda immediately requested for support from the Food and Agriculture Organization (FAO) of the UN to strengthen and widen the surveillance program for the pest, in the regions threatened by the invasion, and to immediately implement phytosanitary measures to limit its spread, and elaborate a pest management or eradication strategy depending on the results of the surveillance as well as the financial and technical feasibility of various phytosanitary options. A Technical Cooperation Program (TCP) was awarded by FAO to the countries in 2003. While most of the objectives of the project were achieved, the first few months of the surveillance revealed that the pest was already widely distributed across the 3 target countries with no specific pest free area although areas of low prevalence were found.

Ongoing Activities, Donor Involvement and NARES Participation: When the initial ambitious objective of containing the pest could not be met, other activities have concentrated on understanding the bio-ecology of the pest, developing management tools that could be utilized to suppress it on-farm, applying post harvest treatment measures and building local capacity in surveillance and management that could still permit profitable production of fruits and vegetables in Africa while allowing export to lucrative markets abroad. These activities are being carried out by the *icipe*-led African Fruit Fly Program (AFFP), Ministries of Agriculture of various countries, Royal Museum of Central Africa, Sokoine University of Agriculture, Eduardo Mondale University, and the private sectors. The projects are funded largely by International Fund for Agricultural Research (IFAD), the German Ministry of Economic Cooperation and Development (BMZ), International Atomic Energy Agency (IAEA), FAO, United State Agency for International Development (USAID), The United States Department of Agriculture (USDA), the World Bank (WB), Citrus Research International (CRI), and South African Avocado Growers Association (SAAGA). The fruit fly activities in the region has enlisted and sustained a broad range of partnership from the National Plant Protection Organizations (NPPOs) and National Agricultural Research and Extension System (NARES) in planning and evaluation of research, collecting and assessing data, preparation of project reports, farmer training, surveillance and promotion of technology uptake and adoption.

Achievements: Through the wide range of partnerships, considerable progress have been made in the following areas: (1) quantification of the impact of the pest status and damage caused by key fruit fly species (2) identification of effective attractants, biopesticides and parasitoids that could be utilized for suppression (3) field releases of *Fopius arisanus* (introduced from Hawaii) in several partner countries, (4) targeted implementation of IPM packages (based on the above) that has resulted in >70% reduction in fruit losses at project benchmark sites (5) establishment of post harvest treatment parameters (6) moving locally developed control packages into commercialization pathways (7) production of extension materials – manuals, posters, leaflets, distribution maps, taxonomic tools, databases etc leading to improvement in regional quarantine setting and public awareness in

fruit fly related problems and (8) building capacity through the training of NPPOs, NARES and growers as well as advanced level training at PhD (12 students) and MSc (6 students).

Regional Cooperation and Needs: Despite these achievements, there are still significant gaps in knowledge and the overall approach to the management of fruit flies in the ESA region. The quarantine and trans-boundary nature of most fruit fly pests, the limited availability of funds and current "down-sizing" trends that are being felt by all publicly funded research and development programs requires that implementing agencies must move towards developing strategies that favor greater integration and cooperation in collectively addressing issues of national development. Regional needs for future fruit fly activities would include but not limited to: (1) maintaining biosecurity through effective and continuous monitoring for alien invasive pest fruit flies and general phytosanitary measures across the countries; (2) large scale implementation of the IPM toolbox that have been developed using farmer field schools (FFS) and experiential learning with growers, exporter and extension agent; (3) exploring area-wide management approach and sterile insect technique (SIT) in isolated ecologies; (4) cooperation and unified acceptance of management products that are permissible for fruit fly management across the region and monitoring and enforcing compliance; (5) testing standardized or generic post harvest treatment regimes that is acceptable for all countries in the region; (6) pest risk analysis for fruit fly species that exist in trading partner countries; (7) establishment of a regional quarantine pest policy that can be adapted into a regional format and implemented across the ESA; (7) improving preparedness through the procurement and emergency stockpiling of attractants, traps etc in the advent of an invasion; (8) developing a regular newsletter to facilitate communication between countries in the ESA on all aspects of fruit fly R&D; (9) explore inter-regional cooperation with other similar regional fruit fly program to share experiences that may enhance rapid dissemination of useful results; and (10) regular quarantine training needs (e.g. in areas such as taxonomy and identification, early warning systems, pest risk analysis, emergency response action, eradication techniques and internal and border quarantine).

Proposed strategy: In the ESA region, there are currently 5 organizations that can play a leading role in fruit fly surveillance and management. These are, Association for Strengthening of Agricultural Research in Eastern and Central Africa (ASARECA), The Food, Agriculture and Natural Resource Directorate of the Southern African Development Community (FANR/SADC), Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC), and the International Centre of Insect Physiology and Ecology (*icipe*). Among the sub-regional organizations (SROs), ASARECA's high value non-staple crop program (HVNSCP) places horticulture high in its priority agenda and require strong consideration as a focal point for regional cooperation approach for fruit fly management and mitigation. Such cooperation would require a sound agreement, such as a Memorandum of Understanding (MoU) between the parties that would give the relevant parties, a framework under which cooperative projects can be conducted with mutual benefit. One other option could be to have two separate regional initiatives with the East African activities handled by ASERECA and the Southern Africa initiative operating under FANR/SADC with strong inter-regional cooperation among the two. In the events of possible conflicting issues among the SROs, a neutral technical agency such as *icipe* would be an ideal lead agency and there are number of reasons to support this suggestion including its exclusive focus on insect science and its application through regional and international cooperation, its Pan-tropical mandate with activities spread across several African countries including the ESA, its long history of R&D in fruit flies, its strong ties with several technical agencies (e.g. FAO, IAEA, USDA-ARS, ARIs, CGIAR centres, CIRAD etc) and the confidence that these agencies have in its R&D activities, 40 years experience in development and implementation of effective R&D program in insect science and finally its strong collaborative ties with NPPOs, NARES and SROs. Since the COMESA, EAC, and SADC are formal political organization representing governments of Eastern and Southern Africa with close ties to multi-lateral and other development agencies, their roles should be related to providing political leadership to

the program and in keeping the fruit fly problem high on the priority list of all the partner countries in the proposed initiative. These 3 political organizations should also play a significant role in fund mobilization, either internally or in partnership with bilateral and multilateral development agencies. It is proposed that the technicalities of the regional initiative and its implementation should be the responsibility of the SROs and *icipe*.

The initial step in the development of the regional cooperation would be to organize a forum in which representatives of ASARECA, FANR/SADC, COMESA, EAC and *icipe* meet either directly or through videoconference to explore possibilities and develop a common strategy to tackling the fruit fly menace in the region. Included in the above forum will be the traditional dialogue partners (FAO, WB, IAEA, GlobalHort, USAID and USDA-APHIS) and any other specialized agency. It is anticipated that such a high level forum could elicit positive signal to attract a regional support from the development partners. Based on the outcome of the above gathering, the next step should be agreed upon and could include the designing and implementing the process to move the initiative forward through broader consultation with stakeholders, political level, donor communities leading to the design of the scientific and technical aspect of the regional initiative and project implementation of the technical components through ASARECA, FANR/SADC, *icipe*, private sectors and stakeholders. Internal and external coordination and monitoring of the implementation activities should be the responsibility of ASARECA, FANR/SADC and *icipe*. The proposed strategy allows for a “bottom-up” input from the stakeholders, which is integrative with an effective “top-down” management function and should allow for effective implementation if adopted.

BACKGROUND

Most of the world's poor are rural and will remain so until 2035 (IFAD 2001). Greater majority of these rural poor depend directly or indirectly on agriculture for food security, poverty alleviation and improving livelihood. Over the last two decades diversification into high value horticultural crop has been pushed as an economic development strategy for Sub-Saharan Africa (SSA) (Delgado, 1995; ODI/DFID, 2004; Weinberger and Lumpkin, 2007; World Bank, 2008). Diversification into horticulture should contribute to poverty eradication by providing income to poor rural households and minimizing food insecurity while helping to restore the equilibrium in the balance of payments by increasing total export earnings for African countries as well as reducing fluctuations in revenues from exports. Horticulture offers one of the most important opportunities for employment creation, affording access to education and health care and providing women with economic opportunities in rural economies where the highest production of fruits and vegetables takes place (Weinberger and Lumpkin, 2007). Beyond the role of horticulture in providing a "reserve army" of labour force and income, the sector can also contribute to the expansion of agro-processing and processed food marketing thus providing new engines of growth and opportunities to substitute for imports. In many developed countries, domestic demand for fruits and vegetables continues to grow thereby providing ready market outlets for increased domestic production and export.

Status of Horticulture in some Eastern and Southern African Countries

Horticulture currently constitutes a large share of national output of several SSA countries and, the sector has been integral to any thinking of economic development and growth. A strengthened horticultural sector can have a positive impact on the Millennium Development Goals (MDGs) (GHI, 2005) and in most of the Eastern and Southern Africa (ESA) countries the sub-sector has consistently retained its position as the fastest growing industry in the agricultural sector.

Kenya: The sub-sector has had a tremendously growth over the last decade to become a major foreign exchange earner, employer of labour and key contributor to food security. In 2008, the industry generated US$1 billion in foreign exchange from exported commodities and over US$ 650 million domestically; directly and indirectly employing over 4 million people (HCDA, 2009). Total horticultural production is estimated to be close to 3 million tonnes making Kenya one of the major producers and exporters of horticultural products in the world (HCDA, 2009).

Tanzania: A diagnostic trade integration study identified floriculture, vegetables, fruits and horticultural seeds as important emerging export crops in Tanzania and the government has proposed to give high priority to the development of these particular sub-sectors (Nyambo and Verschoor, 2005). Generally, the level of organization in the agricultural sector is low compared to countries like Kenya, Uganda or Zambia but the establishment of sector wide organizations and networks is emerging as means to effectively lobby for collective interests and to enhance the delivery of agricultural support services to the sector. In Tanzania, horticulture generates US$ 120 million annually to the economy and it is believed that this figure is expected to double in the next five years due to ongoing farm expansion programmes and new investments (TAHA, 2010).

Uganda: Over the past two decades, Uganda has experienced strong economic growth and horticulture is central to the government's action plan for the modernization of agriculture. The action plan's strongly emphasis the revitalization of horticulture as an engine of growth and economic development. Because of the lack of reliable system for official collection of export statistics exact export value are relatively scarce in Uganda but it is believed that the value of horticultural exports should be around US $ 100 million based on fruits and vegetables

that are already being exported in relatively small quantities (Sonko et al., 2005). In the long run, existing exports could be increased by at least ten times with sufficient investment.

Zambia: Horticultural production and export have formed the core of Zambia's successful diversification away from dependence on volatile mineral exports (Nakaponda, 2006). In value terms, agricultural exports amounted to $265 million in 2005, and they provided employment to roughly 330,000 smallholders and 140,000 commercial farm workers. Specifically, the Export Board of Zambia estimates the total value of horticulture exports to be US$36 million in 2004 (Nakaponda, 2006). However, recent analysis of horticulture value chain foresees increase in production and export value (FSRP, 2009).

Mozambique: As with other ESA countries, horticultural production is being viewed as a major source of export-led growth in Mozambique. Fruit exports, notably citrus and, more recently, bananas and mangoes, has shown considerable potential for production and growth. Export of these fruits alone to neighboring South Africa, the largest destination market for horticultural produce from the country is estimated to be worth around US$ 20 million annually (Cugala et al., 2009).

South Africa: Of all the agricultural sub-sector in South Africa, the economic multiplier effect of the horticultural industry is the largest. It includes linkages to input supply industries and service providers such as chemical, fertilizers and carton suppliers, as well as forward linkages to wholesalers, retailers, hawkers, many other role-players in the supply chain and several rural communities are dependent on the industry for their livelihood (Hurndall, 2005). The growth in exports of horticultural products has been very impressive. For example gross export earnings in the deciduous fruit industry alone were estimated at R8.1 billion in 2002. Fresh deciduous fruit volumes are approximately 600,000 tons with the industry creating ~104,500 permanent job equivalents, with 417,000 dependants (Hurndall, 2005).

Crops, Farm Sizes and Export Destinations

Most of the ESA land area is well suited to growing fruit and vegetables. Abundant rainfall allows rainfed cultivation with low-input production techniques due to the existence of fertile soils. An increasing number that grow for export also rely on irrigation. Substantial quantities of the produce are consumed within the household contributing to food security, and surpluses are sold at the farm gate prices to domestic rural, urban and export markets. Across the countries a variety of fruits are grown including mango, banana, avocado, citrus, pineapple, passion fruit, grapefruit, grape, apple, pear, papaya, jack fruit, peach, strawberry and guava. Vegetables include sweet pepper, French beans, pea, cabbage, lentil, onion, leek, chillies, okra, tomato, garlic, ginger, carrot, turnip, celery, mushroom, asparagus, cucurbits, lettuce, spinach and other local leafy vegetables. Fruit and vegetables are traded and consumed fresh while others are used in the processing factories, primarily producing fruit juices and fruit juice concentrates. The sub-sector is characterized by varying diversity in farm sizes ranging from large-scale producers with substantial investments in irrigation and agricultural inputs, skilled management to small-scale farmers that are usually under 0.5 ha.

The primary export destination of all fresh produce from the region is the EU (Belgium, France, Germany, Italy, The Netherlands, Switzerland, UK etc) partly as a result of historically strong trade relations and familiarity with their export requirements; and the USA as an emerging market. Other important importing countries are Saudi Arabia and South Africa. Within Africa, several fresh fruit and vegetables are also traditionally traded among neighboring countries. Indeed, local exchanges between communities on both sides of the border are very common. Unfortunately, transactions usually remain unregistered and are not recorded in national statistics. Several well-developed and dynamic private sectors (e.g. Fresh Produce Exporters Association of Kenya

(FPEAK), Horticultural Exporters Association of Uganda (HORTEXA), Tanzania Horticultural Association (TAHA), Zambia Export Growers Association (ZEGA), Citrus Research International (CRI), South African Avocado Growers Association (SAAGA), South Africa Tables Grapes (SAT) etc) ensures monitoring of compliance with quality standards, access markets, improving industry's international image, enlisting government support and providing limited funding for research and development. Most of the industries operate in a free market environment with very minimal government intervention, mainly facilitating sectoral growth through infrastructure development, incentives and support services. Indeed, structural and macroeconomic reforms and the introduction of liberal trading have led to increased growth in the horticultural industry.

CONSTRAINTS TO THE HORTICULTURE INDUSTRY

The USAID (2005) commissioned global horticulture assessment identified the following primary issues that are of core importance to the development of the horticulture industry in producer countries: (1) market systems, (2) post harvest systems and food safety, (3) genetic resources conservation and development (4) sustainable production systems and natural resource management, (5) capacity building, (6) enabling environment, (7) gender equity and (8) nutrition and human health. A critical look at the situation in ESA region shows a similar situation and within the constraints in the sustainable production system, biotic stresses that include insect pest and diseases and considered as crucial to development.

Fruit Flies in Africa – Their Threat to the Horticulture Industry

Although, many insect pests attack fruits and vegetables, none have garnered greater notoriety than Tephritid fruit flies and they are recognized worldwide as the most important threat to the horticultural industry (Allwood and Drew, 1997; Barnes, 2004; Ekesi and Billah, 2007). Sub-Saharan Africa (SSA) is the aboriginal home to 915 fruit fly species from 148 genera, out of which 299 species develop in either wild or cultivated fruit. They belong mainly to four genera: *Bactrocera, Ceratitis*, *Dacus,* and *Trirhithrum* (White and Elson-Harris, 1992). Most of the fruit fly species are highly polyphagous attacking several important fruits and vegetables. Female fruit flies that lay eggs under the skin of fruits and vegetables cause 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. Beside the direct damage to fruits, indirect losses is associated with quarantine restrictions because infestation and sometimes mere presence of the flies in a particular country could also restrict the free trade and export of fresh horticultural produce to large lucrative markets abroad. The introduction of uniform and strict maximum residue levels (MRL) across Europe compounds the problem and further jeopardizes export. Of greater concern is the fact that even in countries where fruit fly management methods are undertaken, rejection by European markets is on the increase largely because with global trade and passenger trafficking, they are easily translocated and the risk of majority of African fruit flies as key and potential quarantine pests is becoming increasingly realized (Ole MoiYoi and Lux, 2004).

Indigenous fruit fly species

Africa is the aboriginal home of several species of highly damaging fruit flies. For example, on mango, the results of several surveys across ESA shows the crop is attacked by native fruit fly species such *Ceratitis cosyra, C. quinaria, C. fasciventris, C. rosa, C. anonae* and *C. capitata*. Traditionally, yield loss on this crop due to native fruit flies can range between 30–70% depending on the locality, season and variety (Lux et al., 2003). Other important native species *Ceratitis* species in the region include *C. quinaria, C. rubivora, C. puntata, C. discussa, C. ditissima,* and *C. pedestris* that attack a variety of important fruits and vegetables. On cucurbits, several native

Dacus species (e.g. *D. bivittatus, D. lounsburyi, D. ciliatus*, *D. puntatifrons*, *D. frontalis*,*D. vertebratus* etc) also inflict considerable losses to crops (White and Elson-Harris, 1992; De Meyer et al., 2002; Ekesi and Billah, 2007).

Exotic fruit flies

Although Africa is known to be the origin of several fruit fly introductions and establishments worldwide, (the most notorious species being the Mediterranean fruit fly, *C. capitata*) with the intensification of fruit trade, the continent has also become highly vulnerable to introduction of alien fruit fly species. In 1997, *Bactrocera zonata* was introduced into Egypt (De Meyer et al., 2007). In 2003, *Bactrocera invadens* was detected for the first time in Africa (Drew et al., 2003) (See Box 1). In 2006, the Solanum fruit fly *Bactrocera latifrons* was detected in Tanzania (Mwatawala et al., 2007). The solanum fruit fly is primarily a pest of solanaceous crops such as eggplant, pepper and tomato. Although damage is currently concentrated on local solanum species such as *Solanum aethiopicum* and *S. macrocarpon* (Maulid et al., 2009; De Meyer et al., 2007; Ekesi et al., unpublished); tomato seems to be most at risk. The melon fly *Bactrocera cucurbitae* has also been in Africa for years without a clear date of introduction (White and Elson-Harris, 1992). *Bactrocera cucurbitae* is possibly the world's most damaging fruit fly species on cucurbits. The invasion of alien species can cause extensive economic and ecological damage, with unpredictable negative effects on native populations. Alien species impact on environment is believed to be second only to habitat destruction (Naeem *et al*., 1995; Lyon and Miller, 2000). Invasive species can alter successional patterns, mutualistic relationships, community dynamics, ecosystem functions and resource distributions. Invasive species that cause extinction of native species will ultimately reduce local and global species diversity (Vitousek et al., 1996).

Box 1

Bactrocera invadens is an invasive fruit fly species believed to be native to Sri Lanka and currently reported from 28 African countries including the Comoros Island and Cape Verde. It attacks over 40 host plants but mango is the preferred host plant causing over 80% damage on the crop. It has rapidly displaced several of the indigenous fruit fly species and currently ranked as the most important fruit fly pest in the African continent. The Inter-African Phytosanitary Council of the AU has described it as a devastating quarantine pest (French, 2005). It has a broad temperature range, has been trapped at an altitude > 1600 m above sea level and has the capability for invading other regions of the world. Several countries in Africa continues to suffer significant loss in revenue due to lost export markets associated with the presence of the pest in the countries where it has been reported. A concerted effort is required by the fruit fly and donor communities to provide technologies, build capacity and create awareness on the importance of this important pest for improve horticulture in Africa and beyond

Among all the native and exotic fruit fly species listed here, one species, *B. invadens* is thought to be responsible for causing extensive economic losses to horticultural crops throughout Africa since its first report in 2003. The rapid spread and devastating impact of *B. invadens* in SSA has been a matter of serious concern to the horticulture industry. For example, export of potential host species of *B. invadens* such as mango, avocado and cucurbits from Kenya, Tanzania and Uganda 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. The current export volume for banana in

Mozambique is estimated at 35,000 tons per year with a foreign exchange value of US$ 17.5 million. South Africa, its major trading partner has closed its markets to fresh fruits including bananas and mangoes from the northern part of the country due to the presence of *B. invadens*. At Vanduzi Company in the Central province of Manica about US$ 1.5 million has been lost due to the presence of *B. invadens* and quarantine restrictions on the export of various fresh fruits and vegetables (Cugala et al., 2009).

The direct damage caused by *B. invadens* and SSA-wide restrictions that are being imposed by importing countries seriously threaten the income, food security and livelihood of millions of families that produce and sell fresh fruit and vegetables across Africa. However, despite the enormous challenges that come with *B. invadens* invasion, production of quality fruits to meet with the stringent export market requirement is still possible with the current availability pre-harvest and post-harvest management methods as well as institutional support aimed at strengthening phytosanitary management to minimize spread and new incursions into the region.

IMMEDIATE ACTION BY GOVERNMENT AUTHORITIES AND TECHNICAL AGENCIES AFTER DETECTION OF *BACTROCERA INVADENS*

In one of its regular monitoring activities, 3 fruit fly specimens resembling the oriental fruit *Bactrocera dorsalis* were collected by *icipe* at the Kenya Coast under the then African Fruit Fly Initiative (AFFI) in March 2003. Preliminary identifications suggested that the specimens found were likely to be a pest of Asian origin and a member of the *Bactrocera dorsalis* complex. Later taxonomic identification by world authorities described it as a pest that is completely new to science and the insect was named *B. invadens* in 2005 (Drew et al., 2005). Soon after the detection, *icipe* immediately notified the Kenya Plant Health Inspectorate Service (KEPHIS) and a joint surveillance activity between the 2 organizations was started in March 8 – 16, 2003. The immediate survey activity in Eastern Kenya revealed that the alien species was distributed in an area of about 25 000 km^2. The pest was found in the area of Sultan Hamud (100 km East of Nairobi up to Mombasa), from Lunga Lunga to Malindi, and from Voi to Taveta. About 800 specimens were collected in traps baited with methyl eugenol during that period. KEPHIS in collaboration with *icipe* continued their surveillance to determine the spread of the pest but the activity could not be expanded to neighboring countries and was severely hampered by lack of resources at the time. The Governments of Kenya, Tanzania and Uganda through the respective Ministries of Agriculture then immediately requested for support from the Food and Agriculture Organization (FAO) of the UN to strengthen and widen the surveillance program for the pest in the regions threatened, and to immediately implement phytosanitary measures to limit its spread, and elaborate a pest management or eradication strategy depending on the results of the surveillance as well as the financial and technical feasibility of various phytosanitary options. A TCP grant TCP/RAF/2923 (A) was granted to the 3 countries in September 2003 with *icipe* as a technical agency with the broad objectives of strengthening the emergency response and management capability regarding the newly introduced fruit fly species. Specifically the TCP had the following objectives: (1) Conducting specific surveillance throughout the countries threatened; (2) determine the distribution of the pest through delimiting surveys; (3) identify hot spots of infestation which could be immediately subjected to phytosanitary measures to contain the pest and prevent its spread; (4) identify and put in place phytosanitary measures determined to be effective in containing the pest; (5) elaborate a regional strategy to eradicate or manage the pest; (6) determine areas of production which can be maintained as pest free or areas of low pest prevalence in order to maintain export markets under these measures; (7) train government personnel and stakeholders in aspects of fruit fly surveillance and management; and (8) train government officers in regulatory aspects of fruit fly eradication/containment. While most of the objectives of the project were achieved, the first few months of the surveillance revealed that the pest was already widely distributed across the 3 target countries with no specific

pest free area although areas of low prevalence were found. A larger proposal was developed following completion of the FAO TCP to address the long-term management of the pest. Unfortunately several attempts at securing funding address the long-term management approach have been rather futile but the project document is still receiving attention with various donor agencies. When the initial ambitious objective of containing the pest could not be met, other activities have concentrated on understanding the bio-ecology of the pest, developing management tools that could be utilized to suppress it on-farm, applying post harvest measures and building local capacity in surveillance and management that could still permit profitable production of fruits and vegetables in Africa while allowing export to lucrative markets abroad.

ONGOING STRATEGIES AND APPROACH TO CURTAIL *BACTROCERA INVADENS* AND OTHER NATIVE FRUIT FLY SPECIES

Ongoing Fruit Fly Research and Development (R&D) in the ESA

Until relatively recently, fruit fly R&D in the ESA region outside of the Republic of South Africa was rather fragmentary. To some extent, this can be attributed to the fact that the local fruit industries are under-developed and they can neither afford nor economically justify investment required for fruit fly management. In this region, as in most of the SSA, activities were restricted to exploration activities for export of natural enemies for shipment to the USA and Latin America largely by experts from the US. Other activities included studies related to basic taxonomic identification by individual government agricultural laboratories and universities. However, during the last decade, there has been a slow but steady increase in awareness of the importance of fruit flies in the region partly due to their direct damage and in their importance in export fruits and vegetables as well as the recent invasions into areas where they were not present. As a result of these concerns, several initiatives were started including:

African Fruit Fly Program (AFFP): AFFP is an *icipe*-led initiative formally called the African Fruit Fly Initiative (AFFI) and was established in response to requests from African fruit growers, national authorities and regional commodity and quarantine bodies. The program began operations in 1999 and currently operates in Benin, Cameroon, Kenya, Tanzania, Ethiopia, Uganda, Nigeria, Mozambique, and Sudan with request from several other African countries to join. It has the broad objectives of (1) assessing the impact of fruit fly infestation on key crops in Africa (2) develop and evaluate affordable fruit fly management methods based on locally produced tools and materials, such as traps, attractants and biopesticides (3) explore, introduce and release natural enemies of exotic fruit fly species in Africa (4) establish parameters for post-harvest treatment for key fruit fly species on export fruits and vegetables (5) produce and disseminate tools for strengthening fruit fly quarantine in Africa, such as distribution maps and pest identification keys and (6) train personnel in the participating African countries in order to develop a cadre of fruit fly experts.

FAO *Bactrocera invadens* surveillance and management: This project was the emergence response project given to the governments of Kenya, Tanzania and Uganda following the first detection of *B. invadens* in Kenya as outlined earlier.

FAO Mozambique *Bactrocera invadens* management and mitigation: Following the spread of *B. invadens* to the southern African region, Mozambique was particularly hit by closure of export markets and in response to the invasion, the FAO granted the country this TCP project with the objective of (1) rapidly introducing proven IPM packages (developed by *icipe*) for the management of native and invasive fruit fly species into the country to suppress the insect; (2) develop and implement public awareness campaign to encourage cooperation among stakeholders and general public on the pest; (3) determine possible areas of freedom from fruit fly which could be consider for maintenance as such to allow export to South Africa in particular; (4)

strengthen the surveillance programme for *B. invadens* to provide reliable data as a scientific basis for negotiations regarding trade with South Africa; (5) establish and strengthen domestic quarantine activities to prevent the spread of *B. invadens* if applicable and (6) build capacity through the training of National Plant Protection Organizations (NPPOs) and industry personnel on the application of the various management options.

World Bank Mozambique Bactrocera invadens project: Most of the activities of the Eduardo Mondale University-led WB project overlap with the on-going FAO activities. The 2 projects complement the activities of each other and currently carry out joint trainings, trappings and meetings together.

United State Agency for International Development (USAID)/ The United States Department of Agriculture, Foreign Agricultural Service (USDA-FAS), United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS) fruit fly surveillance activities: The USAID and USDA activities have largely concentrated on the aspects of building capacity of NPPOs in the region on fruit fly R&D. The training activities address the implications of fruit flies on fruit production, export and quarantine in the region. It also tackles basic aspects of fruit flies biology, host range, distribution, taxonomy and management.

International Atomic Energy Agency (IAEA) activities (surveillance and management of B. latifrons; lure testing and, fruit fly mass rearing in support of Sterile insect Technique (SIT): The IAEA was the first organization to respond to the first detection of *B. latifrons* in Tanzania by providing funding to the Royal Museum of Central Africa, Tervuren and the Sokoine University of Agriculture, Tanzania to carry out surveillance and management activities for the pest. The funding was also extended to *icipe* following the detection of the pest at the Kenyan border of Taveta. In addition to this activity, the Agency has also funded *icipe* in areas of attractant testing and development and fruit fly mass rearing in support of Sterile Insect Technique (SIT).

Citrus Research International (CRI) post harvest treatment activities on citrus: The CRI have been rather proactive in its approach to the *B. invadens* problems in Africa. Although *B. invadens* has not been detected in South Africa, the organization is involved in development post harvest treatment regime jointly with *icipe* for *B. invadens* on citrus to facilitate citrus export to lucrative markets abroad just to guard against any possible spread to S/Africa.

South African Avocado Growers Association (SAAGA) post harvest treatment activities on avocado: Following on the initiative by the CRI, the S/African avocado growers have also embarked on similar activity. This is also a joint initiative between SAAGA, Fresh Produce Exporters Association of Kenya (FPEAK), KEPHIS and *icipe*. Data generated are shared among partners to facilitate avocado export to international markets.

The United States Department of Agriculture, Agricultural Research Service (USDA-ARS) exploration for natural enemies of Bactrocera oleae: Several explorations have been conducted in Kenya for natural enemies of *B. oleae* for shipment to California for the management of the insect.

Others: In addition to the above activities, various national surveillance programs that are either funded by government or external agencies are currently underway in most of the ESA countries in response to trade pressures as result of the threat posed by *B. invadens*.

The *icipe*-led AFFP had in the past made significant strides towards bringing all the actors together but as with all projects, funding constraints, limited support from the national partners and poor political will on the part of the regional political bodies has hampered progress. However, with the growing awareness of the fruit fly problem

and as pressures continue to build at both ends of the export chain, the need for a regional approach to deal with the fruit fly problem is becoming crucial.

Degree of Involvement of National Partners and Stakeholder

The fruit fly program in the region has over the years enlisted and sustained a broad range of partnership from the national systems, private sectors and various other stakeholders in the effort to combat the fruit fly menace in the region. The NPPOs and National Agricultural Research and Extension System (NARES) are full partners in planning and evaluation of research, collecting and assessing data, preparation of project reports, farmer training, and promotion of technology uptake and adoption. Private sector partners are involved in moving the pest management science into product commercialization pathways. For example, the *icipe*-led AFFP works extensively with the following NARS and private sectors: Kenya – KEPHIS, Kenya Agricultural Research Institute (KARI), Ministry of Agriculture, Kenyatta University, Fresh Produce Exporters Association of Kenya (FPEAK), Kenya National Federation of Agricultural Producers (KENFAP), RealIPM and several growers associations; Tanzania – Ministry of Agriculture Food Security and Cooperatives, Mikocheni Agricultural Research Institute (MARI), Amagro Mango Growers Association etc; Uganda – National Crop Resources Research Institute (NaCRRI), Ministry of Agriculture, Animal Industries and Fisheries, Assubira Mango group; Mozambique – Provincial Department of Agriculture; Department of Plant Protection; Eduardo Mondale University.

The first USAID/USDA-APHIS training attracted participants from NPPOs in Zambia (Zambian Agricultural Research Institute), Rwanda (Rwanda Agricultural Development Authority), Botswana (Department of Agriculture), Swaziland (University of Swaziland), Mozambique (Eduardo Mondale University), South Africa (CRI and SAAGA) and Kenya (KEPHIS). As indicated earlier, the NPPOs and NARES themselves have been catalyzers of various other fruit fly initiatives in the region and also foster collaboration and partnerships locally among themselves within the countries. Similarly, the private sectors have also been very proactive in tackling the *B. invadens* threat and an example is the development of post harvest treatment parameters for *B. invadens* on citrus and avocado which were spearheaded by the South African citrus and avocado industries with *icipe* providing the technical inputs to the research activities. Another recent private sector initiative in Kenya involves the development of early warning systems for invasive pests, which is a joint initiative between FPEAK, KEPHIS and KARI. The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and its other networks will evidently become the most important stakeholders at the regional level in the nearest future in the fights against fruit flies. Recently, *icipe* is in the process of signing collaborative agreement with the organization in R&D activities related to high value crops, climate change, and knowledge management and dissemination.

Donor Involvement

Bilateral donor assistance to fruit fly activities in the ESA region has largely come from the following sources:

- The International Fund for Agricultural Development (IFAD) – IFAD is the pioneering donor organization in the fight against fruit fly in Africa. From 1999-2003, it provided $2,000,000 for core operations in Kenya, Tanzania (mainland), Tanzania (Zanzibar), Uganda, Côte d'Ivoire, Sudan, Republic of South Africa with limited activities in Ethiopia, Namibia and Nigeria. This project was led by *icipe*
- FAO of the UN has provided $345,000 for surveillance activities of *B. invadens* following is first detection. This project was led by governments of Kenya, Tanzania and Uganda through NPPOs with *icipe* providing technical support. Following the spread of the pest to Mozambique, FAO has also recently provided $298,000 to the Mozambican government for management and mitigation measures against *B. invadens*.

- The German Ministry of Economic Cooperation and Development (BMZ) is currently funding an *icipe* –led project on mango IPM that is addressing 3 pests that include fruit fly (mango seed weevil, mango mealy bug and *B. invadens*). The project is funded at €1,050,000 from 2008-2010 in 3 countries - Kenya, Tanzania and Benin.
- IAEA from 2005-2010 has provided to *icipe* approximately $120,000 for activities related to development of attractant and fruit fly mass rearing in support of SIT and surveillance and management of *B. latifrons* in Kenya.
- USAID/USDA-FAS/USDA-APHIS has provided $16,954 for training of NPPOs of the Southern Africa Development Community (SADC).
- The German Academic Exchange Service (DAAD) and The Netherlands through the Direct Support to Training Institutions in Developing Countries programme (DSO) has provided approximately $500,000 for training of PhD and MSc students attached to the *icipe* ARPPIS program.
- USDA-ARS has provided approximately $30,000 for exploration for natural enemies of *B. oleae* for shipment to California.
- The World Bank has provided $200,000 to governments of Mozambique on *B. invadens* management and mitigation measures and the Bank is involve in various other activities in Burundi, Rwanda and Zambia.

Achievement

Problem Assessment: All the above projects have significantly contributed to the scientific knowledge of the complex of fruit fly species with regard to their pest status, distribution and abundance. Fruit infestation and yield losses have been described for several locations in all the ESA countries. For example, yield loss on mango is known to range from 10 to 80%.

Fruit fly attractants: Several commercial and locally developed attractants have been tested and evaluated against the different complex of fruit flies resulting in the selection of the most efficient attractants that could be used for field suppression. The locally developed bait by *icipe* is known to be 30% more effective than the commercial imported product, and can be produced at only a fraction (less than 20%) of the cost.

Biopesticides: New fruit fly control agents that are based on fungal pathogens (*Metarhizium anisopliae* and *Beauveria bassiana*) that infect and kill the fruit flies and can substitute for harmful chemical pesticides for soil treatment and in bait stations have been developed and field-tested.

Exploration, introduction and releases of parasitoids: Exploration for natural enemies of *B. invadens* was initiated in Sri Lanka by the *icipe*-led BMZ project and a diversity of natural enemies were found in the country. Unfortunately, the programme could not introduce natural enemies from Sri Lanka to Africa due to restrictions on movement of biological diversity. However, 2 parasitoids (*Fopius arisanus* and *Diachasmimorpha longicaudata*) were introduced from Hawaii and tested with proven efficacy. Experimental releases of *F. arisanus* have begun in Kenya, Tanzania and Mozambique with huge request from several other Africa countries.

Availability of IPM package and reduction in fruit damage, improvement in fruit Quality and increase in income of smallholders at program benchmark sites: The approach being promoted in the region and elsewhere is to use as little insecticide as possible by adopting an IPM strategy based on continuous monitoring attractants followed by application of baiting and male annihilation techniques, biopesticides, parasitoid releases and conservation, orchard sanitation and use of augmentorium. Through these methods, fruit losses have been reduced by >70% and the quality of fruits are greatly improved thus enhancing market prices at project benchmark sites.

Post harvest treatment regimes: Post harvest treatment regimes for *B. invadens* on citrus and avocado are being established to permit export of these produce to quarantine sensitive markets.

Product Commercialization pathway: private sector interests have been crucial in the development of control agents (traps, bait and fungus). Traps developed by the program were used to detect the invasion of *B. invadens* in 2003. ReallPM have signified interest in moving the fungus-based biopesticide to commercial pathways.

Production of extension and training materials: Fruit fly manuals, posters, leaflets and distribution maps have been produced and distributed to relevant government authorities across Africa.

Identification tools: Taxonomic keys for easy identification of pest fruit fly species have been developed, and means of distinguishing the pests from the non-pest species advanced.

Creation of fruit fly databases: Fruit fly databases have been created with over 4000 entries on nearly 15,000 specimens and a total of more than 195 tephritid species. This resource hosted at *icipe* is made available to national partners for research and training and to visiting collaborators and it is generally accessible to schools and colleges on educational visits.

NARES and grower trainings; and establishment of National Fruit Fly Teams: With technical backstopping from *icipe*, over 800 extension, and quarantine personnel and growers have been trained in the IFAD, FAO, BMZ, IAEA and USDA-APHIS projects on fruit fly taxonomy, monitoring and management in the region. National fruit fly teams (NFFT) consisting of quarantine specialists, extension personnel and growers have also been established in Kenya, Tanzania, Uganda and Sudan.

Advanced level training at PhD and MSc: A total of 12 PhD and 6 MSc students have been trained in various aspects of fruit fly biology and ecology, biological control and IPM. These areas of expertise in fruit fly management are especially in short supply in SSA and are generally needed to shore up the scientific, research and developmental capacity in agricultural pest management of the targeted countries.

Improvement in regional quarantine settings: Regional system of quarantine has been significantly improved in fruit fly detection and management through the provision of taxonomic tools, quarantine equipment (traps, lures and killing strips), fruit fly distribution maps, and warning posters to national partners for rapid detection and identification of native and invasive fruit flies. Community-based quarantine system is also consistently encouraged and being implemented by quarantine and extension specialists.

Improved project coordination capacity of NPPOs and NARES: Through the utilisation of information generated by the project and participation in its implementation, NPPOs and NARES of the targeted countries have improved their capacity in research coordination, dissemination of technical information and training activities relevant to fruit fly related problems.

Improved public awareness of fruit fly related problems: Effective public awareness campaigns have been essential to the success of the fruit fly management strategy. As part of this component, the programme periodically updates the local media (TV, radio, newspaper) on all aspects of the programme.

Projects spin-off benefits: Although mango has generally been the target crop for most of the projects, the control package developed for these activities is having a direct benefit on other crops such as citrus and cucurbits.

Perspectives

Despite the above achievement in the recent past especially in countries participating in the *icipe*-led AFFP network and others who are not members but have taken their own stride in addressing the fruit fly problem; several other African countries in the ESA region have not made similar inroads with regards to fruit fly surveillance and management. This is exemplified in the overwhelming request to *icipe* for help in addressing the *B. invadens* menace in their countries. This is coupled with the fact that the technologies that have been tested and proven to be effective have not undergone large-scale participatory validation, promotion and dissemination in most of the countries. In several of the ESA countries, there are still significant gaps in training, knowledge and technological application to management of fruit flies, especially the invasive species, and highlights the need for donor support for expansion of activities to other countries. However, limited funding has continued to hamper expansion of activities to other countries and dissemination of already developed technologies. Investments required for fruit fly management are enormous. For example, the *annual* cost of maintaining fruit fly preventative barrier along the Mexican-Guatemala border under the MOSCAMED Program ranged from US$ 4.1-19.2 million; and it is estimated that the cost of various medfly control and preventative operations outside of Africa is > US$ 100 million, *annually* (Ole-Moiyoi and Lux, 2004). Currently, less than 1% of this figure is spent on fruit fly management in SSA. Indeed, effective fruit fly management in Africa and building local capacity for efficient quarantine surveillance will increase fruit and vegetable production for both domestic and export market and also minimize the risk of incursions to regions outside of Africa.

NEED FOR REGIONAL COOPERATION

One of the key reasons for a regional cooperation in fruit fly surveillance and management is that the great majority of Tephritid fruit flies by their nature are quarantine pests and no country can look at its fruit fly problems and risk in isolation. World trade in fresh tropical fruits is expanding rapidly to meet the increasing demands on existing markets resulting from international trade agreements. Accompanying the improved international trade is the increased risk for inadvertently transporting fruit flies to countries or regions where they do not already occur because tropical fruits are host or vehicles of transport of these insects. The problem is compounded by international passenger traffic, along with shorter transit times. As Armstrong and Jang (1997), pointed out there is actually more risk for introductions of quarantine pests from contraband fruits smuggled by airline passengers than commercial shipments of fruits. No matter how vigilant customs and passenger profiling are, there will eventually be one important infestation that will slip through the checkpoints. Collaboration among countries in helping each other at either end of the airline routes will evidently help in minimizing translocation and accidental introductions. To this end, transparency with information regarding fruit flies, their distribution and what measures are being taken to manage them is crucial in any regional management approach.

Another reason for considering a regional cooperation in tackling fruit fly problem is that globally, the resources available for designing and implementing crop protection research in general are not protected from the current “down-sizing” trends that are being felt by all publicly funded R&D programs. Worst of all is that it is very likely that this operating principle will remain with us for several years to come. This, therefore, requires implementing agencies to pool and leverage resources for the purpose of economies of scale in addressing regional issues. Additionally, it is increasingly becoming evident that the traditional narrow view approach to project activities are no longer acceptable and implementing agencies must move towards developing strategies that favour greater integration and cooperation in collectively addressing issues of national development. Indeed, examples abound on how regional programming can be effective to achieving sustainable development and such an initiative will not be working in isolation.

The establishment of a regional cooperation in the region would be helpful in improving the research capacity of the national systems, in collective identification of research needs, and in organizing and disseminating already

existing knowledge in managing fruit flies. By harnessing political leadership in such cooperation, appropriate regional organizations are able to provide the necessary advocacy to governments to increase awareness about the burden of fruit fly problems and to combat the threat of invasions at necessary levels that could translate to improvement in the horticulture industry in the region.

Nonetheless, this approach is paramount, and in dealing fruit fly problems in the region, it is worth mentioning that there is always a general reluctance on the part of many countries to move from the more familiar and comfortable nation-by-nation, project-by-project bilateral arrangement to regional initiatives. Despite this, pressure will continue to mount from development partners to move towards this direction and the fruit management activities must also respond accordingly.

Elements of such a Regional Cooperation

Setting up the priorities: The numbers of projects or development activities that warrant assistance whether nationally or internationally currently far exceeds the available resources to support them. In this regard, securing funds will require the development of clear priorities and the process by which the priorities are established must be very rigorous and easily defendable from technical, socioeconomic and political perspectives. Even within the proposed fruit fly program, areas requiring attention are fairly broad and a careful assessment of keys areas of relevance must be carefully scrutinized for support.

The short- and long-term cooperation needs should define: The long-term goals of any regional cooperation requires high level strategic-thinking and decision-making to ensure that available and scarce resources are not diverted into achieving short term goals that although may be solid and attractive, they can also thwart the achievement of major long-term goals.

Identification of the key collaborators and partners: As mentioned earlier, there are already a number of actors in fruit fly R&D in ESA that are attracting funding either directly from government agencies or from external sources. All these institutions should be considered as potential partners and stakeholders in the proposed regional cooperation. Major institutions and groups for partnership should include agricultural research institutions, universities, agricultural extension services, the CGIAR and advanced research institutions, NGOs, private sector, farmer groups and socioeconomics and market research groups.

Tackle complementing and competing issues: In all regional cooperation initiatives, there will be overlapping and competing issues. To minimize duplication of effort and to move the program agenda into complementarity, a system must be devised that allows a fair and equitable distribution of roles and responsibilities among collaborating partners in the regional cooperation initiative to minimize conflict.

Identification of the focal point of cooperation: A valid regional cooperation initiative requires a focal point to lead the plan of action, and then a strategy to sustain the program. Such a central point could be specific collaborative partners, specialized agency of the UN, regional financial institution, a regional economic commission or a sub-regional organization with interest in the problem to be addressed. Any organization that is selected as a lead agency must have close relationships with the NPPOs and NARES in the region to provide a greater sense of ownership and necessary commitment to the course of action.

Consultation with stakeholders: A key element of regional cooperation is ensuring that the interest of the stakeholders is adequately captured especially the growers and particularly during all phases of project design and implementation.

Define strategies for sustainability: Institutional strengthening, capacity building and effective service delivery will be pivotal to the sustainability of the regional initiative. Experience has shown that majority of developmental projects that have failed in the past, the underlining cause of the failures are attributed to the fact that technical activities are not accompanied by development of local capacity. In addition to capacity building and institutional development, another important aspect ensuring sustainability relates to policies and legislation created to support the scientific and technical development. For example, the establishment of regional and community-based quarantine system to restrict movement of fruits and vegetables, area-wide trapping activities and other phytosanitary measures will only be enforced if they are backed up by appropriate legislation. External funding will also not be available eternally. A regional cooperative initiative must be prepared to adequately advocate and lobby policy support from government authorities to ensure that proper attention is given to improving fruit and vegetable production through fruit fly management and especially development of efficient quarantine systems and overall success of the project after external funding dries out.

Regional Needs for Future Activities

Whilst significant achievement has occurred in the region with regard to combating fruit flies, there are still some major gaps that require attention especially within the context of a regional approach to addressing the fruit fly menace. These are briefly highlighted:

- Fruit flies are notable for breaching quarantine barriers. Although maintaining biosecurity through effective phytosanitary management across the borders is a considerably costly endeavor, this will be very crucial in the regional effort to deal with the fruit fly problem. The practicalities and system for ensuring security through systematic quarantine surveillance using trapping and host fruit survey must be immediately discussed. While most countries have their own system in place, the commonalities in approach would suggest a real advantage in focusing on a more cooperative and regional monitoring approach. The protection of the regional horticultural production against the introduction of alien invasive pest fruit flies should in the long-term be as important as the creation of short-term export opportunities through suppression of fruit flies that are already in the continent.
- Based on the achievements presented earlier from the various projects, technologies (that are based on baiting and male annihilation technique, use of biopesticides and parasitoids, orchard sanitation and others elsewhere such as the ant technology) are now available for field suppression of both the exotic and native fruit fly species. In the nearest future, parameters for post harvest treatment will become available for *B. invadens* and the native *Ceratitis* spp. Despite the availability of these technologies, large-scale implementation of this management toolbox is yet to be carried out in most of the countries. Participatory execution through farmer field school (FFS) and experiential learning with growers, exporter and extension agent is urgently needed.
- An area-wide management approach that is tailored to specific region may be practical although difficult across the entire region due to the fragmented nature of the production systems.
- Sterile Insect Technique (SIT) should also be useful in some isolated ecologies in the region and its application is worth exploring.
- There is the need for cooperation and unified acceptance of management products that are permissible for fruit fly management across the region and how to monitor and enforce compliance.
- Cooperation needs to include countries from both the importing and exporting regions since rejection or detection in one country may place others under suspicion.
- A standardized or generic post harvest treatment regimes acceptable for all countries in the region and negotiated and agreed with importing countries will be necessary.
- The need to continue to strengthen the quarantine security in the whole region cannot be overemphasized.
- Knowledge of existence of certain species of fruit flies in trading partner countries and pest risk analysis of the same are urgently required.

- There is the need to identify an existing national or regional quarantine pest policy that can be adapted into a regional format and implemented across the ESA.
- Invasion cannot be completely prevented and a regional strategy in the event of an incursion will need to be discussed at one forum. Improving preparedness through the procurement and emergency stockpiling of attractants, traps etc will be essential.
- Borrowing from the West African regional cooperation, a regular newsletter to facilitate communication between countries in the ESA on all aspects of fruit fly R&D (occurrence, distribution, detection, ongoing surveillance, management methods) will improve the effectiveness of a regional approach.
- Inter-regional cooperation also needs to be established (i.e. there is the need for linkages with other regional program in West and North Africa) to share experiences that may enhance rapid dissemination of useful results.
- Quarantine training needs to be regularly upgraded and topics for training should include:
  - Taxonomy and identification;
  - Early warning systems (continuous surveillance and management);
  - Pest risk analysis;
  - Emergency response action;
  - Eradication techniques; and
  - Internal and border quarantine.

PROPOSED STRATEGY FOR CONSIDERATION

In the ESA region, there are currently 5 organizations that can play a leading role in fruit fly surveillance and management. These are: ASARECA, The Food, Agriculture and Natural Resource Directorate of the Southern African Development Community (FANR/SADC), Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC), and the International Centre of Insect Physiology and Ecology (*icipe*).

ASARECA and FANR/SADC are both members of the Forum for Agricultural Research in Africa (FARA) with similar broad objective of collaboration in agricultural research to foster effectiveness, efficiency, responsiveness, complimentarity and economies of scale.

ASARECA has the primary goal of facilitating agricultural research in eastern and central Africa that promotes agriculture oriented towards markets and income generation. Its secondary goal is to serve as the main forum where strategies and ideas for agricultural research and their relationship to agricultural development in the sub-region are conceived and exchanged. High value non-staple crops, which are main host plants of fruit flies, constitute a major program within ASARECA's thematic programmatic areas. Also using its knowledge and up-scaling program, it has considerable experience in technology transfer initiatives and should have an important role to play in any future fruit fly R&D.

The FANR cluster of the SADC comprises the following technical areas of co-operation (1) Food Security (2) Crop Development (3) Livestock Production and Animal Disease Control (4) Natural Resources Management comprising Forestry, Wildlife and Fisheries; and (5) agricultural and Natural Resources Research and Training. The rather broad crop development sub-cluster would address the proposed regional activities.

ASARECA's high value non-staple crop program (HVNSCP) perhaps place horticulture high in its priority agenda and gives it a little edge over the programmatic structure of the FANR/SADC. Among the various organizations, ASARECA requires strong consideration as a focal point for regional cooperation approach for fruit fly management and mitigation. Such cooperation would require a sound agreement, such as a Memorandum of Understanding (MoU) between the parties. This would give the relevant parties, a framework under which cooperative projects can be conducted with mutual benefit.

One other option could be to have two separate regional initiatives with the East African activities handled by ASERECA and the Southern Africa initiative operates under FANR/SADC with strong inter-regional cooperation among the two.

However there is no denying the fact that regional cooperation can be beset with competing issues related to the unequal distribution of costs and benefits, conflicts and unrealistically high expectations among others. In the events of possible conflicting issues among the sub-regional organizations (SROs), a neutral technical agency such as *icipe* would be an ideal lead agency and there are number of reasons to support this suggestion:

- *icipe's* exclusive focus on insect science and its application through regional and international cooperation;
- It's Pan-tropical and Pan-African mandate with activities spread across several African countries including the ESA;
- Strong history of R&D in fruit flies – the initiator of major fruit fly research in Africa;
- Its strong ties with several technical agencies (e.g. FAO, IAEA, USDA-ARS, ARIs, CGIAR centres, CIRAD etc) and the confidence that these agencies have in its R&D activities;
- 40 years experience in development and implementation of effective R & D program in insect science; and
- Strong collaborative ties with NPPOs, NARES and SROs.

Given this profile, it also makes sense to consider *icipe* as well, as a focal institution for any fruit fly R&D in the region. However, in acting as a lead agency, *icipe* must work closely with the other SROs (ASARECA and FANR/SADC).

COMESA, SADC and EAC, and are formal political organization representing governments of Eastern and Southern Africa with close ties to multi-lateral and other development agencies. The role of these 3 organizations should be related to providing political leadership to the program and in keeping the fruit fly problem high on the priority list of all the partner countries in the proposed initiative. These 3 political organizations should also play a significant role in fund mobilization, either internally or in partnership with bilateral and multilateral development agencies. The technicalities of the regional initiative and its implementation should be the responsibility of the SROs.

Within all the above organizations and others not listed here, there are several ongoing fruit fly initiatives that are taking place but by bringing everyone on board through a more collective effort focused on complementing the strength (technical and political) and minimizing duplication, a stronger voice to the fight against fruit flies will emerge in the region. The following steps are suggested:

- The initial step would be to organize a forum in which representatives of ASARECA, FANR/SADC, COMESA, EAC and *icipe* meet either directly or through videoconference to explore possibilities and develop a common strategy to tackling the fruit fly menace in the region.
- Included in the above forum will be the traditional dialogue partners (FAO, the WB, IAEA, GlobalHort, USAID and USDA-APHIS) and any other specialized agency all of which will be central to establishing the priority agenda necessary for a regional approach.
- It is anticipated that such a high level forum could elicit positive signal to attract a regional support from development partners.
- Based on the outcome of the above gathering, the next step to be agreed upon could include the designing and implementing the process to move the initiative forward through broader consultation with stakeholders.

- Subsequently, the process of moving the plan of action through the bureaucratic and political level to garner greater profile and compete effectively with other issues on the development and political agenda would commence. At this point the political organization involve in the process (COMESA, EAC, SADC) should play a significant role in the negotiations.
- Based on the earlier broad consultation with the stakeholders, the needs of the stakeholders that had generic implications for the horticulture industry in the region as a whole is identified and then feed into the design of the scientific and technical aspect of the regional initiative.
- *icipe*, in collaboration with ASARECA and FANR/SADC with their expertise in fruit fly R&D then identifies the technical elements required to address the concerns of the stakeholders and prepares a project design. A first approach could be a 2 year pilot project on surveillance, technology promotion and dissemination in strategic bench areas in some or all of the target countries to permit integration and consolidation of the process and strategize towards a long-term (e.g. 5-6 years) project while seeking for donor endorsement for the same.
- COMESA, EAC, and SADC's political expertise would be enlisted to move the above technical plan forward for consideration and approval at the appropriate levels.
- At this point significant attention would be given to publicizing the initiative in a way that favors endorsement by representative government bodies.
- Once approval is granted by relevant government authorities, and articulated by the SROs, discussion regarding funding from development partners will then be required by engaging the donors broadening the support for the initiative.
- Project implementation of the technical components through ASARECA, FANR/SADC, *icipe*, private sectors and stakeholders could then proceed.
- Internal and external coordination and monitoring of the implementation activities could be the responsibility of ASARECA, FANR/SADC and *icipe*.

The proposed strategy allows for a "bottom-up" input from the stakeholders, which is integrative with an effective "top-down" management function and should allow for effective implementation if adopted.

CONCLUSIONS

The joint efforts of IFAD, FAO, BMZ, IAEA, USAID through USDA-FAS and USDA-APHIS and The WB have tremendously improved the technical knowledge on fruit flies in the ESA region. The contributions of these donor and technical agencies and the awareness that the various projects has created has vastly broaden our understanding on the distribution, seasonal abundance, host range, pest status, surveillance and management of key fruit fly species in the region. These information and available technologies are useful for countries in negotiating quarantine and trade opportunities with importing countries and it also provide the importing countries a reasonable degree of confidence in the management strategies that are implemented to curtail the fruit fly problem in the exporting countries. Despite these enormous strides, there are still significant gaps in technical knowhow across the region, large-scale implementation of proven technologies, continuous surveillance, preparedness in the event of future invasions and capacity in various aspects of phytosanitary management. A regional cooperation approach with ASARECA or *icipe* as the lead agency working closely with FANR/SADC and with COMESA, EAC and SADC providing political leadership to such an initiative is proposed. A regional cooperation program backed up by appropriate legislation should ensure that participating countries adopt common surveillance and management approach and effective quarantine system to restrict movement of fruits and vegetables thereby enhancing horticultural production in the region.

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