TP-NA-D4-02
Limited Distribution

International Atomic Energy Agency

THEMATIC PLAN FOR FRUIT FLY CONTROL USING THE STERILE INSECT TECHNIQUE

VIENNA, AUSTRIA
15 - 19 NOVEMBER 1999

Table of Contents

I. EXECUTIVE SUMMARY

This thematic plan for fruit flies is the summation of ideas and recommendations put forth by a group of experts composed of fruit fly program managers and workers, stakeholders from the affected industry, a commodity specialist from the FAO, and technical, planning and policy specialists from the IAEA and the FAO (Annexes A, B, and C). This document provides strategic guidance and direction on how and where the Sterile Insect Technique (SIT) can most effectively be applied to control or eradicate fruit flies in the future.

The presence of certain fruit flies in a country can pose a significant barrier to trade in fresh fruits and vegetables. SIT can play a major role in facilitation of trade through the development of fruit fly free zones and low prevalence areas, that facilitate new and expanding market opportunities.

One of the driving forces for using the SIT in the future will be the need to protect and preserve the environment. Use of SIT for purposes of control, not just eradication, could significantly reduce pesticide use, residues, pollution, and associated costs. Solid evidence suggests that benefit-cost ratios are increasing for the Mediterranean fruit fly, *Ceratitis capitata* (medfly) SIT as an alternative to insecticides, and as a mitigating technique for environmental and human health concerns about insecticide use. In fact, the cost of medfly control in Israel with SIT is the same as control with insecticide applications.

Increased use of the SIT and other biological insect management systems will result from additional government restrictions on pesticide use. These biologically-based systems will meet the demands of regulatory agencies and the public with regard to pollution, insecticide residues, and effects on non-target organisms. Of particular concern is the imminent reclassification of malathion, one of the most widely used insecticides today for fruit fly control, as a potential carcinogen by the United States Environmental Protection Agency. Other countries are sure to follow suit with similar legislation further limiting the tools available for fruit fly control. As a result, the market for sterile medflies for pest control programmes is expected to expand dramatically.

Major breakthroughs from FAO/IAEA R&D, particularly the development of genetic sexing (male only) strains and improved rearing systems, serve to increase the efficiency of the SIT and lower operational costs. This also addresses other constraints, such as sterile female stings on fruit that reduces market value of the crop. Commercial application of the SIT will drive operational costs even lower with improvements in sterile fly production, handling and release methods.

The group also recognizes the need for continued investment in FAO/IAEA R&D. IAEA, with it Joint Division with FAO, is the global leader in SIT technology for fruit fly control by virtue of its international position, technical competencies and capabilities, and following among plant protection specialists. Based on this high level of expertise, these efforts must continue together in partnership with others who share a common interest in protecting the environment, in facilitating global trade of agricultural commodities and in increasing farm productivity and sustainability to address both food safety and food security needs of IAEA and FAO Member States.

The expert group identified Central America, Southern Cone of South America and the Mediterranean Basin as regions where the greatest gains in using the SIT for fruit flies can occur in the short and medium term. These areas were chosen because of the high level of interest by industry and governments together with strong plant health infrastructures that lend themselves toward area-wide implementation of the SIT. In addition, the state of technological development against specific species of fruit flies, primarily medfly, were a major consideration. Medfly serves as a model for development of SIT for other fruit flies species. Since the SIT package for medfly is the most advanced and demonstrably cost-effective, it should be the initial technology package for building new partnerships between the IAEA, FAO and the private sector. Thus, a major strategic objective of the SIT programme for fruit flies of IAEA and its Joint Division with FAO, is to complete a commercial technology package for medfly over the next ten years.

Member States in other areas cannot be ignored, however, but in many cases this will require a long term commitment toward R&D, often supported by IAEA and FAO, before minimum requirements to use the SIT effectively for other fruit fly pests can be met. Genetic transformation and other biotechnology approaches could potentially shorten the time required to develop new fruit fly strains in the future. Therefore, an operational objective of the SIT programme for fruit flies of IAEA and its Joint Division with FAO, is to develop technology packages for other fruit fly species over the next ten years.

The fact that SIT can be used for "control", and not solely for eradication, was emphasised throughout the discussions. This, more than any other development, will open the doors to greater acceptance and use of the SIT in the future. Out of necessity, it also will lead to increased commercial use and sustainability of SIT technology. It eliminates the criticism often directed at the SIT that eradication is unrealistic, and unsustainable in many cases, for lack of adequate quarantines.

Present day public fly-production facilities cannot meet current market demand for sterile medflies and other fruit fly species needed for control. The group recognizes that the involvement of the private sector is essential for expanded success in applying the SIT to fruit flies. The obvious profit center is the production of sterile fruit flies for control activities. Commercialization of fly production is the only practical solution for meeting the increasing demand for sterile flies and would undoubtedly result in greater efficiencies in production and provide commercial incentive for further research and development efforts. Such collaboration would benefit all stakeholders from farmers to fruit consumers.

Commercial investment in SIT for medfly will accelerate if IAEA and FAO emphasize activities that minimize investment risk: pursuing research and development activities that improve production efficiency and operational effectiveness; building technical competency to manage field operations; and disseminating best practices and lessons from successful field programmes to stakeholders.

II. STATEMENT OF THE PROBLEM

Extensive fresh fruit and vegetable production industries are developing in many parts of the world in response to the large demand for high quality fresh fruits and vegetables. Significant investments are made by governments and major lending institutions to assist in this development. Tephritid fruit flies, however, cause devastating direct losses to many of the fresh fruits and vegetables that these investors target for the market place thus requiring regular insecticide treatments to protect the crop. In addition, few insects have a greater impact on international marketing and world trade in agricultural produce than tephritid fruit flies (see Annexes E and F). With expanding international trade, fruit flies as major quarantine pests of fruits and vegetables have taken on added importance. This will trigger additional demands by increasing numbers of Member States to implement area-wide national or regional (transboundary) control programs against fruit fly pests.

The IAEA periodically performs a thorough review of the state of the art in a specific technical field, in this case the area of development and application of the Sterile Insect Technique (SIT) for national/regional fruit fly control/eradication. The Thematic Planning process provides clear guidance for Country Programme Frameworks through an analysis of the technology package that ensures relevance, sustainability and impact of IAEA support.

III. GENERAL TRENDS

The fresh fruit and vegetable industry is facing the dual demand of rapidly rising population in developing countries which requires more production for food security and nutrition as well as a demand by developed country importers for products with pesticide residues below critical levels. As part of this process new areas are being brought into production, which require control of fruit fly pests.

Developed importing countries are giving increased attention to food safety issues, partially driven by the BSE crisis, food adulteration in Western Europe and outbreaks of food borne infections in the USA. Concerns over insecticide residues in fresh fruits and vegetables have become widespread particularly as it affects children who are believed to be more vulnerable. These concerns are leading to changes in regulations of permissible pesticide residues. Thus fruit fly control methods that require minimum insecticide use are welcomed by wholesalers and consumers alike.

As part of globalization, trade in fresh fruits and vegetables is being liberalized on a world-wide basis. The issues of this trade are considered in many fora, among them the WTO, Codex Commission of the Joint FAO/WHO Food Standards Programme, the International Plant Pprotection Convention (IPPC) of FAO, and other organizations with SPS (Sanitary and Phytosanitary Standards) issues in the forefront of concerns. In order to be able to export their products many developing countries must comply with increasing stringent SPS measures being mandated. Pesticides are less and less acceptable as compliance means for these SPS requirements. Among the major trading blocks, EU, NAFTA, MERCOSUR, SPS issues have become contentious and vital to the prosperity of many members. Ways must to be found to facilitate production to meet these requirements and which in turn provide trading opportunities to many developing countries. Newly adopted International Standards for Phytosanitary Measures under the IPPC of FAO serves to expand such opportunities through the establishment of areas of low prevalence, pest (fruit fly) free areas, systems approaches, etc. Environmental elements reinforce the favorable cost benefit economic analysis for the use of SIT as an alternative to purely chemical based controls.

IV. ROLE OF SIT

a) Explanation of SIT

Since the 1950’s it is known that insect pests can be controlled or eradicated through a “birth control” method based on genetic manipulation know as autocidal pest control or the Sterile Insect Technique (SIT). It involves the colonization and mass rearing of the target pest species, sterilization through the use of gamma radiation and releasing them into the field on a sustained basis and in sufficient numbers to achieve appropriate sterile to wild insect overflooding ratios. Here the sterile males find and mate with fertile females, transferring the genetically modified sperm. No offspring results, thereby causing a reduction in the natural pest population. The validity of this method has been demonstrated for many insect pests, including moths, screwworms, tsetse and fruit flies.

b) Need for Nuclear Technology

Sterilization is accomplished by exposing insects to a specific dose of gamma radiation emitted by radioisotopes (Cobalt 60 or Cesium 137). No other methods are available or appropriate to achieve sterilization. Chemosterilants carry a high risk for environmental contamination and pose serious health concerns. Linear accelerators have not shown sufficient applicability and reliability in consistently achieving the desired level of sterility.

Nuclear technology has not only a comparative advantage in sterilizing mass reared insects, but is, at present, the only technology available for this purpose. As every single insect used in SIT activities must to be sterilized, irradiation is a central and indispensable part of the total process.

c) Integration of Nuclear and Non-Nuclear Techniques

SIT is not a stand-alone technology. To be effective it should be integrated in a package together with non-nuclear techniques, including economics, public education, quarantines, sanitation, and biological, cultural and chemical controls, etc. The criteria for effective application of SIT are presented in Annex D.

Central to the application of fruit fly SIT, within an integrated approach, is the area-wide concept in which the total population of the pest in an area, or region, is managed. Present insecticide use can best be described as an uncoordinated attack by individual farmers on a small segment of the pest population. Insects move, often over considerable distances. Therefore such uncoordinated field-by-field action is only a temporary control measure. As long as the farmer's neighbors do not join in the efforts, the pest insects will re-invade his fields requiring regular insecticide applications to protect his crops. However, when growers of a given area or region organize themselves into farmer associations to apply an area-wide fruit fly control program against the total population of the pest, much less insecticide inputs will be required and the control achieved will be more effective.

d) Attributes of SIT

SIT has special attributes which make it a unique insect pest management tool:

> species specificity: unlike non-selective insecticide-based control, SIT represents a biologically-based tool for pest control in view of the species specificity involved. The induced sterility is directed exclusively at the target species, thereby controlling only the pest populations. Furthermore, unlike biological controls where many cases of adverse impact on non-target organisms have been reported, no such case is known for radiation induced sterility and related genetic pest control methods.
>
> inverse density-dependence: unlike most control methods, SIT has the unique attribute of increased efficiency with decreasing target population density. SIT is the only environment-friendly technology available to eradicate insect pests if applied consistently on an area-wide basis: the sterile males have the ability to find the last wild females in the whole area.
>
> compatibility for integration: SIT is compatible with other pest control methods, and can therefore be effectively integrated with other methods including biological methods, such as parasitoids, predators and insect pathogens. In this way, totally biological systems for managing some of the world's most important insect pests can be made available.

e) Applications of SIT

Considerable advances in the development of SIT have resulted in major applications of this technology against tephritid fruit flies of economic importance. There are four major roles SIT application can play:

> Control: To avoid devastating fruit losses caused by fruit flies, intensive insecticide treatments are routinely required to produce worm-free fruit. The resulting damage to non-target beneficial organisms, disruption of biologically based controls of other orchard pests, residues on fruit and general contamination of the environment, are driving the need for more environment-friendly methods such as SIT to control fruit flies.
>
> As a result of its species-specificity, SIT can be effectively used to replace insecticides for control of fruit fly pests. Pilot tests have demonstrated the effectiveness of SIT to control fruit flies, and economic analyses have shown that SIT applied as part of an integrated approach is competitive with conventional methods. The development of genetic sexing strains enhances the application of SIT for purposes of control in the absence of fruit stings resulting from sterile females. Routine use of sterile insects for control will allow the future commercialization of SIT for fruit flies.
>
> Also, SIT for pre-harvest control, applied as part of a systems approach in

combination with a post-harvest treatment, can be used to create internationally recognized fly free or low prevalence areas to overcome these trade barriers to agricultural produce. Irradiation is an effective and innocuous post-harvest treatment for commercial fruit which is often affected by other treatments. Food irradiation can guarantee quarantine security of importing countries and it is increasingly accepted internationally.

Eradication: As a result of its inverse density dependence, SIT used on an area-wide basis and with adequate quarantine support, has been shown to eradicate fruit fly pests successfully in Chile, Mexico, parts of Patagonia, and urban areas of the USA.

Barrier and Prevention: To protect pest-free fruit production areas that are contiguous to infested areas, SIT can also be used as a biological barrier to maintain the pest-free status of the free areas. SIT can also be applied in a preventive form over pest-free areas with high risk of invasion to avoid the establishment of the pest species.

f) Where not to use SIT against fruit fly pests:

In general, the use of SIT is not recommended for those fruit fly species of economic importance that respond to methyl-eugenol, which is a potent fruit fly lure. The Male Annihilation Technique (MAT), which is based on the elimination of males of these species as a result of a strong attraction to a bait composed of the lure and insecticide, is effective in controlling and even eradicating these fruit flies when applied on an area-wide basis. A list of *Bactrocera* species that respond to methyl-eugenol is presented in Annex G. The distribution of these flies is mainly confined to the Asia-Pacific region.

V. CURRENT STATUS OF SIT APPLICATION AGAINST FRUIT FLIES

For certain fruit flies the SIT technology is well advanced and has resulted in successful application. The Mediterranean fruit fly (medfly), C*eratitis capitata*, a notorious quarantine pest due to the extremely wide range of host it attacks, has been one of the main thrusts in the application of SIT. The medfly originated in Sub-Saharan Africa and has been spread to many regions of the world due to man's activities, and has therefore the status of introduced species in most areas where it is of economic importance. The first large SIT programme against medfly was initiated in Mexico in 1977, with the construction of a 500 million per week sterile fly mass rearing facility in southern Mexico. The aim of the programme was to prevent the spread of medfly, which had become established in Central America, into Mexico and the USA. Presence of medfly in Mexico threatened its multi-million fruit and vegetable export trade with the USA. The programme succeeded in 1982 in eradicating medfly from areas it had already infested in southern Mexico and has been able since then to maintain a sterile fly barrier from southern Belize through Guatemala to southern Mexico to assure the fly-free status of Mexico, USA and half of Guatemala.

This successful programme, which was supported by IAEA and FAO, was the starting point for similar medfly mass rearing facilities (Annex H) and control or eradication programmes in various other parts of the world, including Argentina, Chile, Peru and USA (all supported directly or indirectly by IAEA and FAO). In Chile, after various decades attempting to eradicate the pest using insecticides, medfly eradication from the northern part of the country was achieved with SIT in 1995, opening trade opportunities estimated at up to ca. $US 500 million over five years for the Chilean fruit industry. In Argentina, as a result of SIT programmes against medfly initiated in the early 1990's, recognized fly-free areas have been developed in various Patagonia valleys. Argentina recently succeeded in negotiations with Chile to transport fruit from Mendoza and Patagonia provinces through medfly-free Chile for export from Chilean ports. Argentina and Chile have joined efforts to expand the fly-free areas in western Argentina. Also with IAEA and FAO support, efforts are currently under way to expand the fly-free area in northern Chile to the two southern-most valleys of Peru.

The repeated medfly introductions into California and Florida, have required recurrent emergency eradication actions, costing millions of US dollars annually. Allowing the establishment of medfly in California would result in the loss of ca. $US 1 billion a year in export and would result in a drastic increase of insecticide use. In view of the strong public opposition to aerial bait-spraying, often over urban areas, and the failure to eradicate these outbreaks with insecticides, authorities successfully embarked on the area-wide use of SIT over the whole Los Angeles Basin starting in 1994, involving the aerial release of over 300 million sterile flies per week. The SIT strategy was so successful politically environmentally, and economically (costing on average less than half of the recurrent emergency programmes), that after eradication in 1996, area-wide aerial releases were continued on a permanent basis over high risk areas in the Los Angeles basin. This preventive or prophylactic approach has been running since then without major outbreaks of medfly occurring. This prophylactic approach cannot be used with insecticides.

In the Mediterranean region, where some of the initial medfly pilot SIT projects took place in the 1960's and early 1970's, many fewer advances have been made in the application of SIT, even though environmental concerns due to intensive insecticide use against medfly, particularly in coastal areas where tourism and fruit orchards coexist, are increasingly of major importance. The recent development of male-only strains, opening the possibility of using SIT for routine medfly control rather than eradication, has resulted in SIT programmes in various stages of development in Madeira, Israel and Jordan, as well as South Africa, and feasibility studies in Sicily and Maghreb countries in North Africa. This considerable activity indicates an increasing interest in the region in substituting medfly control based on insecticide sprays with environment-friendly medfly control based on SIT. The economic feasibility of this approach has been confirmed by a number of benefit-cost analyses. With the exception of the Madeira mass rearing facility, the first in the whole region, the lack of a source of sterile medflies for use in SIT control programmes is presently a major limiting factor for the expanded application of this technology in the Mediterranean Basin. The establishment of regional mass-rearing facilities is therefore of high priority to meet the anticipated demand for sterile flies. In November 1999, the European Union organized an SIT Seminar in Madeira, with the participation of all countries of Southern Europe, in which it actively encouraged SIT as a biologically-based pest control replacement of insecticide sprays for medfly control in the Mediterranean Basin.

Fruit flies belonging to the genera *Bactrocera* and *Anastrepha* are also devastating fruit fly pests of economic and quarantine importance. Great advances have been made in developing sterile insect technology for some of these species, particularly *B. cucurbitae* (melon fly), and *B. tryoni*(Queensland fruit fly), as well as, *A. ludens* (Mexican fruit fly), *A. suspensa* (Caribbean fruit fly), and A. *obliqua* (West Indies fruit fly), and a number of mass rearing facilities are now available (Annex H).

The melon fly programme in southern Japan, which started with a small pilot test on Kume island in the early 1980's, culminated in the mid-1990's in the eradication of this species from all islands of the Kagoshima, Amami, Okinawa, Miyako and Yaeyama archipelagos. In Australia, SIT was successfully applied to eradicate the Queensland fruit fly from Western Australia, and preventive SIT releases are being used in Southern Australia to protect fruit growing areas from the seasonal movement of the pest into commercial areas. In the Philippines the sterile insect technology has been adapted to B. *philippinensis* and a pilot programme has been in progress in mango-producing Guimaras Island.

In relation to *Anastrepha spp.*, there has been an operational SIT programme in the USA as a quarantine against the Mexican fruit fly along the border with Mexico since 1964, and SIT is being used in Florida against *A. suspensa*, in combination with parasitoids and other methods, to establish fly free zones in areas of citrus production. In Mexico a large SIT programme against various *Anastrepha* species, funded by the fruit industry and federal and state governments has been in progress since the early 1990's in northern Mexico with the objective of developing fly-free areas. As a result of the programme, fruit flies have been eradicated from several areas in States bordering the United States, eliminating the need for expensive post-harvest treatments to export fruit to the United States. Currently there is much interest in various South American countries to developing SIT technology for *A. fraterculus*, the South American fruit fly, and a pilot facility to mass rear this species has recently been established in Piura, Peru.

The following tables show the current status of development of the SIT package for the main groups of fruit flies of economic importance. There is no absolute requirement for all methods to be available for SIT to be applicable. The tables reflect the state of the art for each major species. The more complete the package of technology available, the more applicable it will be in its overall effectiveness and cost.

A) ANASTREPHA

PRESENT STATUS OF SIT DEVELOPMENT & DELIVERY

METHODS	*Anastrepha*					
	fraterculus	*ludens*	*obliqua*	*serpentina*	*striata*	*suspensa*
SURVEILLANCE COMPONENT						
Trap	Yes	Yes	Yes	Yes	Yes	Yes
Food lure	Yes	Yes	Yes	Yes	Yes	Yes
Female Attractant	R&D	R&D	R&D	R&D	No	No
Male Attractant	No	No	No	No	No	No
Fruit sampling	Yes	Yes	Yes	Yes	Yes	Yes
IDENTIFICATION COMPONENT						
Level of Knowledge	Complex lacks definition	Based only on female ovipositor; male taxonomy relatively unknown				
Adult ID	Female only	Female only	Female only	Female only	Female only	Female only
Larvae	Yes	Yes	Yes	Yes	Yes	Yes
Sterile/Fertile	No	Yes	No	No	No	Yes
Genetic Methods	R&D	R&D	No	No	No	No
STERILE INSECT TECHNIQUE COMPONENT						
Mass Production	R&D	Yes	Yes	R&D	No	Yes
Genetic Sexing Strains	No	No	No	No	No	No
Transformed Strain	No	No	No	No	No	No
Sterilisation	No	Yes	Yes	R&D	No	Yes
Shipping	No	Yes	Yes	No	No	Yes
Emergence	No	Yes	Yes	No	No	Yes
Release	No	Yes	Yes	No	No	Yes
Quality Control Standards	No	Yes	Yes	No	No	Yes
Commercial Use	No	Yes	Yes	No	No	No
BIOLOGICAL CONTROL COMPONENT						
Parasitoids	R&D	R&D	R&D	No	No	Yes,R&D
Release	No	Yes,R&D	Yes,R&D	No	No	Yes,R&D
Mass Production	R&D	Yes;R&D	R&D	No	No	Yes,R&D
CHEMICAL CONTROL COMPONENT						
Protein Bait Spray	Yes	Yes	Yes	Yes	Yes	Yes
Bait Stations/Lure & Kill Devices	R&D	R&D	R&D	R&D	No	No
Male Annihilation (MAT)	No	No	No	No	No	No
Alternative Toxicants						
Abamectin	No	R&D	R&D	R&D	No	R&D
Cyromazine	No	R&D	R&D	No	No	No
Fipronil	No	R&D	R&D	No	No	R&D
Spinosad	No	R&D	R&D	No	No	R&D
Sure Dye	No	R&D	R&D	No	No	R&D
REGULATORY CONTROL COMPONENT						
Fumigation (MBr)	Yes	Yes	Yes	Yes	Yes	Yes
Hot Forced Air	Yes	Yes	Yes	Yes	Yes	R&D
Hot Water Dip	Yes	Yes	Yes	Yes	Yes	No
Vapor Heat	No	Yes	No	No	No	No
Cold Treatment	Yes	Yes	Yes	Yes	Yes	Yes
Systems Approach	No	Yes	No	No	No	Yes
Low Prevalence	No	R&D	No	No	No	Yes
Pest Free Areas	No	Yes	Yes	Yes	Yes	No
Irradiation	Yes	Yes	Yes	Yes	No	Yes
BIOLOGICAL UNDERSTANDING						
BIOLOGY/ECOLOGY						
Dispersal	Limited studies	Well studied	Studied	Studied	Unknown	Studied
Foraging Behaviour	Unknown	Well studied	Studied	Unknown	Unknown	Studied
Host Range	Studied	Well studied	Well studied	Studied	Studied	Well studied
Host Phenology	Studied	Well studied	Well studied	Studied	Studied	Well studied
Mating Behaviour	Limited studies	Well studied	Limited studies	Unknown	Limited studies	Studied
Pest Phenology	Studied	Well studied	Well studied	Studied	Studied	Studied
Parasitoid/ Predator Interaction	Limited studies	Well studied	Limited studies	Limited studies	Limited studies	Well studied

B) BACTROCERA

PRESENT STATUS OF SIT DEVELOPMENT & DELIVERY

METHODS	*Bactrocera*					
	cucurbitae	*dorsalis*	*olea*	*philippinensis*	*tryoni*	*zonata*
SURVEILLANCE COMPONENT						
Trap	Yes	Yes	Yes	Yes	Yes	Yes
Food lure	Yes	Yes	Ammonium bicarbonate	Yes	Yes	Yes
Female Attractant	No	No	R&D	No	No	No
Male Attractant	Cuelure	Methyl Eugenol	R&D	Methyl Eugenol	Cuelure	Methyl Eugenol
Fruit sampling	Yes	Yes	Yes	Yes	Yes	Yes
IDENTIFICATION COMPONENT						
Level of Knowledge	Improved understanding; especially the *dorsalis* complex based upon female ovipositor & male aedeagus					
Adult ID	both sexes	both sexes	both sexes	both sexes	both sexes	both sexes
Larvae	Yes	Yes	Yes	Yes	Yes	Yes
Sterile/Fertile	Yes	Yes	Yes	Yes	Yes	No
Genetic Methods	No	R&D	R&D	R&D	R&D	No
STERILE INSECT TECHNIQUE COMPONENT						
Mass Production	Yes	Yes	R&D	Yes	Yes	R&D
Genetic Sexing Strains	No	R&D	No	No	No	No
Transformed Strain	No	Yes	No	No	R&D	No
Sterilisation	Yes	Yes	Yes	Yes	Yes	Yes
Shipping	Yes	Yes	No	Yes	Yes	No
Emergence	Yes	Yes	?	Yes	Yes	R&D
Release	Yes	Yes	No	Yes	Yes	R&D
Quality Control Standards	Yes	Yes	Yes	R&D	Yes	No
Commercial Use	No	No	No	No	No	No
BIOLOGICAL CONTROL COMPONENT						
Parasitoids	No	No	No	No	No	No
Release	No	No	No	No	No	No
Mass Production	No	No	No	No	No	No
CHEMICAL CONTROL COMPONENT						
Protein Bait Spray	Yes	Yes	Yes	Yes	Yes	Yes
Bait Stations/Lure & Kill Devices	No	Yes	No	No	No	No
Male Annihilation (MAT)	No	Yes	No	Yes	No	Yes
Alternative Toxicants						
Abamectin	No	No	No	No	No	No
Cyromazine	No	No	No	No	No	No
Fipronil	R&D	R&D	No	No	No	R&D
Spinosad	No	R&D	No	No	No	No
Sure Dye	No	R&D	No	No	No	No
REGULATORY CONTROL COMPONENT						
Fumigation (MBr)	Yes	Yes	No	No	Yes	No
Hot Forced Air	No	Yes	No	No	R&D	No
Hot Water Dip	Yes	Yes	No	Yes	Yes	No
Vapor Heat	Yes	Yes	No	Yes	No	No
Cold Treatment	Yes	Yes	No	Yes	Yes	No
Systems Approach	R&D	R&D	No	No	No	No
Low Prevalence	No	R&D	No	R&D	No	No
Pest Free Areas	Yes	No	No	No	Yes	No
Irradiation	Yes	Yes	No	Yes	Yes	No
BIOLOGICAL UNDERSTANDING						
BIOLOGY/ECOLOGY						
Dispersal	Well studied	Well studied	Studied	Limited studies	Well studied	Few studies
Foraging Behaviour	Well studied	Studied	Studied	?	Studied	?
Host Range	Well studied	Well studied	Well studied	Studied	Well studied	Studied
Host Phenology	Well studied	Well studied	Well studied	Studied	Well studied	Studied
Mating Behaviour	Well studied	Well studied	Studied	Studied	Well studied	Studied
Pest Phenology	Well studied	Well studied	Studied	Studied	Well studied	Studied
Parasitoid/ Predator Interaction	Studied	Studied	Studied	?	Studied	Studied

? = No data, references or other information currently available on this topic.

C) CERATITIS and RHAGOLETIS

PRESENT STATUS OF SIT DEVELOPMENT & DELIVERY

METHODS	*Ceratitis*		*Rhagoletis*		
	capitata	*rosae*	*cerasi*	*pomonella*	*indifferens*
SURVEILLANCE COMPONENT					
Trap	Yes	Yes	Yes	Yes	?
Food lure	Yes	Yes	Ammonium acetate	Ammonium acetate	Ammonium acetate
Female Attractant	3 component lure	3 component lure (Wet)	No	No	No
Male Attractant	Trimedlure	Trimedlure	No	No	No
Fruit sampling	Yes	Yes	Yes	Yes	Yes
IDENTIFICATION COMPONENT					
Level of Knowledge	Well known	Well known	Well known	Well known	?
Adult ID	both sexes	both sexes	?	?	?
Larvae	Yes	?	?	?	?
Sterile/Fertile	Yes	No	?	?	?
Genetic Methods	R&D	No	No	R&D	R&D
STERILE INSECT TECHNIQUE COMPONENT					
Mass Production	Yes	R&D	R&D	R&D	R&D
Genetic Sexing Strains	Yes	No	No	No	No
Transformed Strain	R&D	No	No	No	No
Sterilisation	Yes	No	Yes	No	No
Shipping	Yes	No	No	No	No
Emergence	Yes	No	?	?	?
Release	Yes	No	No	R&D	R&D
Quality Control Standards	Yes	No	No	R&D	No
Commercial Use	Yes	No	No	No	No
BIOLOGICAL CONTROL COMPONENT					
Parasitoids	R&D	R&D	No	No	No
Release	R&D	No	No	No	No
Mass Production	R&D	No	No	No	No
CHEMICAL CONTROL COMPONENT					
Protein Bait Spray	Yes	Yes	Yes	Yes	No
Bait Stations/Lure & Kill Devices	R&D	No	R&D	R&D	No
Male Annihilation (MAT)	No	No	No	No	No
Alternative Toxicants					
Abamectin	R&D	R&D	No	No	No
Cyromazine	R&D	No	No	No	No
Fipronil	No	No	No	No	No
Spinosad	R&D	No	No	No	Yes
Sure Dye	R&D	No	No	No	R&D
REGULATORY CONTROL COMPONENT					
Fumigation (MBr)	Yes	Yes	Yes	Yes	Yes
Hot Forced Air	Yes	No	No	No	R&D
Hot Water Dip	Yes	No	No	No	No
Vapor Heat	Yes	No	No	No	No
Cold Treatment	Yes	Yes	Yes	R&D	Yes
Systems Approach	Yes	No	No	R&D	R&D
Low Prevalence	No	No	No	No	R&D
Pest Free Areas	Yes	No	No	R&D	R&D
Irradiation	Yes	No	?	Yes	Yes
BIOLOGICAL UNDERSTANDING					
BIOLOGY/ECOLOGY					
Dispersal	Well studied	Studied	Studied	Well studied	?
Foraging Behaviour	Studied	Studied	Studied	Studied	Studied
Host Range	Well studied	Studied	Studied	Well studied	Studied
Host Phenology	Well studied	Studied	Studied	Well studied	Studied
Mating Behaviour	Numerous studies	Studied	?	Studied	Studied
Pest Phenology	Numerous studies	Studied	Studied	Well studied	Studied
Parasitoid/ Predator Interaction	Numerous studies	Studied	?	?	?

? = No data, references or other information currently available on this topic.

VI. ROLE OF THE IAEA AND THE JOINT FAO/IAEA DIVISION

IAEA and its Joint Division with FAO, have played a central role throughout the development and successful implementation of the sterile insect technique for fruit flies and other key insect pests. Currently, this role involves a normative component consisting of information dissemination, setting of standards and promotion of SIT, as well as research and development, and technology transfer and field application.

The normative and R&D components are carried out by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and the FAO/IAEA Agriculture and Biotechnology Laboratories at Seibersdorf. The IAEA Technical Cooperation Programme that transfers the SIT technology to field application is managed programmatically by the Technical Cooperation Department of IAEA, and technically by the Joint FAO/IAEA Division.

The IAEA and FAO have provided leadership in developing the SIT capabilities for use against the various fruit flies in different regions of the world. The IAEA and FAO have provided leadership in medfly genetics by developing all male strains for use in medfly control and eradication programs, improved rearing techniques to maintain genetic stability for the all male strains, and supported the development and field testing of female attractants. IAEA and FAO need to continue to provide this technical leadership and services.

The IAEA and FAO have trained a relatively large number of technicians in various SIT procedures, and provided leadership in reviewing and recommending changes in medfly eradication procedures in the USA (CA & FL).

The IAEA and FAO assist Member States identify the need for, develop and implement SIT programs to control or eradicate major insect pests. It provides support to:

1. Determine if an SIT program is justified on economic and environmental grounds.

2. Obtain technical base-line data required to implement a field program, including support to the collection of ecological, seasonal and distribution data, as well as whether pest population levels are suitable for SIT, or require previous suppression as part of an integrated area-wide approach.

3. Identify and provide the R & D support required to backstop a successful field program.

4. Assist in development of the required infrastructure, including programme assessment tools, strengthening of plant protection services and quarantine systems and grower organizations.

5. Assist in design and implementation of national public information campaign to

obtain public support for area-wide activities that will address the insect problem.

6. Assist in developing the capacity for mass production of sterile insects, and encourage commercialization of production and other activities related to SIT application.

There are several mechanisms by which IAEA and FAO can assist Member States in identifying opportunities and implementing SIT programs to solve insect pest problems. Basically these are via research and development, education/training, information exchange and specific activities in the Member States.

Problems to implementing the overall programme are identified through input from technical experts, action agencies, and stakeholders. Problem-based R & D is essential for backstopping field programs, to eliminate roadblocks to further development (usually because of high costs) and to obtain feed-back to develop new approaches for improving the SIT. Of primary importance are the in-house R & D capability and the Co-ordinated Research Programme. The latter creates networks among researchers in developing and developed countries to work on the same problem, such as development of an all male strain for a fruit fly species.

Education/training is accomplished through regional and inter-regional training courses, fellowships, scientific visits and workshops. IAEA and FAO disseminate information through newsletters, publications, an Internet website, and holds international symposia every four years.

Field programs are usually the final step in transferring research results to practical application. The steps required to obtain a funded field project from the IAEA normally involve country application for a TC Project. The TC Project requested usually fits within the country programme framework between the country and the IAEA. The IAEA Member States are encouraged to request few large projects with potential for impact rather than many small projects. All project proposals are submitted through the country's organization responsible for atomic energy. Project requests are evaluated technically and programmatically.

National programmes are usually linked to related on-going projects in the region via regional or sub-regional arrangements. These can be either technical or administrative. IAEA is a technical agency with no field representation and limited financial and human resources. Therefore, IAEA financial resources are used as a catalyst to stimulate the initiation of field programs which require the full commitment of the participating organizations and governments. IAEA must partner with diverse organizations to optimize its input. IAEA should seek greater cooperation or access with organizations and government institutions that have responsibility for insect pest management and agricultural development.

VII. OPPORTUNITIES

Justification for Setting Priorities

Social issues such as population growth, food security and the conservation of natural resources are central to global politics. The problems associated with maintaining a reliable food supply, developing sustainable agriculture and ensuring food safety offer a significant challenge to today's science and technology. The growth of fruit and vegetable production can assist in improving nutrition and quality of life.

One of the most significant threats to fruit and vegetable production is fruit flies. With the addition of environmental considerations and pest mobility through global trade the problem of controlling fruit flies offers an even greater challenge to technology. With the development of SIT, a viable and environmentally friendly solution is now available.

The need for SIT technology for fruit fly control or eradication is being realized where:

a) there were tangible benefits for local fruit/vegetable industry,

b) the host government endorsed programme efforts,

c) grower organization and plant protection infrastructure was at least partially developed, and

d) sufficient programme resources were made available by governments as well as the fruit/vegetable industry.

SIT Project selection must take these conditions into account. In view of the above, as well as the progress in development of SIT technology against the different fruit fly species of economic importance (see section V above), the following short term opportunities for immediate impact, as well as medium to long term opportunities for SIT application against fruit flies have been identified:

A) SOUTHERN CONE OF SOUTH AMERICA SUB-REGION

1. Issue / Justification:

The Southern cone of South America is the major area of fruit production of the Southern Hemisphere. There is an important fruit industry and exports total above US$ 2 billion / year. There is a Regional plant protection committee (COSAVE) formed by representatives of Chile, Argentina, Uruguay, Paraguay and Brazil. This committee issues regulatory resolutions and norms that become law for the countries involved. These same countries formed a common market called MERCOSUR, with a GNP of 1 trillion $US and 300 million people. Chile is free from the most important economic fruit flies (medfly and *Anastrepha* spp.) and it holds international recognition in this respect. It has a Fruit Fly Program run by SAG, the national plant protection organisation (NPPO), whose main goal it to prevent the entrance of exotic flies to the country. Argentina has a national program (PROCEM), run by SENASA, the NPPO, whose main goal is to develop free fruit fly areas and to bring other areas under effective control using environment-friendly technologies. Three subprograms under way in San Juan, Mendoza and Patagonia, use SIT for medfly over 365,000 ha, with flies provided by the rearing plants of Mendoza, San Juan and Arica (Chile). Peru, together with Chile, has started to implement a similar program (eradication and control) in different departments of the country.

There is an international agreement between Chile and Peru for the eradication of medfly, using SIT, in the common region of Arica - Tacna and Moquegua. A second international agreement between Argentina and Chile will incorporate isolated fruit growing valleys of Western Argentina (La Rioja, San Juan, Mendoza and Patagonia) adjacent to the existing fruit fly free country of Chile. SIT technology transfer for the medfly to the area has been done under joint projects of IAEA, FAO and Argentina and Chile and Peru. There is also an agreement among countries of MERCOSUR and the European Union on plant protection issues in the common citrus growing areas, with a component devoted to fruit flies control.

The presence of several fruit fly species in the isolated valleys, as well as the main citrus growing areas of Argentina, Paraguay, Uruguay and Brazil, represents a barrier to the expansion of the industry, especially the development of export markets. Chemical control alternatives are limited because of potential environmental impacts, public acceptance, and non-target organisms. Chemical controls also result in residues on commodities that affect fruit safety, limit export markets, and conflict with the increasing demand for organic products. EU currently provides financial incentives to Mercosur countries to address concerns related to insecticide residues on fruit exports to Europe. In addition, for some fruits, viable post harvest treatments have not been developed

Fruit produced in backyards and small orchards is important for the nutrition of the rural poor, however, fruit losses due to fruit flies are very high. Control of fruit flies using SIT on an area-wide basis protects not only the fruit of large commercial farms that produce for exports, but also the fruit of small local producers and the rural poor.

2a. Overall Objective:

To support sub-regional efforts to overcome trade barriers and decrease production losses caused by fruit fly infestation by developing and utilizing the SIT for fruit fly control in areas of Argentina, Bolivia, Brazil, Peru, Paraguay and Uruguay that currently depend on insecticide. In addition, the current medfly programs in Argentina, Chile and Peru will be strengthened.

2b. Specific Objectives:

1. Implementation of SIT for control of medfly in the humid eastern citrus growing areas of Argentina, Brazil, Paraguay, and Uruguay.
2. Use of SIT for control or eradication of medfly in isolated fruit production areas of Argentina, Brazil, and Peru.
3. Strengthen the quarantine systems to protect areas already eradicated in Chile and under eradication in isolated valleys in Argentina and Peru.
4. Integrate biocontrol component, fruit fly parasites, as part of a systems approach.
5. Initiate activities in Bolivia through training, improved infrastructure, export advise, equipment, etc.

3. Short Term Activities (1-5 years)
3a. Phase I - Feasibility Assessment & Project Planning (years 1-2)

1. Validate assumptions put forth in this Thematic Plan with the appropriate officials in Governments, Plant Protection Agencies and Producer Groups in relevant countries of the region.
2. Create an awareness of benefits and advantages of using area-wide SIT for fruit fly control amongst national, plant protection and industry counterparts.
3. Facilitate and assist in the planning, coordination and development of detailed proposals for a fruit fly management programme for the sub-region.
4. Provide training to enable countries to fully participate in planned activities in the future.

3b. Phase II - Project Implementation (years 3-5):

1. Implementation of proposals in accordance with work plans developed during the feasibility phase.
2. Provide further training to strengthen plant health infrastructure in support of area-wide SIT activities.
3. Provide technical support for SIT implementation, including provision of facility design and other technical backstopping.
4. Provide genetic sexing strains and backstopping to use them.
5. Provide follow up consultation, and quality assurance in use of the SIT.
6. Co-ordinate among participating institutions and provide leadership.

4. Medium (5-10 years) to Long Term Activities (Beyond 10 years):

1. Assist in developing the technology to implement SIT programmes for additional economically important fruit flies, especially *A. fraterculus* and *A. obliqua*.
2. Develop an integrated package of pre- and post-harvest controls for Low Prevalence Areas, including SIT and parasitoids, for South American countries not presently included.

5. Expected Outcomes:

1. Reduced fruit crop losses
2. Improved the nutrition of the rural population
3. Increased diversification of crops and improved food quality
4. Reduced insecticide use in the subregion.
5. Strengthened plant protection system in the subregion.
6. Fruit export facilitated.

6. Recommended Action Plan:

1. Communicate plan to appropriate officials in Governments, Plant Protection Agencies and Producer Groups in relevant countries of the region (1st Quarter 2000).
2. Identify resources and submit regional project proposal to implement the Phase I feasibility activities noted above during 2001-2002 (2nd Quarter 2000).
3. Field mission(s) or hold seminars as needed to consult with Member States on objectives and strategy, validate assumptions and formulate workplans in preparation of Phase I activities.

7.. Roles and Partnerships:

PARTNERS	*LEADERSHIP*	*FINANCING*	*PROGRAM IMPLEMENTATION*	*R&D*	*TECHNOLOGY TRANSFER*	*REG /LEG*	*FACILITATION*
IAEA - FAO/IAEA	X		X	X	X		X
COSAVE						X	X
SENASA-ARG	X	X	X		X	X	
SENASA-PERU	X	X	X		X	X	
SAG-CHILE	X	X	X		X	X	
NPPOs: PAR/URU/BRA/ BOL		X	X			X	
INDUSTRY (growers & exporters)	X	X	X				
UNIVERSITIES & INSTITUTES				X	X		
IICA			X				X
EU		X					X
INTER-AMERICAN DEVELOPMENT BANK		X					

8. Resources Available and Needed:

Argentina and Chile have available trained personnel, rearing facilities and infrastructure necessary to optimize the resources provided by IAEA and FAO.

Component	**Needed from IAEA**
Expert Services- Regional Coordinator	12 m/m/year
Expert Services - Technical Support	3 m/m/year
Infrastructure/equipment	-------------
Training	24 m/m/year
Group Activities (Coordination Workshops)	3 meetings/year

B) CENTRAL AMERICA SUB-REGION

1. Issue / Justification:

Central America represents a closely knit group of states that share similar agricultural systems and pest problems. These nations possess a competitive advantage to provide tropical and semi-tropical fruits and vegetables for their NAFTA neighbours in the north. However. agricultural exports and inter-regional trade is restricted by the existence of economically important fruit flies. SIT applied as part of a systems approach in combination with other control and orchard management and post-harvest treatments can be used to create internationally recognized fly free or low prevalence areas to overcome these trade barriers to agricultural produce.

The existence of a well established medfly control and eradication project in Guatemala and Mexico, as well as, a National campaign to control 4 species of *Anastrepha* in Mexico, offers opportunities to effect change in the region. The Mexico/Guatemala/US cooperative medfly programme offers an opportunity to expand medfly, as well as *Anastrepha* control throughout the region. The existing technical infrastructure is able to provide technical support for fruit fly control for the CA countries. The programme has a large sterile medfly mass rearing facilities that can augment control activities utilising SIT. The sterile insect technique can be applied across geopolitical boundaries without the negative side effects associated with chemical use.

There is a growing fruit industry in Central America. However, the presence of several fruit fly species is a barrier to agricultural growth. Chemical control alternatives are limited because of potential environmental impacts, public acceptance, and non-target organisms. Chemical controls also result in residues on commodities that affect food safety, limit export markets, and conflict with the increasing demand for organic products. In addition, for some fruits, viable post harvest treatments have not been developed. Food irradiation would be a means of addressing quarantine security requirements of importing countries, and a feasibility study for such facilities in the subregion has already been completed. Also, plant protection systems need to be further developed. A strong plant protection system would generate confidence required to satisfy potential trading partners to effectively expand markets. Individual growers are just beginning to organize themselves to manage pests on an area-wide basis, so that in the future they can negotiate greater access to export markets.

Fruit produced in backyards and small orchards is important for the nutrition of the rural poor, however, fruit losses due to fruit flies are very high. Control of fruit flies using SIT on an area-wide basis protects not only the fruit of large commercial orchards that produce for exports, but also the fruit of small local producers and the rural poor.

2a. Overall Objective:

Assist in expanding fruit exports through implementation of a systems approach in support of the development of the fruit industry in Central America, Panama, and Mexico (Annex M).

2b. Specific Objectives:

1. Assist in the establishment of low prevalence and free areas for fruit flies, using SIT as part of a pre- and post-harvest system to facilitate fruit and vegetable exports.
2. Strengthen the plant protection systems of the countries to increase their capacity to prevent and manage insect pest problems through training and experience.
3. Expand the current free areas in Belize, Mexico, and northern Guatemala to other countries in the subregion through linkages with national Governments, regional and interregional organizations (USDA, IICA, OIRSA, etc.
4. Integrate biocontrol component, fruit fly parasites, as part of a systems approach.
5. Encourage the formation of grower associations to facilitate a more effective approach to trade, pest management and other problems.
6. Encourage the application of post-harvest systems including the use of irradiation.

3. Short Term Activities (1-5 years)

3a. Phase I - Feasibility Assessment & Project Planning (years 1-2)

1. Validate assumptions put forth in this Thematic Plan with appropriate officials in Governments, Plant Protection Agencies and Producer Groups in relevant countries within the subregion.
2. Create awareness of benefits and advantages of using area-wide SIT for fruit fly control amongst national, plant protection and industry counterparts within the subregion.
3. Facilitate and assist in the planning, coordination and development of detailed proposals for a fruit fly management programme for the sub-region.
4. Provide training to enable countries to fully participate in planned activities in the future.

3b. Phase II - Project Implementation (years 3-5):

1. Implementation of proposals in accordance with work plans developed during the feasibility phase
2. Provide further training to strengthen plant health infrastructure in support of area-wide SIT activities
3. Provide technical support for SIT implementation, including provision of facility design and other technical backstopping.
4. Provide genetic sexing strains and backstopping to use them.
5. Provide follow up consultation, and quality assurance in use of the SIT.

6. Co-ordinate among participating institutions and provide leadership in the determination of protocols and standards for management systems involving SIT that are acceptable to NPPO's.

4. Medium (5-10 years) to Long Term Activities (Beyond 10 years):

1. Complete SIT package including mass-rearing and sexing strains for *Anastrepha ludens*, *A. obliqua*, *A. serpentina* and *A. striata*.
2. Integrate the use of fruit fly parasitoids with SIT.
3. Encourage the industry to invest in post-harvest treatment facilities.

5. Expected Outcomes:

1. Strengthened plant protection system in the subregion.
2. Fruit export facilitated.
3. Reduced fruit crop losses
4. Improved the nutrition of the rural population
5. Increased diversification of crops and improved food quality
6. Reduced insecticide use in the subregion.

6. Recommended Action Plan:

1. Communicate plan to appropriate officials in Governments, Plant Protection Agencies and Producer Groups in relevant countries of the region (1st Quarter 2000).
2. Identify resources and submit regional project proposal to implement the Phase I feasibility activities noted above during 2001-2002 (2nd Quarter 2000).
3. Field mission(s) or hold seminars as needed to consult with Member States on objectives and strategy, validate assumptions and formulate workplans in preparation of Phase I activities.

7. Roles and Partnerships:

PARTNERS	*LEADERSHIP*	*FINANCING*	*PROGRAM IMPLEMENTATION*	*R&D*	*TECHNOLOGY TRANSFER*	*REG /LEG*	*FACILITATION*
IAEA - FAO/IAEA	X		X	X	X		X
OIRSA						X	X
IICA	X	X	X		X	X	
MOSCAMED	X		X	X	X		
NPPOs	X	X	X		X	X	
INDUSTRY (growers & exporters)	X	X	X				
UNIVERSITIES & INSTITUTES				X	X		
INTER-AMERICAN DEVELOPMENT BANK		X					
CIRSA	X					X	X
USDA	X	X	X	X			X

8. Resources Available and Needed:

Guatemala and Mexico have available trained personnel, rearing facilities and infrastructure necessary to optimize the resources provided by IAEA and FAO to implement an integrated fruit fly control in Central American countries.

Component	**Needed from IAEA**
Expert Services - Regional Coordinator	12 m/m/year
Expert Services - Technical Support	3 m/m/year
Infrastructure/equipment	----------
Training	24 m/m/year
Group Activities (Coordination Workshops)	3 meetings/year

C) MEDITERRANEAN BASIN INTER-REGION

1. Key Issues/Justification

The Mediterranean Basin is the center of a vast fruit and vegetable industry which not only feeds the expanding population of the region, but which also exports great quantities of fresh fruits and vegetables to Northern Europe and elsewhere. For example, one-third of the world's citrus fruit production and exports originate in the Mediterranean Basin.

The Mediterranean fruit fly is well established in the region. Control is by 4-12 insecticide sprays /year. Increasingly stringent restrictions on currently employed insecticides by importing regulatory agencies demands that alternative, non-chemical control measures be developed and applied to fruits and vegetables exported from the region. Crop losses due the fly in developing countries of the region reduce food availability and food security as well reducing export earnings from very important crops such as citrus and tropical fruits.

The SIT offers a comprehensive and effective alternative to chemical control, mitigating environmental and health concerns. In one relatively large area in the Eastern Mediterranean there are plans to control medfly using SIT. Integration of the SIT with other control techniques offer the opportunity to control the pest over much of the geographical region, and will permit in the absence of insecticide sprays the implementation of effective biological control schemes against secondary citrus pests.

In order to move forward and stay ahead of the regulatory curve which could cut off export markets for many developing countries in the region an integrated SIT strategy backed up by the availability of flies is required. In this connection there is an urgent need for at least one large sterile fly production facility in the region.

Fruit produced in backyards and small orchards is important for the nutrition of the rural poor, however, fruit losses due to fruit flies are very high. Control of fruit flies using SIT on an area-wide basis protects not only the fruit of large commercial farms that produce for exports, but also the fruit of small local producers and the rural poor.

The olive fly, another pest of substantial economic importance in the region, could in time be included in the effort, making the economics even more attractive, as olive plantations are mixed with subtropical fruit (especially citrus). SIT has been partially developed for olive fly,

Recently the peach fruit fly, *Bactrocera zonata*, was accidentally introduced into Egypt (Annex J). This fruit fly is also polyphagous, attacking a very wide range of hosts of economic importance. It has already dispersed to most fruit growing regions of Egypt, from where it threatens to spread to other countries in the region. Its presence in the region will result in greatly increased insecticide use unless emergency response capabilities are developed in neighboring countries to continue to confine it to Egypt. This fruit fly responds to methyl eugenol and is therefore amenable to the Male Annihilation Technique (MAT).

2a. Overall Objective:

To support efforts in the Mediterranean Basin to move to more environment-friendly pest control methods, to decrease insecticide residues and production losses caused by fruit fly infestation, and to help strengthen plant protection infrastructure.

2b. Specific Objectives:

1. To reduce insecticide use in the Mediterranean Basin by controlling the Mediterranean Fruit fly through the integration of SIT and IPM techniques.
2. To develop factory capacity to produce sterile flies for sub-regional control programs.
3. To strengthen plant protection infrastructure and inter-regional co-ordination.

3. Short Term Activities (1-5 years)
3a. Phase I - Feasibility Assessment & Project Planning (years 1-2)

1. Validate assumptions put forth in this Thematic Plan with appropriate officials in Governments, Plant Protection Agencies and Producer Groups in relevant countries within the subregion.
2. Create awareness of benefits and advantages of using area-wide SIT for fruit fly control amongst national, plant protection and industry counterparts within the subregion.
3. Facilitate and assist in the planning, coordination and development of detailed proposals for a fruit fly management programme for the sub-region.
4. Provide training to enable countries to fully participate in planned activities in the future.
5. Conduct an economic feasibility program on the use of SIT in specific sub-regions of the Mediterranean Basin.
6. Develop a detailed sub-regional approach for control.
7. Identify R & D requirements to support an effective SIT program in the areas on which the program is to be applied.
8. Create a special awareness among all Member States within the Mediterranean basin of the potential impact of the Peach Fruit Fly, *Bactrocera zonata*, on the fruit industries in the inter-region and develop emergency response capacity in neighboring countries to contain its spread from Egypt through early detection of outbreaks and immediately eradication actions.
9. Make known to venture capital sources and International Financial Institutions (IFIs) the fact that sterile flies can be sold on a commercial basis which can provide a positive cash flow to potential investors in order to encourage the establishment of commercial rearing of sterile fruit flies.

3b. Phase II - Project Implementation (years 3-5):

1. Implementation of proposals in accordance with work plans developed during the feasibility phase
2. Provide further training to strengthen plant health infrastructure in support of area-wide SIT activities
3. Provide technical support for SIT implementation, including provision of facility design and other technical backstopping.
4. Provide genetic sexing strains and backstopping to use them.
5. Provide follow up consultation, and quality assurance in use of the SIT.
6. Co-ordinate among participating institutions and provide leadership in the determination of protocols and standards for management systems involving SIT that are acceptable to NPPO's.
7. Integrate all necessary technology related to post harvest treatments for fruits and vegetables as part of the SIT systems wide approach.
8. Field test Genetically Modified Flies as part of an on-going R & D effort to up-date the SIT technology.
9. Conduct R & D for the application of SIT to the Olive Fly, as the olive industry continues to be of great economic importance throughout the region, and is severely impacted by this pest.
10. Encourage and support strengthening and co-ordination among national and regional plant protection organizations throughout the Mediterranean Basin.

4. Medium Term Activities (5-10 years):

1. Assess and validate the short term results.
2. Expand the program to additional sub-regions of the Mediterranean Basin.
3. Improve effectiveness and efficiency of rearing facilities through the application of up-dated technology, techniques and equipment.
4. Develop an SIT-based olive fly control/eradication program.
5. Evaluate the economics and technical feasibility of using SIT on European cherry fruit fly and other species.
6. Deployment of genetically modified sterile flies where appropriate.

5. Long Term Activities (Beyond 10 years):

1. Determine which areas are appropriate for eradication of medfly.
2. Identify areas which might be declared pest-free of other flies, with the consequent economic advantages to exporters of fruits and vegetables in the area.
3. Expand SIT to all countries of the region where fruit flies are present.
4. Implement preventive fly release programs where appropriate in order to maintain effective control and or eradication.

6. Expected Outcomes:

1. Strengthened plant protection system in the subregion.
2. Fruit export facilitated.
3. Reduced fruit crop losses
4. Improved the nutrition of the rural population
5. Increased diversification of crops and improved food quality
6. Reduced insecticide use in the subregion.

7. Recommended Action Plan:

1. Communicate plan to appropriate officials in Governments, Plant Protection Agencies and Producer Groups in relevant countries of the region (1st Quarter 2000).
2. Identify resources and submit regional project proposal to implement the Phase I feasibility activities noted above during 2001-2002 (2nd Quarter 2000).
3. Field mission(s) or hold seminars as needed to consult with Member States on objectives and strategy, validate assumptions and formulate workplans in preparation of Phase I activities.

8. Roles and Partnerships:

PARTNERS	LEADERSHIP	FINANCING	PROGRAM IMPLEMENTATION	R&D	TECHNOLOGY TRANSFER	REG /LEG	FACILITATION
IAEA - FAO/IAEA	X		X	X	X		X
CLAM					X	X	X
EU	X	X	X		X	X	
IFI (EBRD & others)		X		X			
INDUSTRY (growers & exporters)	X	X	X				
UNIVERSITIES & INSTITUTES				X	X		
NPPOs	X	X		X		X	X
EPPO	X					X	X
Wholesalers	X	X	X	X			X

Explanatory Notes:

1. *CLAM* (Comité de Liasion de L'Agrumiculture Mediterraneenne). CLAM, as the organization representing the citrus industry of the Mediterranean region, the most important economic host to the medfly, has already expressed an interest in integrating SIT into current control programs. Although a small organization with a modest staff CLAM has the advantage of covering the most important industry in the area which is economically damaged by the medfly. CLAM can be expected to play a facilitator role rather than a leadership role.
2. *Industry (growers & exporters).* Consists of local commercial and grower organizations. In the final analysis it is only through the efforts of these organizations that the application of SIT can be effective, as all members of such organization have to understand the benefits of SIT and participate in

the effort, particularly in combination with other IPM measures. The *Olive Oil Industry* is another key industry adversely affected by the olive fly, a Tephritid pest. In light of the significant economic losses suffered each year by this industry due to this pest , and the increasingly stricter controls placed on pesticide residues in olive oil, this industry group can be expected to be interested in participating in the SIT R & D and control efforts envisage above.

3. *FAO International Plant Protection Convention/European Plant Protection Organization:* These organizations can set the framework in terms of integrating SIT into an area-wide IPM approach or as part of a systems approach under IPPC rules, and can help educate farmers and guide NPPOs and grower associations in the inter-region in this respect.
4. *National Plant Protection Organizations:* The full integration and participation of these national organizations into the SIT effort brings forth technical resources and political support for the local and national efforts in each participating country.
5. *Technical/Extension Institutions:* Extension services need to be fully engaged in what will be to some participating countries an entirely new approach to the biological control of one of their major pests. The adaptation of broader SIT R & D to the local conditions will be facilitated by these more local institutions.
6. *International Financial Institutions.* The *European Union* for the EU members of the Med. Region**,** *IFAD* for work with the poorer strata of small farmers in North Africa; the *European Investment Bank* for remote regions within the EU; the *European Bank for Reconstruction and Development (EBRD)* for financing facilities in countries in transition -e.g. a major fly production facility in Slovakia; the *Common Fund for Commodities* for control efforts in citrus and tropical fruits; the *World Bank* as part of its poverty eradication and environmental efforts and other appropriate IFIs.
7. *Major Wholesalers and Buyers of Mediterranean Products:* These players increasingly set the standard for what is acceptable to the consumer in the fruit and vegetable market. This includes an absence of pesticide residues and high quality produce not affected by larvae or other insect damage. They are to be considered both financial contributors and partners in publicizing the importance of SIT technology.

9. Resources Available and Needed:

Madeira has trained personnel and a small rearing facility, and several countries in the Mediterranean Basin have a strong fruit and vegetable production and export industry, which together with national governments and the European Union, could fund most of the activities.

Component	**Needed from IAEA**
Expert Services - Coordinator	12 m/m/year
Expert Services - Technical Support	3 m/m/year
Infrastructure/equipment	----------
Training	24 m/m/year
Group Activities (Coordination Workshops)	3 meetings/year

D) ASIA-PACIFIC REGION

The best opportunities identified in this region are in the Pacific Region, because it includes isolated islands with potential for tropical fruit production. Most of these are not Member States of the IAEA, however, most of these are members of UNDP and FAO (Annex L). This opens the door to possible linkages within the region with these UN organizations and others (ACIAR, USAID, etc.) that currently are lacking.

1. Key Issues/Justification:

Melon fly is the only economically important fruit fly in Guam and Commonwealth of the Northern Mariana Islands (CNMI). Both countries have regular air and shipping services to other Micronesian countries, other Pacific Island countries and territories (PICTs) and to Hawaii. Tourism is a major industry in both countries. This combination of factors places other PICTs at a significant quarantine risk while melon fly exists in Guam and CNMI. Eradication of melon fly in Guam and CNMI will remove this quarantine threat. The success of an eradication attempt will be dependent on the use of SIT, in combination with male annihilation and protein bait spraying. No expertise in SIT is available in this area of the Pacific or within regional organizations in the South Pacific.

Eradication of melon fly will facilitate local vegetable and fruit production, primarily for local consumption and for use in the tourist hotels. Removal of the losses caused by melon fly will be an incentive for more farmers to take up vegetable production and, consequently, reduce the reliance on imported fresh commodities. Increased availability of less expensive and high quality fresh commodities may entice greater consumption of fresh fruits and vegetables, thus improving the diets of Micronesians. Improvements to the trade balance by reducing the amount of fresh produce imported, increased agricultural production, and combating nutritional disorders fall within the ambit of Government policies. The prospects for export, particularly within the region, will be enhanced if the constraints imposed by the presence of melon fly are removed.

Concern has been registered regionally at the lack of eradication techniques available for coping with outbreaks of species of fruit flies that are attracted to cue-lure and those that are not attracted to any known lures, e.g., *Bactrocera cucumis, B. latifrons, B. jarvisi, B. decipiens, B. atrisetosa, B. minax*, and probably others from Asian countries. Development of the capacity to use SIT for some candidate species is seen as a critical adjunct to the techniques available for fruit fly eradication, particularly in outbreaks situations.

2a. Overall Objective:

To assist in the successful integration of SIT in support of the development of the fruit production in the region.

2b. Specific Objectives:

1. To eradicate melon fly from Guam and CNMI
2. To develop SIT capacity for candidate fruit flies that cannot be eradicated with MAT because they are not attracted to methyl-eugenol.

3. Short Term Activities:

1. Carry out an economic assessment on the eradication of melon fly from Guam and CNMI.
2. Train personnel in Guam and CNMI on the SIT.
3. Establish a small laboratory for holding fruit samples and a headquarters for the SIT program.
4. Assess existing data on melon fly and collect additional data on the ecology of melon fly in the local environment.
5. Negotiate the supply of sterile melon fly from the Japanese factory.
6. Provide a package for SIT in Guam and CNMI.
7. Undertake the SIT.
8. Assess the success of SIT (at least annually)
9. Support the cataloguing of fruit fly species in Asian-Pacific countries, with the view of identifying candidate species for SIT development.
10. Identify economically important species that are not responsive to known lures, that should be candidates for SIT.

4. Medium Term Activities (5-10 years):

1. Develop SIT technology for candidate fruit fly species, such as *B. jarvisi*, *B. latifrons*, and other species of economic importance, that do not respond to strong lures such as methyl eugenol.

5. Long Term Activities (Beyond 10 years)

1. Implement SIT throughout the region, especially as an emergency response in outbreak situations.

6. Roles and Partnerships

PARTNERS	LEADERSHIP	FINANCING	PROGRAM IMPLEMENTATION	R&D	TECHNOLOGY TRANSFER	REG /LEG	FACILITATION
Secretariat of the Pacific Community	X		X	X	X		X
Pacific Plant Protection Organisation						X	X
Asian Plant Protection Organisation		X	X				X
USDA-ARS Pacific Basin Agricultural Program				X	X		
USAID & ACIAR		X		X	X		
Japanese Government		X	X		X		X
UNIVERSITIES & INSTITUTES			X	X	X		
INTER-AMERICAN DEVELOPMENT BANK		X					
FAO	X	X	X	X		X	X
IAEA	X	X	X	X	X		X
UNDP		X			X		X
Government of Guam & CNMI		X	X			X	

Explanatory Notes:

1. *Secretariat of the Pacific Community:* regional coordination, assist in identifying funds, technical support in operations, liaison with donors.
2. *Pacific Plant Protection Organization:* regional and national quarantine.
3. *Asian Plant Protection Organizations:* assistance with fauna surveys.
4. *Pacific Basin Agricultural Program (USDA-ARS):* technical assistance and advice
5. *USAID:* possible funding source.
6. *Japanese Government:* source of sterile flies
7. *University of Guam:* facilities and technical and administrative support.
8. *College of Micronesia – Land Grant Program:* limited matching funds.
9. *FAO:* conduit to IAEA, technical advice and advice on Asian surveys in Cambodia, Laos, Myanmar, Vietnam, and other Asian countries.
10. *UNDP:* cost-shared funding source
11. *Governments of Guam and CNMI:* local operations, commitment of funds, facilities and resources.

7. Resources Available and Needed

A joint project carried out by FAO, ACIAR and other partners in the Pacific region has trained staff in most island nations, developed a quarantine and response infra-structure, and successfully conducted pilot fruit fly eradication projects. To integrate SIT in the implementation of eradication projects, there are the following requirements:

1. Trained technical and professional national staff
2. Project management
3. Public awareness/relations programme

4. Government and institutional commitment
5. Donor commitment – funding
6. Quarantine capacity
7. Access to Japanese sterile flies
8. Capacity to distribute sterile flies from ground and air
9. Capacity to carry out other techniques – BAT, MAT
10. Development of SIT package for Guam and CNMI
11. Economic evaluation and quality control

VIII. LONG TERM PROSPECTS OF SIT APPLICATION VS FRUIT FLIES

As a result of the strengthening of regulatory controls between trading blocks, fruit flies will increasingly represent major barriers to trade in agricultural commodities. Also losses to fruit flies in the developing world will continue in the foreseeable future to be unacceptably high. A conventional IPM approach is not effective for fruit flies, which continuously cause damage above economic threshold levels, therefore requiring intensive insecticide applications. The presence of a few surviving females, each of which with the ability to deposit hundreds of eggs, cannot be tolerated in commercial orchards, as this represents considerable fruit damage.

Public opinion, supported by scientific data, will continue to mount against dependence on repeated insecticide treatments and the associated negative environmental effects. The importance of these issues will increase over the medium term in direct proportion to the increasing public awareness and opposition against the risk of pesticide residues in food and the environment. At the same time, the economic feasibility of SIT will become increasingly apparent with more realistic accounting of the negative environmental effects of pesticide applications, and further improvement in its cost-effectiveness as a result of continuing investment in applied R & D.

The development of an SIT package for a specific fruit fly pests, involving mass rearing and aerial release, as well as field monitoring and suppression system, will take several years depending on funding level and technical complexity of the specific species involved. This is more favorable in comparison to the development of a synthetic insecticide, where it now takes an average of 10 years to bring a new product to market at an average cost of ca. US$ 120 million. These costs will probably continue to rise because of increasingly stringent standards imposed by regulatory agencies, and will be reflected in more expensive newer insecticides. As a result, non-chemical control-based methods such as SIT will increasingly be more economically viable than insecticides, even without taking into account the environmental costs. Already in Israel for example, medfly control costs US$ 80 per hectare per year, compared to the current cost of US$ 73 per hectare per year applying the SIT in the Arava valley.

Based on these trends it is foreseen that demand for SIT application against fruit flies will continue to expand. A majority of programmes still require some government or regional coordination and will at least partially be government-funded. The supportive and facilitating role of IAEA and its Joint Division with FAO, is critical in developing and implementing the SIT in both developing and developed countries. As these methods become increasingly more economical, pressure increases for global trade and public attention continues to focus on health and environmental management, it is almost certain that commercial interests will be attracted to SIT. Most immediately, the new technical developments in medfly, permitting the use of SIT for routine control of this pest rather than eradication purposes, will open the way for the eventual commercialization of SIT.

The proposed programme of activities outlined in this report, taken together with expanding field activities involving SIT field operations for New and Old World Screwworm and the Tsetse Fly, have significant implications upon the technical capabilities of the IAEA. Senior Management must be resolute in maintaining the high level of competency of IAEA and its Joint Division with FAO in this field.

IX. RESEARCH AND DEVELOPMENT NEEDS

1. IAEA Fruit fly R & D Priorities

Continuous research and development is fundamental to maintaining a viable SIT programme for any of the many fruit fly species that put countries at economic risk. Development of R&D must be given high priority for implementation of technology developed through IAEA programmes.

The role of the IAEA through its Joint Division with FAO. is to conduct research at its own facilities, but it is also charged with developing Co-ordinated Research Projects (CRP's) and identifying collaborators who can be funded to carry out a particular piece of research through the award of a Technical Contract. In house research is both problem solving and strategic and ensures that both immediate needs and long term goals can be met.

The emphasis of CRP's is on accelerating research and development needed to address specific bottlenecks and generate technology for immediate transfer.
Recently concluded and current programs include:

Medfly Mating Behavior
Development of Medfly Female Attractants
Fruit Fly Genetic Sexing
Genetic Transformation of Pest Insects
Mass Trapping of Fruit Flies
Quality Control of Mass Produced Fruit Flies
Natural Enemies (Biological Control Agents)

2. Problem Solving Solutions for Future Consideration

R and D for the various fruit fly species is at different levels depending on the evolution of SIT in each species (see IV above). In general the medfly is the most well studied and much can be learned from these studies to accelerate development in other important fruit fly species.

2.a General R & D Needs (Medfly and Other Fruit Flies):

- *Improvements in Fly Production and Storage*

Fly production technology has not changed significantly for 30-40 years despite rapid improvements in other technologies from which much can learned. There are two areas in which improvements could lead to major economic savings, namely diet development and materials handling. A semi-defined diet would enable commercial companies to either produce the diet for sale or even become involved in the developmental process. Materials handling systems can be dramatically improved by technologies used in many sectors of private industry. Sourcing expertise should be widespread and not limited to fruit processing organizations. Potential exists in areospace industry, food processing and medical fields. Processes evolving eclosion, tray maintenance and pre-chilling for distribution are all areas were improvements could be made. The ability to store the insect at different developmental stages would provide flexibility in operation and enable facilities to be developed which are specialized in the production of a particular stage. It should be stated that, mass rearing technologies still need to be developed in some very important fruit fly species.

- *Irradiation*

Irradiation procedures and too high doses need urgent re-evaluation, especially when all male releases are being used or when SIT is being used for control programmes. Also the physiological effects of radiation need to be assessed in order that remedial procedures can be developed.

- *Shipment and Release Technology*

Some progress has been made in this area in terms of aerial release of chilled flies, however, additional work is required for fly marking, long-distance shipment and eclosion procedures. An eclosion tower for medfly is currently under development but needs considerable further refinement for application in medfly and other species. New marking procedures are required which can utilize genetic transformation or PCR or a combination of both. Release strategies need to be improved by correlating them with the dynamics of host availability, phenology, fly population density and trap back/detection data.

- *Standardized Trapping and Detection*

Trapping and detection systems need to be standardized to provide consistency of data for evaluation of efficacy. This is particularly important in control of low density populations and their relationship to the systems approach for movement of impacted commodities in channels of trade.

- *SIT and Control*

The use of SIT for control will demand a much more detailed knowledge of the fly and its environment. The implementation of a control programme will also enable new radiation protocols to be developed. The reverse side of this is that during eradication or preventative programmes full sterility will probably continue to be required. Assessment of sterility in the wild females in the field is a powerful tool to monitor the progress of a campaign but is difficult to accomplish. Some progress has been made but the development of improved tools is important. In the initial phase of a control programme it would be possible to develop and evaluate these procedures.

- *Quality Assurance/Control*

Systems for quality control need improvement to better reflect the performance of the fly in the field. For example can laboratory tests be developed in order to predict sterile fly capacity for predator avoidance or levels of dispersal in the field? Improvements in the field quality of released flies is also urgently needed and research on the impact of the nutritional status of the fly on its survival needs to be clarified.

- *Strain Development*

The development of improved strains for SIT, for example the genetic sexing strains in medfly, have made a significant positive contribution to the implementation of operational field programmes. However, the efficiency of these strains is not yet optimized and they are not yet available for other fruit fly species. Genetic transformation will provide a powerful tool for the manipulation of important characteristics of the fly which are relevant for SIT. The use of this technology to develop better sexing strains in medfly need to be continued and expanded to include the other fruit flies. The transferability of this type of technology between species is one of its greatest potential strengths.

- *SIT as a Part of Integrated Biocontrol Systems*

There needs to be a complete understanding of the relative importance and cost-effectiveness of the augmentative use of biocontrol agents as complementary tools to SIT. The relationship of SIT to other biocontrol agents must be evaluated to assure compatibility within the system. Given the synergistic interaction between such systems, methods development must be conducted to allow evaluation and assure success.

- *Germplasm Stock Centre*

The development of improved SIT strains to produce only male insects will require that a set of genetic stocks and mutants be available with which the strains can be synthesized. It is not necessary that all facilities working in this area maintain all the strains and a centralized facility set up to maintain and distribute the different genetic stocks as required.

- *Speciation*

In the *Bactrocera* and *Anastrepha* groups the species status of pest fruit flies needs clarification. This is essential to determine the feasibility of SIT. A genetic analysis of individuals from different species will enable some relevant conclusions to be arrived at but it will essential to carry out ecological and mating studies to assess the relevance of this data for the SIT. Providing that flies mate at random with each other under semi-natural conditions, their species status is to some extent irrelevant. Currently experiments are being carried out in in Surinam to see if sterile *Bactrocera dorsalis* males will mate with *B. carambolae* females in field cages. Similar studies are being funded in Thailand and Malaysia.

2b. Medfly:

Medfly will continue to be used as the model for the future development of SIT as there are many tools available and a large group of active researchers is available. In the area of genetic sexing, improvements are being developed which will enable different genetic backgrounds to be crossed into the strains either to satisfy local requirements or to improve genetic variability. Evaluations have to be continued to monitor the effectiveness of all male releases. In the area of genetic transformation progress has been rapid and many transgenic strains have been developed. These strains now need to be assessed in terms of their relevance to use in SIT and to develop risk assessment protocols for eventual release in an SIT programme.

In the area of rearing there is the need for automating labour intensive processes and to fully develop the "filter concept" as part of a more effective colony management system in order to extend the useful life of a strain under mass rearing conditions. Also there is the urgent need to develop of a much cheaper larval diet, as well as a more practical fly handling and emerging system, similar to that already in routine use for screwworm flies.

2.c Anastrepha:

To develop an R and D plan for the *Anastrepha* species, which is relevant to the implementation of SIT programmes, will require a detailed analysis of species, needs and objectives. This should be accomplished by convening a Consultants Meeting which should include participants from research, action Agencies and stakeholders. This would identify priorities for in house research and CRP's and indicate where the resources of the TC Department could be best placed.

2.d Bactrocera:

To develop an R and D plan for the *Bactrocera* species which is relevant to the implementation of SIT programmes requires a detailed analysis of needs and objectives along the same lines described above for *Anastrepha*. This should be accomplished by convening a Consultants Meeting which should include participants from research, action Agencies and stakeholders. This would identify priorities for in house research and CRP's and indicate where the resources of the TC Department could be best placed. The process for *Bactrocera* should also include an evaluation of specific species that do not respond to strong lures and which will require SIT as part of a control/eradication system. One of the major R & D requirements for *Bactrocera,* besides the above mentioned need for resolution of the species complex issue, is the use of lures to increase the competitiveness of sterile males and to reduce their response to poison baits.

3. Conclusions for R & D:

1. Experience gained by the IAEA in the development of the medfly SIT programs must be applied to the planning concepts for other fruit fly species of economic importance.
2. The IAEA is best positioned to provide leadership in establishing a vision for applied R & D and master strategies for practical problem solving.
3. The IAEA needs to include action agencies and stakeholders in the Consultants meetings for priority setting.

X. RECOMMENDATIONS

A. GENERAL

1. It is recognized that R & D provides the basis to effectively implement the SIT and to provide continuous improvements in the technology resulting in more cost effective implementation. We therefore recommend that the fruit fly R & D budget to support the SIT at the IAEA be increased to meet both the short and long term requirements requested by the Member States.

2. Existing technical and research partnerships should be strengthened, particularly through co-ordinated research projects (CRPs).

3. The SIT should be recognized as part of a package for insect control and thus it is important that all parts of the package be identified and recognized as essential for the practical implementation of the technology. We recommend that both the nuclear and non-nuclear components of the SIT package be supported by IAEA in order to insure effective implementation and sustainability.

4. As the SIT reaches maturity for any particular fruit fly species to the point of where commercial interests arise, it is essential that the technology be recognized as requiring an area-wide approach.

5. A regional or sub-regional approach is recommended for SIT programmes and this is consistent with the area-wide philosophy required to manage the transboundary nature of fruit fly pest problems.

6. The fruit industry and pest management infrastructure is sufficiently advanced in three regions to utilize SIT for practical fruit fly control. Therefore we recommend that three technical cooperation projects be initiated immediately to assess regional feasibility of fruit fly activities: two sub-regional in Latin America (one in Central America and one in Southern Cone of South America) and one inter-regional in the Mediterranean Basin (N. Africa, W. Asia and S. Europe).

7. The Ministry of Agriculture in each country is the official representative of the agricultural sector. Therefore, we recommend that these programmes be endorsed by the appropriate agricultural authorities.

8. New financial partnerships need to be established between IAEA and International Financial Institutions (IFIs) that make investments in plant production, plant protection, agricultural trade promotion, environmental protection and other programmes within Member States.

9. We recommend that staffing needs for field projects and within the IAEA be reviewed since SIT is a management intensive technique requiring strong backstopping.

10. We recommend greater recognition and support be given by the IAEA to the need for co-operation and networking at an interregional level in support of SIT activities.

11. We recommend that TC Programming identify opportunities for collaboration and co-operation with Member State governments and grower groups in relevant fruit fly control activities.

12. We recommend the continued promotion by IAEA of the SIT technology to the many potential users, decision-makers and educators, including the private sector, grower groups and the academic community. The IAEA, through its promotion of the SIT, should emphasize the area wide philosophy required to manage the trans-boundary nature of pest problems.

B. SPECIFIC

1. CRPs should be initiated over the next four years addressing specific bottlenecks for the technical application of the SIT for control/eradication of *Anastrepha* and *Bactrocera* fruit flies. These should be preceded by Consultants Meetings to assist in focusing and priority setting.

2. Pre-project planning meetings should be organized by TC Programming before the end of April 2000 to validate and define the range and scope of the three proposed sub/inter regional projects, and to formulate phased subregional project proposals:
   a) Countries of the Mediterranean Basin
   b) Central America, Panama & Mexico
   c) Southern Cone of South America

3. Representatives of major grower associations should take part in all pre-project planning meetings. These representative should assist in obtaining the support of national agricultural authorities.

4. We recommend that this report and proposed programme of activities be formally communicated to the appropriate agricultural authorities in each of the countries mentioned in recommendation B. 2., above.

5. In order to ensure that future programming is consistent with thematic planning, we recommend that the TC envisaged joint “steering mechanism” be established for this thematic plan, and that options be explored to use teleconferencing capabilities to facilitate performance monitoring by the experts involved in its formulation.

6. Inter-regional training courses should be regularly held as they represent an important component in the promotion and future implementation of area-wide SIT against fruit flies.

7. An abbreviated version of the textbook now in preparation on area-wide SIT should be made available to decision-makers in national and regional plant protection organizations and eventually be translated into Spanish, French and Arabic.

8. With respect to new partnerships with IFIs, we recommended a systematic analysis by TCPC of agricultural investment trends identified in Recommendation A. 8. In addition, financial support should be sought by IAEA to foster commercial production of sterile insects , such as, the proposed facility in the Slovak Republic (SLR/5/002) (Annex I), with the European Bank for Reconstruction and Development and other sources of investment.

9. Detailed specifications and requirements should be developed for building and equipping a generic modular plant for large scale production of sterile medflies.

10. A Consultants meeting should be held in the medium-term to review the status, R&D needs, and potential for area-wide application of SIT for olive fly.

11. TCPC should develop a follow-up action plan leading to the successful implementation of each recommendation in this Thematic Plan and report semi-annually progress made to the respective DDGs and to the experts that formulated this Thematic Plan.

XI. ANNEXES

- **A. List of Experts**
- **B. Agenda of the Meeting**
- **C. Meeting Prospectus and Background Note**
- **D. Criteria for Successful SIT**
- **E. List of Quarantine Species and Countries**
- **F. List of Fruit Flies Subject to Control Action in USA.**
- **G. List of Pests Responding to Methyl Eugenol and Cue lure**
- **H. Existing Fruit Fly Mass-Rearing Facilities**
- **I. Slovakia Feasibility Project for Mass-Rearing Facility**
- **J. Evaluation of *Bactrocera zonata* Problem in Egypt - Summary from Mission Report**
- **K. Relevant Contact-Address List**
- **L. Member States of IAEA, FAO, IPPC, WTO**
- **M. Strategy for Sub-Regional Program in Central America**

Annex A - List of Experts

LIST OF PARTICIPANTS

1.	**Dr. Allan ALLWOOD**	Regional Management of Fruit Flies in the Pacific Secretariat of the Pacific Community Suva Fiji Tel.: 00679 400344; 322626 Fax: 00679 322800 E-mail: allwood@is.com.fj
2.	**Mr. Fred A. BATKIN III**	Citrus Research Board 323 W. Oak Visalia, CA 93291 USA Tel: 00 1 559 7380246 Fax: 00 1 559 7380607 E-mail: tbatkin@lightspeed.net; or batkin@psnw.com
3.	**Dr. Mena DAVIDSON**	Citrus Marketing Board of Israel (Jaffa) P.O. Box 80 Beit Dagan 50250 Israel Tel.: 00972 3 9683811/9 Fax: 00972 3 9683838 E-mail: davidzon@netvision.net.il; or cmbi@netvision.net.il
4.	**Mr. Pablo E. GÓMEZ RIERA**	ISCAMEN Boulogne sur mer 3050 Mendoza Argentina Tel.: 0054 261 4231510; 4299103; 42991015 Fax: 0054 261 4299013; 42991015 E-mail: iscamen@cpsarg.com; gergomez@infovia.com.ar

5. **Mr. Jonathan D. KNIGHT**
Imperial College of Science, Technology and Medicine
Centre for Environmental Technology
Silwood Park
Ascot Berkshire SL5 7PY
United Kingdom

Tel.: 0044 344 294496
Fax: 0044 344 294308
E-mail: j.d.knight@ic.ac.uk
Website: www.huxley.oc.ac.uk

6. **Mr. Donald LINDQUIST**
Friedlgasse 25/2
A-1190 Vienna
Austria

Tel.: 0043 1 3676398
Fax:
E-mail: DLINDQUIST1@compuserve.com

7. **Dr. Aldo MALAVASI**
Department of Biology
University of São Paulo
R. do Matão
477 - São Paulo SP
Brazil 05431-900

Tel.: 0055 11 8187567
0055 11 38715584
Fax: 0055 11 8187553
E-mail: malavasi@usp.br *or* iiacacff@sr.nwet

8. **Mr. Paul PILKAUSKAS**
Horticultural Group
FAO
Rome
Italy

Tel: 0039 06 5705 2003
Fax: 0039 06 5705 4495
E-mail: Paul.Pilkauskas@fao.org

9. **Mr. Michael B. STEFAN**
Plant Protection & Quarantine
Animal & Plant Health Inspection Service
United States Department of Agriculture
4700 River Road, Unit 134
Riverdale, Maryland 20737-134
USA

Tel.: 00 1 301 73447
Fax: 00 1 301 7348584
E-mail: Michael.B.Stefan@usda.gov

10. **Mr. Gordon TWEEN**

Medfly Program Mexico and Central America
USDA/APHIS/IS, Unit 3319
American Embassy
Guatemala City
Guatemala

Tel: 00502 3312156; 3312036; 3322037; 3322153
Fax: 00502 3335446
E-mail: gtween@guate.net
mgtween@csi.com

LIST OF IAEA STAFF

1) **Mr. Abdel Jelil BAKRI**

Insect and Pest Control Section
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

E-mail: bakri14@hotmail.com

2) **Mr. Kingsley FISHER**

Entomology Unit
Agency's Laboratories, Seibersdorf

E-mail: kingsknight@compuserve.com

3) **Mr. Philippe FOUCHARD**

Concepts and Planning Section
Division of Planning, Co-ordination and Evaluation

Tel: 0043 1 2600 26005
E-mail: p.fouchard@iaea.org

4) **Mr. Gerald FRANZ**

Entomology Unit
Agency's Laboratories, Seibersdorf

Tel: 0043 1 2600 28419
E-mail: g.franz@iaea.org

5) **Mr. Patrick John GOMES**

Insect and Pest Control Section
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

Tel: 0043 1 2600 21630
E-mail: p.gomes@iaea.org

6)	**Mr. Jorge HENDRICHS**	Insect and Pest Control Section Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture Tel: 0043 1 2600 21628 E-mail: j.hendrichs@iaea.org	
7)	**Mr. Royal KASTENS**	Concepts and Planning Section Division of Planning, Co-ordination and Evaluation Tel: 0043 1 2600 26780 E-mail: r.kastens@iaea.org	
8)	**Mr. Paisan LOAHARANU**	Food and Environmental Protection Section Joint Division of Nuclear Techniques in Food and Agriculture Tel: 0043 1 2600 21638 E-mail: p.loaharanu@iaea.org	
9)	**Mr. Alan ROBINSON**	Entomology Unit Agency's Laboratories, Seibersdorf Tel: 0043 1 2600 28402 E-mail: a.robinson@iaea.org	

Annex B - Agenda of the Meeting

Monday,15 November

09:00 - 09:15	Opening	DDG-TC
	IAEA	
09:15 - 09:30	Thematic Planning concepts	R.F. Kastens
09:30 - 10:00	Review of IAEA fruit fly activities	P. Gomes
10:00 - 10:30	Review of IAEA fruit fly R&D	A. Robinson
10:30 - 10:45	Coffee break	
10:45 - 11:00	Fruit fly post harvest treatments	P. Loaharanu
11:00 - 11:15	Evaluation Lessons learned	P. Fouchard
11:15 - 12:15	Discussion topics : Leader J. Hendrichs Role of SIT and integration with other methods Planned activities for R&D and TC programme	
12:15 - 12:30	Designation of Chairman and Rapporteur	
12:30 - 14:00	Lunch break	
	I - The problem:	
14:00 - 14:30	Review of US policies and trade issues related to fruit flies	M. Stefan
14:30 - 15:00	Industry perspectives on Management of fruit flies in the Mediterranean	M. Davidson
15:00 - 15:30	Industry perspectives on Management of fruit flies in North America	T. Batkin
15:30 - 15:45	Tea break	
15:45 - 17:45	Discussion topics : Leader T. Batkin Scope and nature of the problem Components of national progammes National commitment	
17:45	Summary of discussions	Chairman

Tuesday, 16 November

	II - The solution	
09:00 - 09:30	Economics of different control strategies	J. Knight
09:30 - 10:00	Opportunities for commercializing SIT	D. Lindquist
10:00 - 10:30	Establishment of fly free areas and systems approach	A. Malavasi
10:30 - 1045	Coffee break	

10:45 - 13:00	Discussion topics : Leader A. Malavasi	
	Control/eradication alternatives	
	Benefit/cost	
	Rearing	
	Criteria for prioritizing SIT intervention	
13:00 - 14:00	Lunch break	

III - Convergence

14:00 - 14:30	Management of fruit flies in the Pacific and strategies for the future	A. Allwood
14:30 - 15:00	Status of sub-regional fruit fly activities (ARG, CHI, PER, URU) and strategies for the future	P.E. Gomez Riera
15:00 - 15:30	Status of USDA Central American fruit fly program	G. Tween
15:30 - 16:00	Trends in investments and trade in fresh fruits and vegetables	P. Pilkauskas
16:00 - 16:15	Tea break	
16:15 - 18:00	Discussion topics: Leader P. Pilkauskas	
	Identification of key partners and stakeholders	
	Role for IAEA and other stakeholders	
	Identification of opportunities	
18:00	Summary of discussions	
	Chairman	
19:00	Social Event	

<u>Wednesday, 17 November</u>

Preparation of Report

9:00 - 10:30	Discussion on consensus issues and draft recommendations
10:30 - 10:45	Coffee break
10:45 - 11:00	Designation of Drafting Groups
11:00 - 13:00	Work in Drafting Groups
13:00 - 14:00	Lunch break
14:00 - 17:00	Work in Drafting Groups
17:30	Meeting of the Drafting Groups

Thursday, 18 November

Morning	Drafting Groups Contd.	
11:00	Submission of Drafting Group Outputs to Rapporteur for Collation of 1st draft	
13:00 - 14:00	Lunch break	
14:00 - 16:00	Review of first draft & agreement on final draft	Rapporteur
16:00 - 16:15	Chairman's Report	
16:15 - 16:30	Closing of meeting -	Dep. DIR-NAFA

Friday 19 November

09:00	Follow up discussions with programming staff TCPA/TCPB/NA
12:00	Final draft report available (B0981)

Annex C - Meeting Prospectus and Background Note

Meeting Prospectus

IAEA Thematic Planning: National/regional Fruit Fly eradication and control campaigns and the role of the Sterile Insect Technique (SIT). 15-19 November 1999, IAEA Headquarters, Vienna Austria

Thematic Planning is a prescriptive planning tool for IAEA technical cooperation (TC) activities. The process seeks to elaborate the relative effectiveness and efficiency of a technique/technology based upon successful TC projects that have demonstrated a significant contribution to national socio-economic development, or where solid evidence exists to predict such a contribution. The process results in a *Thematic Plan* that complements Country Programme Frameworks[1] (CPF) by providing a problem based analysis for a technology package that helps to ensure the relevance, sustainability and impact of technical cooperation between member states and IAEA. The strategic value of a Thematic Plan is in prioritizing and providing guidance for TC technical applications based upon the IAEA's best experience and practices, a clear understanding of the roles and interests of the major stakeholders and opportunities to form new partnerships.

The Problem: Extensive fruit industries are developing in many parts of the world in response to the large demand for high quality fresh fruits and vegetables. Significant investments are made by governments and major lending institutions to assist in this development. Tephritid fruit flies, however, cause devastating direct losses to many of the fresh fruits and vegetables that these investors target for the market place thus requiring regular pesticide treatments to protect the maturing crop. In addition, few insects have a greater impact on international marketing and world trade in agricultural produce than tephritid fruit flies (See Attachment 1 - List of Countries With Quarantines Against Specific Fruit Flies or All Fruit Flies). With increasing international trade, the importance of fruit flies as major quarantine pests of fruits and vegetables will be increasing along with demands by Member States to implement area-wide national or regional (trans-boundary) control programmes against fruit fly pests.
Fruit flies of the *Bactrocera* and *Anastrepha* groups are devastating pests in the Asia/Pacific and Latin American regions, where production of tropical fresh fruit for export is rapidly growing. In these mostly tropical regions, several fruit fly species of economic importance are present (See Attachment 2 - Fruit Flies Subject to Control Action). Eradication is not practical at present in most multi-species environments. Efforts are therefore directed at intensive pre-harvest management, including SIT and augmentative releases of natural enemies, followed by post-harvest treatment, possibly irradiation, to allow fresh fruit exports to countries free of these pests. One strategy is to support the creation of certified Low Fly Prevalence Areas. With increasing sophistication, these can eventually become certified Fly Free Areas, which no longer require post-harvest treatments.

Recent SIT Developments: In the United States, national and state authorities have incorporated preventative releases of sterile Medflies into their overall exclusion plans as the standard strategy in

[1] The CPF is a diagnostic planning tool that provides a concise, demand-based frame of reference for technical cooperation with member states in the medium term (4-6 years). It utilizes the outcomes of Thematic Planning as a basis for pre-project planning and formulation. Strategic value results from common commitment to improving the quality and effectiveness of technical co-operation between member states and IAEA.

major urban areas prone to introduction, such as, the Los Angeles Basin in California and areas near Tampa and Orlando in Florida.

SIT has been successfully incorporated in several national Mediterranean fruit fly programmes particularly in subtropical regions where progress has been considerable. Since this is the only fruit fly surviving in the temperate parts of subtropical latitudes and the technical feasibility of SIT has been proven, attention has focused on demonstrating economic feasible. In Latin America, SIT eradication projects supported directly or indirectly by IAEA are in progress in Argentina (Patagonia and Mendoza), southern Peru, southern Mexico and Guatemala.

Despite the fact that the Mediterranean fruit fly is the major fruit pest and insecticide use is intensive, much less advance has been made in the Mediterranean region. This also applies to Africa where the only major eradication effort underway is in the Western Cape of South Africa where fruit production is an important industry. Israel, Jordan, Lebanon, Portugal, and other member states in the Mediterranean have reached different stages of preparation for utilizing SIT technology against medfly. Considerable activity is therefore expected over the next seven to ten years in these two regions.

It is also noteworthy that several member states are now undertaking or planning to undertake major plant protection and agricultural export promotion activities with financing provided by the World Bank, Inter-American Development Bank and other multi-lateral development banks. As a mature technology, it is reasonable to assume that SIT can play a role in programme efficacy as either a low cost alternative to conventional techniques such as Male Annihilation Technique (MAT), or Bait Application Techniques (BAT), or by ensuring that biological eradication is achieved. However this must be substantiated through feasibility studies at the national project level.

Constraints and Opportunities: Adequate rearing facilities for economical, large-scale sterile insect release in genetic control programmes are a major limiting factor, particularly in the Mediterranean region. Therefore, the establishment of regional mass-rearing facilities could become a high priority. One objective therefore is to ascertain the feasibility of a commercial facility (ies) within the region for the mass rearing, sterilization, handling and shipping of insects for SIT programmes. Technically, a mass-rearing facility can be established in any country. Economically, it could be an attractive investment opportunity if the market for sterile flies were assured. The host municipality would benefit from additional employment and national treasuries throughout the region would gain hard currency balances from not importing insecticides. Part of the commercial value of this undertaking is that mass-rearing facilities are needed not only for sterile insects but also for parasitoids and predators to use in integrated control programmes combining genetic control with biological control.

Since cost-benefit analysis is often the deciding factor in determining the viability of SIT programmes and its acceptance by commercial growers, fly production efficiency of all three genera *Ceratitis*, *Bactrocera* and *Anastrepha*, should remain one of the main objectives of the IAEA programme. Consequently research on insect quality, increased automation, more effective and cheaper diets, longer shelf-life, etc., will continue to be important. The recent breakthrough of dramatically increasing sterile male potency in *Bactrocera* fruit flies using a pheromone precursor may revolutionize fruit fly production and SIT applications in the Asia and Pacific region. However, this will require greater technical and operational outreach activities.

The IAEA has not always taken full advantage of partnerships, particularly with agri-business and other private sector interests, in promoting the value of SIT for fruit fly control. IAEA can serve as a catalyst for economic growth by placing greater emphasis on industrialization of SIT production wherever feasible. Tremendous opportunities exist for commercialization of sterile insect production, as well as cottage industries and jobs to support both production, packaging, transportation and use of sterile insects.

Convergence: Fruit flies impose a fundamental ecological barrier for developing countries seeking to enter the world market for fruit and vegetables, or to simply improve the quality of agricultural production. SIT is a potential ***breakthrough technology*** for eliminating a root cause for constraints to trade in agricultural products, and therefore fostering economic growth and prosperity for both small and large holders. However, IAEA possesses limited human and financial resources and faces competing demands for pest control using SIT. When is SIT the most effective solution for fruit fly control/eradication? Which member states are prepared to formulate programmes and mobilize resources for area wide efforts? What are the conditions necessary for successful campaigns. What implementation strategies are the most efficient and effective? Where are the opportunities for private sector investment and commercialization? Who in the international community is prepared to provide leadership? The answers to these and other questions will provide clear guidance, realistic criteria and a logical framework for future technical cooperation with member states engaged or wishing to engage in fruit fly eradication/control activities using SIT. Member States will directly benefit from the forthcoming *Thematic Plan for SIT eradication/control of Fruit Fly* through better programme development and management strategies for partnerships with potential investors/contributors for fruit fly eradication/control, increased production and trade, reduced pesticide use and residues, and greater acceptance of environmentally sound approaches to pest control.

The desired **outcomes** of this thematic planning meeting will be:

- Identification of future plans and objectives where opportunities exist for collaboration and partnership

- Greater understanding of roles and responsibilities, particularly the private sector and agri-business

- Increased knowledge about member states pursuing or planning agricultural export promotion programmes.

- Validation of programme priorities, including R&D.

- Assessments of country conditions for CPF discussions.

- Agreement on follow-up tasks including: data collection, country assessments, feasibility activities, cost-benefit studies.

- Targets and objectives for outreach and public information activities

- Mechanisms for future coordination.

Background Note

IAEA Thematic Planning: National/regional Fruit Fly eradication and control campaigns and the role of the Sterile Insect Technique (SIT). 15-19 November 1999, IAEA Headquarters, Vienna Austria

A - Introduction

The activities of the IAEA Insect and Pest Control programme fall under three major thrusts:

> First, to strengthen its normative role of providing standards, strategies, advice and other services to Member States. This includes the acquisition, compilation and synthesis of new developments and knowledge in the field, as well as the dissemination of this information through newsletters, publications, operating manuals, web-sites, videos and the organization of seminars, symposia and training courses.
>
> Second, to continue developing and improving, using nuclear and related technologies, systems of pest control that are environment-friendly and sustainable. This involves applied research through focused development work at the Entomology Unit of the FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf, the implementation of focused and results-oriented Co-ordinated Research Projects (CRP), as well as the granting of individual Research and Technical Contracts.
>
> Third, to continue assisting Member States in the implementation of area-wide national or regional (transboundary) control programmes against fruit fly, lepidoptera, screwworm, tsetse and other major insect pests. This involves the integration of the Sterile Insect or other genetic techniques with supportive technologies in field programmes aiming at providing direct benefits at the level of the end-user.

B - TC Projects

During the last ten years the Agency allocated approximately $ 8.5 million on twenty-five fruit fly related national and regional technical co-operation projects through the provision of experts, training and equipment. A descriptive outline of selected projects is given below. In addition under three regional training courses on SIT and area-wide control of fruit fly, 50 participants from Latin America and 19 from West Asia were trained

1. Mediterranean Fruit Fly, Chile [1991-1997] CHI/5/015

Problem: The Medfly attacks over 250 species of fruits and vegetables. For over a decade Chile tried unsuccessfully to eradicate Medfly using conventional methods. The Medfly problem prevented Chile from exporting fruit to economically attractive markets, where the Medfy is not endemic.

Objective: To eradicate the Medfly from northern Chile with a view to declare Chile as a Medfly-free zone thus enabling export of fruit produce to economically attractive markets where the pest is not endemic.

Activities: Together with FAO, extensive expert guidance and staff training was provided on rearing, release, suppression and monitoring procedures that are relevant to Medfly SIT operations. Expert advice was also given on the design of the mass rearing facility and rearing equipment

Results / Status: The eradication of Medfly, using the SIT, was achieved. In December 1995 following verification by American and Japanese inspectors, Chile was recognized officially as a Medfly free zone. This has opened new fresh fruit export markets, resulting in estimated benefits of US$ 500 million over a five year period.

Counterpart: Ministerio de Agricultura ,Servicio Agricola y Ganadero, Avenida Bulnes 140, Santiago, Chile.

http://www.minagri.gob.cl/minagri/sag/sag11.html

2. Mediterranean Fruit Fly, Chile - Peru [1997, continuing] RLA/5/039

Problem: Since achieving eradication, Chile has been interested in expanding the Medfly-free area to the north to reduce the risk of Medfly re-invasion from its neighbour Peru. In addition, due to Medfly presence, Peruvian producers in the Tacna and Moquegua valleys cannot export their vegetable and fruit to markets in Chile. Peru is also interested in creating fly-free areas in mango producing areas in northern Peru.

Objective: The objective is to eradicate Medlfy from the Departments of Tacna and Moquegua, and to establish a strong quarantine infrastructure to be able to maintain a fly-free status.

Activities: Under a bi-national technical co-operation project which was initiated in 1997, FAO/IAEA has been providing economic and technical support to both countries, and Chile in addition is supplying to Peru both funding as well as 20 million sterile flies per week for releases in southern Peru (Tacna province). Two training courses were held in Peru in 1998 to train staff in the SIT and in plant quarantine procedures.

Results / Status: The quarantine and fumigation infrastructure has been established to operate quarantine barriers to protect the Tacna and Moquegua Departments. Staff has been trained in field, mass rearing, release and quality control operations. The genetic sexing technology has been transferred to Chile mass rearing facility. Sterile males are being released by air over the Tacna valley and populations are being effectively suppressed, however, eradication will only be achieve once the quarantine is fully operational.

Counterparts: Ministerio de Agricultura Servicio Agricola y Ganadero , Avenida Bulnes 140, Santiago, Chile, http://www.minagri.gob.cl/minagri/sag/sag11.html

Ministerio de Agricultura, Servicio Nacional de Sanidad Agraria Programa Nacional de Control y Erradicacion de Moscas de la Fruta, Av. Salaverry s/n, Piso 10, Jesus Maria, Lima Peru. Tel.: 0051 13 480720. Email: adelarosa@senasa.minag.gob.pe

3. Mediterranean Fruit Fly, Guatemala, [1995-1998] GUA/5/013

Problem: A TC project in the late 1970's established a Medfly mass rearing facility in Southern Mexico, which was successful in eradicating Medfly from those areas in southern Mexico which the pest had invaded. Later joint Guatemala-US mass rearing facilities were established in Guatemala with a potential capacity to produce 500 million sterile flies /week. Since 1982, a live barrier of sterile flies has been maintained along the border between Mexico and Guatemala, keeping Mexico and the US Medfly-free.

Objective: Because the release of both sexes of Medflies is less effective than males only and harbours other shortcomings, the objective of the project was to transfer the genetic sexing technology to this mass rearing facility.

Activities: Expert guidance and staff training was carried out and a strain of the temperature sensitive lethal (TSL) series, together with modified rearing technologies and specific quality assurance procedures, was transferred to Guatemala. Field behaviour assessments of bisexual and the genetic sexing strains were conducted, the chilled-adult release system was transferred as well as the new female trapping system.

Results / Status: Sterile male production of the sexing strain has reached over 150 million males /week. The TSL rearing and handling process, together with the filter system is well established in Guatemala fly factory, which is weekly providing sterile males for releases in the country and to other SIT projects in California, Florida, Israel and Jordan. The increased field effectiveness of the genetic sexing strain was confirmed in extensive field tests.

Counterpart: Ministerio de Agricultura, Ganaderia y Alimentacion; Programa, Moscamed, Guatemala City.

4. Mediterranean Fruit Fly, Argentina [1994-1999] ARG/5/005

Problem: Argentina's fruit industry already exports over US$ 0.5 billion in fresh fruits. However, due to Medfly presence, many export markets are closed to Argentina. In addition, fruit and vegetable farmers have to spray insecticides during the whole fruiting season and harvest early, to avoid direct losses from fruit fly maggots.

Objective: The programme's aim is to declare 870,000 ha of the main fruit and vegetable production and export valleys in Patagonia, Mendoza and San Juan regions free of the Medfly so as to avoid direct losses and open fruit exports to countries that have imposed a ban on fruit from Medfly endemic areas.

Activities: Using close to US$30 million, mainly provided by the Government and fruit growers of Argentina, of which ca. 5% were provided by FAO/IAEA, a national Medfly SIT capability was established, based on the conventional (bisexual) SIT technology (facility producing ca. 300 million flies per week, and more recently on the genetic sexing technology. The assistance also included guidance and equipment to strengthen quarantine barriers and operations, as well as post-harvest treatments.

Results / Status: More than 15,000 large, medium and small fruit and vegetable farmers are benefiting from the SIT programme. Very low, and in most commercial production areas almost zero, detection of the pest is confirming good progress in establishing fly-free areas. Argentina is now largely self-sufficient in fruit fly control/eradication activities, including the SIT, Medfly genetic sexing technology and post-harvest quarantine treatments against fruit flies. Continued FAO/IAEA expert services have been requested during the final phase of activities to bring the project to a successful conclusion.

Counterpart: Instituto. Argentino de Sanidad y Calidad Vegetal; Programa Nacional Erradicacion y Control Mosca de la Fruta; Buenos Aires.

5. Mediterranean Fruit Fly, Madeira, Portugal [1995, continuing] POR/5/005

Problem: Madeira Island, in the Atlantic Ocean, is an excellent place to produce subtropical fruits, but losses due the Medfly makes this very difficult. Intensive insecticide sprays is not an acceptable control method due to the large tourist industry, which is the main economic activity of the island.

Objective: The objective of this project is to control, not to eradicate, this pest in a biological way to allow the development of a subtropical fruit industry in Madeira for fresh fruit export to the European market.

Activities: This project has a budget of 5.4 million ECU, of which the EU covers 71%, the Government of the Region of Madeira 24% and the IAEA 5%. Even though the IAEA contribution is relatively small in financial terms, the technical direction of the project has fully been the responsibility of IAEA. Expert advice and staff training has been provided. A rearing facility was designed, built (the first in Europe) and equipped, and since then stocked with a genetic sexing strain (TSL) from Seibersdorf. Intensive base-line data collection based on trapping and fruit sampling has been carried out. Aerial releases of sterile males started in 1998 in pilot areas. A twin-engine aircraft is used to release flies with a chilled adult release system. The total area for release is about 370km^2.

Results / Status: The mass rearing facility, designed to produce weekly 50 million sterile males of a genetic sexing strain, was inaugurated in October 1996. Most problems in mass rearing the male-only strain have been overcome and production has reached levels of ca. 25 million males/week. Public information activities have been initiated and the management of field data using GIS is being implemented.

Countrepart: Secretaria Regional de Agricultura, Floresta e Pescas, Direccao Regional de Agricultura, Estrada Eng. Abel Vieira, P-9135 Camacha, Madeira, Portugal.

6. Mediterranean Fruit Fly, Israel, Jordan and Gaza [1997, continuing] ISR/5/009, JOR/5/007, PAL/5/002

Problem: The agricultural communities in the Lower Rift Valley (Arava) in both Israel and Jordan are mostly oases surrounded by desert and have therefore a great potential for the development of vegetable exporting Medfly fly-free areas. Direct losses, are severe unless intensive insecticide controls are applied.

Objective: To conduct a detailed feasibility assessment of Medfly SIT in the area and initiate the eradication of Medfly from the Lower Jordan Rift Valley using the Sterile Insect Technique as a pilot study for eventual wider application in Israel, Jordan and Gaza.

Activities: A detailed economic assessment was prepared, comparing - over time - the costs and benefits of conventional methods vs. SIT for control vs. SIT for eradication of Medfly in the region. Expertise and training on all aspects of insect pest management relevant to the area-wide application of Medfly SIT was made available. The use of traps baited with Medfly female attractants was introduced to systematically monitor together with fruit sampling, Medfly populations. Sterile male Medflies (TSL-strain) are purchased from Guatemala (the TSL strain) and shipped weekly to a release centre that has been established in the Jordan valley.

Results / Status: Area-wide SIT has been confirmed as economically attractive alternative to conventional intervention, both for control and eradication of Medfly in the area. Initial test shipments and releases resulted in some refinements of transport and quality control procedures, and the releases are now conducted on a routine basis on both sides of the border. A chilled-fly release system is being employed to dispense the flies from the air over the desert oases. Wild populations have been drastically decreased and eradication is expected in 2000. In the next phase of the project, the sterile release areas will be expanded to include adjacent areas in Israel, Jordan and Gaza. Representatives from all three entities have signed joint communiques expressing their interest to co-operate in area-wide efforts to control the Medfly using SIT.

Counterparts: Citrus Marketing Board of Israel, Israel Cohen Institute for Biological Control, P.O.Box 80, Bet Dagan 50250, Israel. Tel.: 972-3-9683817. Fax: 972-3-9683838.

Ministry of Energy and Mineral Resources, P.O.Box 140027, Amman, Jordan. Tel.: 962 6 815615. Tel.: 00962 6 863326 Fax: 00962 6 5865714.
Internet: http://www.nic.gov.jo/memr/memr.html

Ministry of Agriculture for the Territories under the Jurisdiction of the Palestinian Authority, P. O. Box 4014, Gaza.

7. Mediterranean and Natal fruit flies, Western Cape, South Africa [1997, continuing] SAF/5/002

Problem: The Western Cape region of South Africa is an important producer and exporter of temperate fruit. In view of increasing rejections of fresh fruit shipments due to fruit fly presence and insecticide residues, as well as progress made by major competitors (Chile, Argentina and Australia) toward developing fly free areas, there is concern that South Africa’s fruit industry may loose their market share in the future.

Objective: To carry out an economic feasibility study of implementing fruit fly SIT, to transfer SIT technology to the Agricultural Research Council and to implement a pilot SIT project in the table-grape exporting Hex River Valley.

Activities: Staff and growers have been trained, a workshop and training course were held, a cost-benefit study and a business plan have been prepared, a mass rearing laboratory is being equipped, and field surveys have been initiated in the Hex River Valley.

Results / Status: Most aspects of the feasibility studies have been completed and major preparations are under way, with the participation of growers and agricultural authorities, to initiate in September 1999 an SIT pilot test in the Hex River Valley.

Counterpart: Agricultural Research Council, Stellenbosch Inst. for Fruit Technology (INFRUITEC), Private Bag X5013, Stellenbosch, Cape Province 7599, South Africa. Tel.: 0027 21 8839090. Fax: 0027 21 8838669. Email: brian@infruit.agric.za

The data below lists all technical co-operation projects by region approved during the period 1990-1999 together with the amounts allocated. Project title in italic denotes a completed project.

Title	**Project no.**	**Allocation in US$**
Latin America		
Bi-national project Chile-Peru: Eradication of the fruit fly	RLA/5/039	468,000
Fruit fly eradication in the South Region	ARG/5/005	1,700,000
Control of fruit fly using the SIT	*ARG/5/004*	*146,000*
Mediterranean fruit fly eradication	*CHI/5/015*	*348,000*
Medfly research laboratory	*COS/5/012*	*148,000*
Control of the fruit fly	*ECU/5/013*	*84,000*
Control of the Mediterranean fruit fly	*GUA/5/007*	*227,000*
Genetic sexing to control the medfly	*GUA/5/013*	*104,000*
West Asia		
Feasibility study of SIT for medfly eradication	ISR/5/009	706,000
Feasibility of area-wide control of medfly by SIT	JOR/5/007	378,000
SIT to control fruit tree pests	LEB/5/013	327,000
Area-wide application of SIT for medfly control	PAL/5/002	107,000
Africa		
Feasibility assessment for fruit fly eradication using SIT	SAF/5/002	520,000
Insect control by sterile insect technique	*MAR/5/005*	*58,000*
Survey of the extent of medfly infestation (ALG,LYB,MOR,TUN)	*RAF/5/013*	*859,000*
East Asia and Pacific		
Integrated control of Oriental fruit fly on Guimaras Island	PHI/5/026	198,000
Extension of areas under integrated fruit fly control	THA/5/044	284,000

Insect pest management by genetic manipulation	*BGD/5/016*	*78,000*
Sterile insect Technique	*PAK/5/018*	*195,000*
Integrated Management of fruit fly	*PAK/5/027*	*58,000*
Feasibility study of integrated control of fruit flies	*PHI/5/022*	*432,000*
Integrated control of fruit flies	*THA/5/038*	*390,000*

Europe

Control of the Mediterranean fruit fly in Crete	GRE/5/018	152,000
Mediterranean Fruit Fly Programme on Madeira	POR/5/005	490,000
Feasibility study for the construction/operation of mass rearing insect facility in Slovakia	SLR/5/002	71,000

C - Evaluation

In January 1999, an external review team conducted under the IAEA Programme Performance Assessment System (PPAS) an evaluation of sub-programme D4: Insect and Pest Control. One of the main outputs of this sub-programme is to provide technical support that enables technology transfer and implementation of field operations under technical co-operation projects. The following relevant recommendations were made:

1. FAO and IAEA should fully recognize and support the potential role that area-wide insect pest management using radiation-induced sterility can have for the effective and efficient management of particular crops and livestock pests.
2. The high relative value of Technical Co-operation funding in the sub-programme should be maintained to provide demand driven field development and implementation activities.
3. Legal mechanisms should be developed to overcome problems which prevent receiving additional funds from outside sources to provide contracted research and development services which would complement the existing work plan within the sub-programme.
4. Staff, resources, and budgets for insect pest control projects within the Joint Division and Agriculture and Biotechnology Laboratory should be in proportion to their high priority and expectations.
5. Insect pest projects, particularly eradication and maintenance of pest-free zones, should be seen through to completion, with agreed milestones so that continuation can be decided on predetermined criteria.
6. To enhance normative and promotional activities:
   a - contract external development of methods for economic and environmental analysis of SIT;
   b - contract external studies on economic feasibility and socio-economic and environmental impact to demonstrate actual and potential impact, to support Member

State demand and to attract additional external funding;

c - internally develop measures of quality assessment in SIT components (such as sterile insect competitiveness, genetic markers).

7. Priorities for the research and development activities should be changed:

   a - increase tsetse R&D effort on diet, sterile fly-target population dynamics and interactions, genetics and rearing facility management;

   b - decrease Medfly related R&D, but retain backstopping capability for Member States programmes, molecular genetic research and a source of genetic material;

   c - initiate research on other economically important fruit fly species (e.g., *Anastrepha* or *Bactrocera* spp).

D - Annexes

The Medium term strategy and pest analysis for the Insect and Pest Control sub-programme as prepared for the PPAS review.

Membership status for FAO,IPPC,WTO

Member States of the IAEA

Criteria for Successful SIT

W. Butt 1973

- **Efficient mass-rearing**
- **Effective sterilization methods**
- **Quality control in rearing, sterilisation & release**
- **Effective release methods**
- **Effective method for monitoring target pest**
- **Low native insect population**
- **Effective means of reducing localised wild populations**
- **Reasonably isolated release area**
- **Knowledge of ecology & biology of target pest**
- **Effective organisational structure with adequate funds & trained personnel**
- **Area-wide control concept accepted by organisation**

Annex E - List of Quarantine Species and Countries

LIST OF COUNTRIES WITH QUARANTINES AGAINST SPECIFIC FRUIT FLIES OR ALL FRUIT FLIES[1]

COUNTRY	Medfly	*Dacus* sp. or *Bactrocera* sp.[2]	Melon Fly	*Anastrepha* sp.[3]	*Rhagoletis* sp.[4]	All Fruit Flies
American Samoa	X	X				
Argentina	X			X		
Australia						X
Austria	X				X	X
Barbados						X
Bermuda						X
Bolivia	X					
Brazil		X		X		
British Virgin Islands	X					
Brunei						X
Bulgaria	X					
Canada					X	
Cayman Islands	X	X				
Ceylon	X					
Chile	X	X	X	X		
China	X	X				
Cook Islands		X				X
Costa Rica	X			X		
Cuba	X					
Denmark	X				X	
Dominican Rep.	X	X				
El Salvador	X	X				
Fiji	X					
Finland	X					X
France	X				X	
Germany	X[7]	X		X	X	
Great Britain	X	X	X	X	X	
Grenada	X					
Guatemala	X					
Haiti	X					
Hungary	X				X	
Italy		X		X	X	
Inter-African Group		X		X		

COUNTRY	Medfly	*Dacus* sp. or *Bactrocera* sp.[2]	Melon Fly	*Anastrepha* sp.[3]	*Rhagoletis* sp.[4]	All Fruit Flies
Jamaica	X					
Japan	X	X		X		
Jersey					X	
Jordan		X				
Korea, Rep. of	X	X	X			
Malta						X[5]
Mauritius		X		X	X	
Mexico		X	X	X		
Netherlands	X				X	
New Zealand		X			X	X
Nigeria		X		X		
Northern Ireland					X	
Panama	X					
Papua New Guinea						X
Philippines	X			X		
Poland	X			X		
Romania	X					
Senegal		X				
South Africa		X		X		
Spain	X	X		X	X	
Sweden	X[6]				X	
Syria	X	X				
Taiwan	X				X	
Tonga	X					X
Trinidad and Tobago	X	X				
Turkey		X	X	X	X	
USSR	X	X			X	
Venezuela	X					
Viet Nam	X					
Yugoslavia	X	X	X	X		

Footnotes to Table:
[1] Data from USDA Export Certification Manual.
[2] Includes guava, melon, Oriental peach fruit flies.
[3] Includes Caribbean and Mexican fruit fly.
[4] Includes apple maggot and eastern cherry fruit fly.
[5] Except Mediterranean fruit fly.
[6] Fruit with low level infestations of Mediterranean fruit fly is allowed in.
[7] Fruit infested with Mediterranean fruit fly is allowed tin between November and March if it is substantially free of maggots.

Source: Final Programmatic Environmental Impact Report. The Exotic Fruit Fly Eradication Program Utilizing Male Annihilation and Allied Methods. California Department of Food and Agriculture (1993)

Annex F - List of Fruit Flies Subject to Control Action in the USA

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
***Anastrepha* spp.**			
Anastrepha antunesi		Costa Rica, Panama, Brazil, Peru, Venezuela	Common guava, hog plum
Anastrepha bistrigata		Brazil	Common guava
Anastrepha distincta	Inga fruit fly	Costa Rica, Guatemala, Mexico, Panama, Brazil, Guyana, Columbia, Peru, Venezuela	Mango, star-apple
Anastrepha fraterculus biotype: Mexican South American	South American fruit fly	Central America, South America	Citrus, common guava, apple, mango, pear, peach, tropical fruits & nuts
Anastrepha grandis	South American cucurbit fruit fly	Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay, Peru, Venezuela	Cucumber, pumpkin, watermelon
Anastrepha leptozona		Guatemala, Mexico, Panama, Bolivia, Belize, Guyana, Venezuela	Star-apple, Sapotaceae
Anastrepha ludens	Mexican fruit fly	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Texas	Citrus, mango, peach, apple, avocado
Anastrepha macrura		Argentina, Brazil, Paraguay, Venezuela	Sapotaceae
Anastrepha obliqua	West Indian fruit fly, Antillean fruit fly	Central and South America, West Indies	Mango, citrus, pear, tropical fruits & nuts
Anastrepha ornata		Ecuador	Common guava, pear
Anastrepha pseudoparallela		Argentina, Brazil, Peru	Passion fruit, mango
Anastrepha serpentina	Sapote fruit fly, Serpentine fruit fly	Costa Rica, Guatemala, Mexico, Panama, South America, Dominica, Trinidad	Citrus, apple, avocado, tropical fruits
Anastrepha sororcula		Brazil	Common guava
Anastrepha striata	Guava fruit fly	Central and South America, Trinidad	Common guava, mango, citrus, avocado, tropical fruits
Anastrepha suspensa	Caribbean fruit fly, Carib fly	Florida, Puerto Rico, Bahamas, Cuba, Dominican Republic, Haiti, Jamaica	Citrus, apple, guava, loquat, Suriname cherry, tropical fruits & nuts
Bactrocera spp.			
Bactrocera albistrigata		Indonesia, Malaysia, Thailand	Syzygium spp., tropical almond

Annex F, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Bactrocera aquilonis		Australia	Apple, mango, avocado, citrus, peach, tropical fruits
Bactrocera atrisetosa		Papua New Guinea	Cucumber, pumpkin, tomato, watermelon
Bactrocera carambolae	Carambola fly	French Guiana, Suriname, Brazil, Indonesia, Malaysia, Thailand	Carambola, mango, chili pepper, banana, tropical fruit
Bactrocera caryeae		Southern India	Citrus, common guava, mango
Bactrocera caudata		Oriental Asia	Pumpkin, cucumbers, gourds
Bactrocera correcta	Guava fruit fly	India, Nepal, Pakistan, Sri Lanka, Thailand	Citrus, mango, common guava
Bactrocera cucumis	Cucumber fruit fly	Australia	Cucurbits, tomato, papaya
Bactrocera cucurbitae	Melon fly, melon fruit fly	New Guinea area, Oriental Asia	Cucurbit crops, avocado, papaya, peach, citrus
Bactrocera curvipennis		New Caledonia, Vanuatu	Citrus
Bactrocera decipiens		New Britain	Pumpkin, cucurbits
Bactrocera depressa		Japan, Taiwan	Pumpkin, cucurbits
Bactrocera distincta		American and Western Samoa, Fiji, Tonga	Breadfruit, star-apple
Bactrocera diversa		China, India, Sri Lanka, Thailand	Cucurbits, pumpkin, gourd
Bactrocera dorsalis	Oriental fruit fly	Guam, Hawaii, Bhutan, China, India, Myanmar, Thailand	Apple, mango, pear, peach, banana, papaya, tomato, citrus, tropical fruits
Bactrocera facialis		Tonga	Avocado, citrus, mango, peach, pepper, tomato, tropical fruit
Bactrocera frauenfeldi		Queensland, New Guinea area, South Pacific	Common guava, tropical almond, mango
Bactrocera jarvisi		Australia	Common guava, mango, pear, peach, papaya, citrus, banana
Bactrocera kirki		South Pacific	Citrus, mango, peach, pineapple, peppers, tropical fruit

Annex F, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Bactrocera latifrons	Solanum fruit fly	China, India, Laos, Malaysia, Pakistan, Sri Lanka, Taiwan, Thailand	Solanaceous crops, eggplant, tomato
Bactrocera melanota		Cook Islands	Citrus, mango, common guava
Bactrocera minax	Chinese citrus fly	Bhutan, China, India	Citrus
Bactrocera musae	Banana fruit fly	Australia, New Guinea area	Banana, common guava
Bactrocera neohumeralis		Australia, Papua New Guinea	Apple, citrus, mango, peach, raspberry, plum, tomato, tropical fruit
Bactrocera occipitalis		Philippines	Mango
Bactrocera oleae	Olive fruit fly	Mediterranean Africa	Olive
Bactrocera papayae		Thailand, Malaysia, Indonesia, Singapore	Guava, mango, citrus, starfruit
Bactrocera passiflorae	Fijian fruit fly	Fiji, Niue Island, Tonga	Avocado, cocoa citrus, mango, papaya
Bactrocera philippiensis		Philippines	Papaya, mango, other tropical fruit
Bactrocera psidi		New Caledonia	Citrus, common guava, mango
Bactrocera pyrifoliae		North Thailand	Guava, peach
Bactrocera tau		Oriental Asia	Cucurbits
Bactrocera trivialis		Torres Strait Islands, Indonesia, Papua New Guinea	Common guava, peach, pepper, citrus
Bactrocera tryoni	Queensland fruit fly	Australia	Apple, avocado, berries, grape, citrus, papaya, peach, pear, pepper, tomato, tropical fruit
Bactrocera tsuneonis	Japanese orange fly	China, Japan	Citrus
Bactrocera tuberculata		Myanmar, Thailand, Vietnam	Peach, mango
Bactrocera umbrosa		New Guinea area, Oriental Asia, South Pacific	Breadfruit
Bactrocera xanthodes		South Pacific	Bell pepper, papaya, pineapple, tomato, watermelon, common guava
Bactrocera zonata	Peach fruit fly	India, Indonesia, Laos, Sri Lanka, Thailand, Vietnam	Peach, apple, papaya, citrus, common guava

Annex F, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
***Ceratitis* spp.**			
Ceratitis anonae		Africa	Mango, coffee, tropical almond, avocado, guava
Ceratitis capitata	Mediterranean fruit fly	Africa, Australia, Mediterranean Europe, Middle East, Central and South America, Hawaii	Tropical and temperate fruits and nuts
Ceratitis catoarii	Mascarene fruit fly	Mauritius, Reunion, Seychelles	Avocado, peppers, mango, peach, tomato, other tropical fruits
Ceratitis colae		Cameroun, Ghana, Cote d'Ivoire, Nigeria, Sierra Leone, Zaire	Cola
Ceratitis cosyra	Mango fruit fly, Marula fruit fly, Marula fly	Africa	Mango, sour orange guava, avocado, peaches
Ceratitis malgassa	Madagascan fruit fly	Madagascar	Citrus, common guava
Ceratitis pedestris	Strychnos fruit fly	Angola, South Africa, Zambia, Zimbabwe	Tomato
Ceratitis punctata		Africa	Cocoa, tropical fruits
Ceratitis quinaria	Five spotted fruit fly, Rhodesian fruit fly, Zimbabwean fruit fly	Africa, Yemen	Apricot, citrus, guava, peach
Ceratitis rosa	Natal fruit fly, natal fly	Africa	Apple, common guava, pear, papaya, mango, peach, citrus, grape
Ceratitis rubivora	Blackberry fruit fly	Cameroun, Kenya, Malawi, South Africa, Uganda, Zimbabwe	Rubus spp.
***Dacus* spp.**			
Dacus axanus		Australia, New Guinea area	Cucurbits
Dacus bivittatus	Pumpkin fly, greater pumpkin fly, two-spotted pumpkin fly	Central and southern Africa	Melons, cucumbers, squash, pumpkin
Dacus ciliatus	Ethiopian fruit fly, lesser pumpkin fly, cucurbit fly	Africa, Middle East, Indian Ocean, Oriental Asia	Melons, cucumber, squash, pumpkin
Dacus demmerezi		Madagascar, Mauritius, Reunion	Cucumber, pumpkin, watermelon
Dacus frontalis		Africa, Cape Verde Islands, Saudi Arabia, Yemen, Arab Republic	Cucumber, pumpkin, melons
Dacus lownsburyii		Angola, South Africa, Zimbabwe	Cucurbits

Annex F, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Dacus punctatifrons		Central and southern Africa	Cucurbits
Dacus smiroides		Brunei, Indonesia, Malaysia	Cucurbits
Dacus solomonensis		New Guinea area	Cucumber, pumpkin
Dacus telfaireae		Kenya, Malawi, Tanzania, Zimbabwe	Cucurbits
Dacus vertebratus	Jointed pumpkin fly, melon fly	Africa, Madagascar, Saudi Arabia, Yemen, Arab Republic	Melons, cucumber, squash
***Rhagoletis* spp.**			
Rhagoletis cerasi	European cherry fruit fly	Europe	Cherries
Rhagoletis conversa		Chile	Solanaceous crops
Rhagoletis lycopersella		Peru	Tomato
Rhagoletis nova		Chile	Pepino
Rhagoletis pomonella	Apple maggot fly	Eastern and Western U.S.	Apple, sour cherry, peach
Rhagoletis tomatis		Chile, S Peru	Tomato
***Toxotrypana* sp.**			
Toxotrypana curvicauda	Papaya fruit fly	Costa Rica, Guatemala, Mexico, Panama, Brazil, Columbia, West Indies	Papaya

This list is based on current available information and does not identify all fruit fly species present in, or of concern to, the United States. Regulatory decisions for a specific commodity will be based on a complete risk analysis that considers the commodity or host (species and variety), known pests and their distribution, origin of host material, and all other factors affecting risk.

Source: Fruit Fly Cooperative Control Program, Draft Environmental Impact Statement 1999, USDA

Annex G - List of Pests Responding to Methyl Eugenol and Cuelure

SPECIES THAT DO NOT RESPOND TO KNOWN ATTRACTANTS

Bactrocera (Afrodacus) montyanus (Munro)
Bactrocera (Austrodacus) cucumis (French)
Bactrocera (Bactrocera) arecae (Hardy and Adachi)
Bactrocera (Bactrocera) barringtoniae (Tryon)[1]
Bactrocera (Bactrocera) halfordiae (Tryon)
Bactrocera (Bactrocera) latifrons (Hendel)
Bactrocera (Bactrocera) quadrisetosa (Bezzi)
Bactrocera (Bactrocera) samoae Drew
Bactrocera (Bulladacus) aenigmatica (Malloch)
Bactrocera (Bulladacus) bullata Drew
Bactrocera (Bulladacus) bullifera (Hardy)
Bactrocera (Bulladacus) eximia Drew
Bactrocera (Bulladacus) gnetum Drew and Hancock
Bactrocera (Bulladacus) mcgregori (Bezzi)
Bactrocera (Bulladacus) neotigrina Drew & Hancock
Bactrocera (Bulladacus) penefurva Drew
Bactrocera (Bulladacus) peterseni (Hardy)
Bactrocera (Bulladacus) tigrina (May)
Bactrocera (Daculus) olea (Rossi)
Bactrocera (Gymnodacus) calophylli (Perkins and May)
Bactrocera (Paradacus) decipiens (Drew)
Bactrocera (Paratridacus) expandens (Walker)
Bactrocera (Paratridacus) garciniae (Bezzi)
Bactrocera (Tetradacus) minax (Enderlein)
Bactrocera (Tetradacus) tsuneonis (Miyake)
Bactrocera (Zeugodacus) depressa (Shiraki)
Dacus (Didacus) amphoratus (Munro)
Dacus (Didacus) binotatus Loew[2]
Dacus (Didacus) botianus (Munro)
Dacus (Didacus) brevis Coquillett
Dacus (Didacus) ciliatus Loew
Dacus (Didacus) plagiatus Collart
Dacus (Didacus) umbeluzinus (Munro)

[1] Records of cuelure attraction in error
[2] Needs confirmation.

SPECIES THAT RESPOND TO CUELURE - 1 of 3

Bactrocera (Afrodacus) hypomelaina Drew
Bactrocera (Afrodacus) jarvisi (Tryon)
*Bactrocera (Afrodacus) minuta (*Drew*)*
Bactrocera (Afrodacus) ochracea Drew
Bactrocera (Asiadacus) apicalis (Meijere)
Bactrocera (Asiadacus) maculifacies (Hardy)
Bactrocera (Asiadacus) melanopsis (Hardy)
Bactrocera (Bactrocera) abdonigella (Drew)
Bactrocera (Bactrocera) abscondita (Drew & Hancock)
Bactrocera (Bactrocera) abundans Drew
Bactrocera (Bactrocera) aemula Drew
Bactrocera (Bactrocera) aeroginosa (Drew & Hancock)
Bactrocera (Bactrocera) affinidorsalis (Hardy)
Bactrocera (Bactrocera) albistrigata (Meijere)
Bactrocera (Bactrocera) allwoodi (Drew)
Bactrocera (Bactrocera) alyxiae(May)
Bactrocera (Bactrocera) ampla (Drew)
Bactrocera (Bactrocera) andamanensis (Kapoor)
Bactrocera (Bactrocera) anfracta Drew
Bactrocera (Bactrocera) anomala (Drew)
Bactrocera (Bactrocera) anthracina (Drew)
Bactrocera (Bactrocera) antigone (Drew & Hancock)
Bactrocera (Bactrocera) aquilonis (May)
Bactrocera (Bactrocera) assita Drew
Bactrocera (Bactrocera) aterrima (Drew)
Bactrocera (Bactrocera) atriliniellata Drew
Bactrocera (Bactrocera) aurantiaca (Drew & Hancock)
Bactrocera (Bactrocera) beckerae (Hardy)
Bactrocera (Bactrocera) bimaculata Drew & Hancock
Bactrocera (Bactrocera) breviaculeus (Hardy)
Bactrocera (Bactrocera) brevistriata (Drew)
Bactrocera (Bactrocera) bryoniae (Tryon)
Bactrocera (Bactrocera) caledoniensis Drew
Bactrocera (Bactrocera) carbonaria (Hendel)[1]
Bactrocera (Bactrocera) cibodasae Drew & Hancock
Bactrocera (Bactrocera) cinnamea Drew
Bactrocera (Bactrocera) circamusae Drew
Bactrocera (Bactrocera) cognata (Hardy & Adachi)
Bactrocera (Bactrocera) congener Drew
Bactrocera (Bactrocera) curreyi Drew
Bactrocera (Bactrocera) curvipennis (Froggatt)
*Bactrocera (Bactrocera) decumana (*Drew*)*
Bactrocera (Bactrocera) distincta (Malloch)
Bactrocera (Bactrocera) dyscrita (Drew)
Bactrocera (Bactrocera) enochra (Drew)
Bactrocera (Bactrocera) epicharis (Hardy)
Bactrocera (Bactrocera) erubescentis (Drew &Hancock)
Bactrocera (Bactrocera) facialis (Coquillett)
Bactrocera (Bactrocera) fagraea (Tryon)
Bactrocera (Bactrocera) frauenfeldi (Schiner)
Bactrocera (Bactrocera) fuliginus (Drew & Hancock)
Bactrocera (Bactrocera) fulvicauda (Perkins)
Bactrocera (Bactrocera) fulvifemur Drew & Hancock
Bactrocera (Bactrocera) furfurosa Drew
Bactrocera (Bactrocera) furvescens Drew
Bactrocera (Bactrocera) furvilineata Drew
Bactrocera (Bactrocera) fuscitibia Drew & Hancock
Bactrocera (Bactrocera) gombokensis Drew & Hancock
Bactrocera (Bactrocera) holtmanni (Hardy)
Bactrocera (Bactrocera) inconstans Drew
Bactrocera (Bactrocera) indecora (Drew)
Bactrocera (Bactrocera) kinabalu Drew & Hancock
Bactrocera (Bactrocera) kirki (Froggatt)
Bactrocera (Bactrocera) kraussi (Hardy)
Bactrocera (Bactrocera) lata (Perkins)
Bactrocera (Bactrocera) lateritaenia Drew & Hancock

SPECIES THAT RESPOND TO CUELURE (continued - 2 of 3)

Bactrocera (Bactrocera) laticosta Drew
Bactrocera (Bactrocera) latissima Drew
Bactrocera (Bactrocera) limbifera (Bezzi)
Bactrocera (Bactrocera) lineata (Perkins)
Bactrocera (Bactrocera) lombokensis Drew & Hancock
Bactrocera (Bactrocera) longicornis Macquart
Bactrocera (Bactrocera) luzonae (Hardy & Adachi)
Bactrocera (Bactrocera) makilingensis Drew & Hancock
Bactrocera (Bactrocera) malaysiensis Drew & Hancock
Bactrocera (Bactrocera) manskii (Perkins & May)
Bactrocera (Bactrocera) melanotus (Coquillett)
Bactrocera (Bactrocera) melastomatos Drew & Hancock
Bactrocera (Bactrocera) merapiensis Drew & Hancock
Bactrocera (Bactrocera) moluccensis (Perkins)
Bactrocera (Bactrocera) morobiensis Drew
Bactrocera (Bactrocera) morula Drew
Bactrocera (Bactrocera) mucronis (Drew)
Bactrocera (Bactrocera) mulyonoi (Hardy)
Bactrocera (Bactrocera) neocognata Drew & Hancock
Bactrocera (Bactrocera) neohumeralis (Hardy)
Bactrocera (Bactrocera) nigrescentis (Drew)
Bactrocera (Bactrocera) nigrotibialis (Perkins)
Bactrocera (Bactrocera) obfuscata Drew
Bactrocera (Bactrocera) oblineata Drew
Bactrocera (Bactrocera) obscura (Malloch)
Bactrocera (Bactrocera) parafrauenfeldi Drew
Bactrocera (Bactrocera) paramusae Drew
Bactrocera (Bactrocera) passiflorae (Froggatt)
Bactrocera (Bactrocera) pedestris (Bezzi)
Bactrocera (Bactrocera) penecognata Drew & Hancock
Bactrocera (Bactrocera) peninsularis (Drew & Hancock)
Bactrocera (Bactrocera) perkinsi (Drew & Hancock)
Bactrocera (Bactrocera) phaea (Drew)
Bactrocera (Bactrocera) pisinna Drew
Bactrocera (Bactrocera) propinqua (Hardy & Adachi)
Bactrocera (Bactrocera) pseudocucurbitae White
Bactrocera (Bactrocera) pseudodistincta (Drew)
Bactrocera (Bactrocera) psidii (Froggatt)
Bactrocera (Bactrocera) pusilla (Hardy)
Bactrocera (Bactrocera) quadrata (May)
Bactrocera (Bactrocera) quasisilvicola Drew
Bactrocera (Bactrocera) recurrens (Hering)
Bactrocera (Bactrocera) redunca (Drew)
Bactrocera (Bactrocera) rhabdota Drew
Bactrocera (Bactrocera) robertsi Drew
Bactrocera (Bactrocera) robiginosa (May)
Bactrocera (Bactrocera) rubigina (Wang and Zhao)
Bactrocera (Bactrocera) rufescens (May)
Bactrocera (Bactrocera) rufofuscula (Drew & Hancock)
Bactrocera (Bactrocera) rufula (Hardy)
Bactrocera (Bactrocera) russeola (Drew & Hancock)
Bactrocera (Bactrocera) sembaliensis Drew & Hancock
Bactrocera (Bactrocera) silvicola (May)
Bactrocera (Bactrocera) simulata (Malloch)
Bactrocera (Bactrocera) sumbawaensis Drew & Hancock
Bactrocera (Bactrocera) thistletoni Drew
Bactrocera (Bactrocera) tinomiscii Drew
Bactrocera (Bactrocera) trifaria (Drew)
Bactrocera (Bactrocera) trifasciata (Hardy)
Bactrocera (Bactrocera) trilineola Drew
Bactrocera (Bactrocera) trivialis (Drew)
Bactrocera (Bactrocera) tryoni (Froggatt)
Bactrocera (Bactrocera) turneri Drew
Bactrocera (Bactrocera) unifasciata (Malloch)
Bactrocera (Bactrocera) unilineata Drew
Bactrocera (Bactrocera) usitata Drew & Hancock
Bactrocera (Bactrocera) ustulata Drew
Bactrocera (Bactrocera) varipes (Malloch)
Bactrocera (Bactrocera) vishnu Drew & Hancock
Bactrocera (Bactrocera) vulgaris (Drew)
Bactrocera (Gymnodacus) petila Drew
Bactrocera (Javadacus) scutellaria (Bezzi)
Bactrocera (Javadacus) trilineata (Hardy)
Bactrocera (Niuginidacus) singularis Drew
Bactrocera (Papuodacus) neopallescentis Drew
Bactrocera (Paradacus) abdopallescens (Drew)
Bactrocera (Paradacus) angustifinis (Hardy)
Bactrocera (Paradacus) aurantiventer Drew
Bactrocera (Paradacus) citroides Drew
Bactrocera (Paradacus) longicaudata (Perkins)[2]
Bactrocera (Semicallantra) aquila Drew
Bactrocera (Sinodacus) angusticostata Drew
Bactrocera (Sinodacus) buvittata Drew
Bactrocera (Sinodacus) chonglui (Chao & Lin)
Bactrocera (Sinodacus) hochii (Zia)
Bactrocera (Sinodacus) infesta (Enderlein)
Bactrocera (Sinodacus) paulula Drew
Bactrocera (Sinodacus) perpusilla (Drew)
Bactrocera (Sinodacus) qiongana (Chao & Lin)
Bactrocera (Sinodacus) quaterna (Wang)
Bactrocera (Sinodacus) salamander (Drew & Hancock)
Bactrocera (Sinodacus) strigifinis (Walker)
Bactrocera (Sinodacus) surrufula Drew
Bactrocera (Sinodacus) transversa (Hardy)
Bactrocera (Sinodacus) triangularis (Drew)
Bactrocera (Sinodacus) univittata (Drew)
Bactrocera (Zeugodacus) abdoangusta (Drew)
Bactrocera (Zeugodacus) abnormis (Hardy)
Bactrocera (Zeugodacus) amoena (Drew)
Bactrocera (Zeugodacus) atrifacies (Perkins)
Bactrocera (Zeugodacus) bogorensis (Hardy)
Bactrocera (Zeugodacus) brachus (Drew)
Bactrocera (Zeugodacus) caudata (Fabricius)
Bactrocera (Zeugodacus) chorista (May)
Bactrocera (Zeugodacus) cilifera (Hendel)
Bactrocera (Zeugodacus) cucurbitae (Coquillett)
Bactrocera (Zeugodacus) curta (Drew)
Bactrocera (Zeugodacus) daula Drew
Bactrocera (Zeugodacus) diaphora (Hendel)
Bactrocera (Zeugodacus) dubiosa (Hardy)
Bactrocera (Zeugodacus) elegantula (Hardy)
Bactrocera (Zeugodacus) emittens (Walker)
Bactrocera (Zeugodacus) fallacis (Drew)
Bactrocera (Zeugodacus) gracilis (Drew)
Bactrocera (Zeugodacus) heinrichi (Hering)
Bactrocera (Zeugodacus) incisa (Walker)
Bactrocera (Zeugodacus) ishigakiensis (Shiraki)
Bactrocera (Zeugodacus) isolata (Hardy)
Bactrocera (Zeugodacus) macrovittata Drew

SPECIES THAT RESPOND TO CUELURE (continued - 3 of 3)

Bactrocera (Zeugodacus) persignata (Hardy)
Bactrocera (Zeugodacus) reflexa (Drew)
Bactrocera (Zeugodacus) scutellaris (Bezzi)
Bactrocera (Zeugodacus) scutellata (Hendel)
Bactrocera (Zeugodacus) sicieni (Chao and Lin)
Bactrocera (Zeugodacus) synnephes (Hendel)[3]
Bactrocera (Zeugodacus) tau (Walker)
Bactrocera (Zeugodacus) trichota (May)
Bactrocera (Zeugodacus) vultus (Hardy)
Bactrocera (Zeugodacus) yoshimotoi (Hardy)[4]
Dacus (Callantra) ambonensis Drew & Hancock
Dacus (Callantra) axanus (Hering)
Dacus (Callantra) calirayae Drew & Hancock
Dacus (Callantra) capillaris (Drew)
Dacus (Callantra) discors (Drew)
Dacus (Callantra) formosanus (Tseng and Chu)
Dacus (Callantra) lagunae Drew & Hancock
Dacus (Callantra) leongi Drew & Hancock
Dacus (Callantra) longicornis (Wiedemann)
Dacus (Callantra) mayi (Drew)
Dacus (Callantra) nanggalae Drew & Hancock
Dacus (Callantra) ooii Drew & Hancock
Dacus (Callantra) ramanii Drew & Hancock
Dacus (Callantra) siamensis Drew & Hancock
Dacus (Callantra) solomonensis (Malloch)
Dacus (Callantra) sphaeroidalis (Bezzi)
Dacus (Callantra) tenebrosus Drew & Hancock
Dacus (Callantra) trimacula (Wang)
Dacus (Callantra) vijaysegarani Drew & Hancock
Dacus (Dacus) absonifacies (May)
Dacus (Dacus) alarifumidus Drew
Dacus (Dacus) badius Drew
Dacus (Dacus) bakingiliensis Hancock
Dacus (Dacus) bellulus Drew *and* Hancock
Dacus (Dacus) bivittatus (Bigot)
Dacus (Dacus) concolor Drew
Dacus (Dacus) demmerezi (Bezzi)
Dacus (Dacus) diastatus Munro
Dacus (Dacus) durbanensis Munro
Dacus (Dacus) eclipsus (Bezzi)
Dacus (Dacus) humeralis (Bezzi)
Dacus (Dacus) ikelenge Hancock
Dacus (Dacus) newmani (Perkins)
Dacus (Dacus) pecropsis Munro
Dacus (Dacus) pleuralis Collart[5]
Dacus (Dacus) punctatifrons Karsch
Dacus (Dacus) sakeji Hancock
Dacus (Dacus) santongae Drew & Hancock
Dacus (Dacus) secamoneae Drew
Dacus (Dacus) signatifrons (May)
Dacus (Dacus) telfaireae (Bezzi)
Dacus (Dacus) xanthopterus (Bezzi)
Dacus (Didacus) aequalis Coquillett
Dacus (Didacus) africanus Adams
Dacus (Didacus) chiwira Hancock
Dacus (Didacus) devure Hancock
Dacus (Didacus) dissimilis Drew
Dacus (Didacus) eminus Munro
Dacus (Didacus) famona Hancock
Dacus (Didacus) frontalis Becker
Dacus (Didacus) hardyi Drew
Dacus (Didacus) kariba Hancock
Dacus (Didacus) langi Curran
Dacus (Didacus) pallidilatus Munro
Dacus (Didacus) palmerensis Drew

---

[1] *B. atramentata* (Hering) is a synonym.
[2] *D. vinnulus* Hardy is a synonym.
[3] *D. ubiquitus* Hardy is a synonym.
[4] Needs confirmation.
[5] *D. masaicus* Munro is a synonym.

SPECIES ATTRACTED TO VERT-LURE (methy-p-hydroxybenzoate)

Dacus (Didacus) vertebratus Bezzi

SPECIES ATTRACTED TO METHYL EUGENOL - 1 of 2

Bactrocera (Apodacus) cheesmanae (Perkins)
Bactrocera (Apodacus) neocheesmanae Drew
Bactrocera (Apodacus) visenda (Hardy)
Bactrocera (Bactrocera) abdolonginqua (Drew)
Bactrocera (Bactrocera) aethriobasis (Hardy)
Bactrocera (Bactrocera) affinis (Hardy)
Bactrocera (Bactrocera) amplexiseta (May)
Bactrocera (Bactrocera) atrifemur Drew & Hancock
Bactrocera (Bactrocera) bancroftii (Tryon)
Bactrocera (Bactrocera) batemani Drew
Bactrocera (Bactrocera) biarcuata (Walker)
Bactrocera (Bactrocera) cacuminata (Hering)
Bactrocera (Bactrocera) carambolae Drew & Hancock
Bactrocera (Bactrocera) caryeae (Kapoor)
Bactrocera (Bactrocera) collita Drew & Hancock
Bactrocera (Bactrocera) confluens (Drew)
Bactrocera (Bactrocera) correcta (Bezzi)
Bactrocera (Bactrocera) curvifera (Walker)
Bactrocera (Bactrocera) dapsiles Drew
Bactrocera (Bactrocera) decurtans (May)
Bactrocera (Bactrocera) diallagma Drew[1]
Bactrocera (Bactrocera) diospyri Drew
Bactrocera (Bactrocera) dorsalis (Hendel)
Bactrocera (Bactrocera) ebenea (Drew)
Bactrocera (Bactrocera) endiandrae (Perkins and May)
Bactrocera (Bactrocera) floresiae Drew & Hancock
Bactrocera (Bactrocera) froggatti (Bezzi)
Bactrocera (Bactrocera) fuscalata Drew
Bactrocera (Bactrocera) honiarae Drew
Bactrocera (Bactrocera) humilis (Drew & Hancock)

SPECIES ATTRACTED TO METHYL EUGENOL - 2 of 2

Bactrocera (Bactrocera) impunctata (Meijere)
Bactrocera (Bactrocera) indonesiae Drew & Hancock
Bactrocera (Bactrocera) infulata Drew & Hancock
Bactrocera (Bactrocera) kandiensis Drew & Hancock
Bactrocera (Bactrocera) kelaena Drew
Bactrocera (Bactrocera) lampabilis (Drew)
Bactrocera (Bactrocera) laticaudus (Hardy)
Bactrocera (Bactrocera) latilineola Drew & Hancock
Bactrocera (Bactrocera) mayi (Hardy)
Bactrocera (Bactrocera) melanogaster Drew
Bactrocera (Bactrocera) mimulus Drew
Bactrocera (Bactrocera) minuscula Drew & Hancock
Bactrocera (Bactrocera) musae (Tryon)
Bactrocera (Bactrocera) neonigritus (Drew)
Bactrocera (Bactrocera) nigella (Drew)
Bactrocera (Bactrocera) nigrescens (Drew)
Bactrocera (Bactrocera) occipitalis (Bezzi)
Bactrocera (Bactrocera) ochromarginis (Drew)
Bactrocera (Bactrocera) ochromarginis (Drew)
Bactrocera (Bactrocera) opiliae (Drew & Hardy)
Bactrocera (Bactrocera) pallida (Perkins and May)
Bactrocera (Bactrocera) papayae Drew & Hancock
Bactrocera (Bactrocera) parabarringtoniae Drew & Hancock
Bactrocera (Bactrocera) pepisalae (Froggatt)
Bactrocera (Bactrocera) philippinensis Drew & Hancock
Bactrocera (Bactrocera) picea (Drew)
Bactrocera (Bactrocera) prolixa Drew
Bactrocera (Bactrocera) reclinata Drew
Bactrocera (Bactrocera) retrorsa Drew
Bactrocera (Bactrocera) ritsemai (Weyenbergh)
Bactrocera (Bactrocera) romigae (Drew & Hancock)
Bactrocera (Bactrocera) seguyi (Hering)
Bactrocera (Bactrocera) sulawesiae Drew & Hancock
Bactrocera (Bactrocera) tenuifascia (May)
Bactrocera (Bactrocera) tuberculata (Bezzi)
Bactrocera (Bactrocera) umbrosa (Fabricius)
Bactrocera (Bactrocera) unimacula Drew & Hancock
Bactrocera (Bactrocera) unistriata (Drew)
Bactrocera (Bactrocera) verbascifoliae Drew & Hancock
Bactrocera (Bactrocera) versicolor (Bezzi)
Bactrocera (Bactrocera) zonata (Saunders)
Bactrocera (Hemigymnodacus) diversa (Coquillett)
Bactrocera (Javadacus) melanothoracica Drew
Bactrocera (Javadacus) montana (Hardy)
Bactrocera (Javadacus) unirufa Drew
Bactrocera (Notodacus) xanthodes (Broun)
Bactrocera (Paratridacus) alampeta Drew
Bactrocera (Paratridacus) atrisetosa (Perkins)
Bactrocera (Semicallantra) memnonius Drew
Bactrocera (Trypetidacus) invisitata Drew
Bactrocera (Zeugodacus) pubescens (Bezzi)[2]
Dacus (Callantra) melanohumeralis Drew
Dacus (Callantra) pusillus (May)

---

[1] Questionable (see Drew et al 1999).
[2] Two records show it is attracted to ME, but still needs confirming as this is the only *Zeugodacus* to respond to it.

ATTRACTION TO LURES UNKNOWN - 1 of 4

Bactrocera (Afrodacus) biguttulus (Bezzi)
Bactrocera (Afrodacus) brunnea (Perkins and May)
Bactrocera (Afrodacus) grandistylus Drew & Hancock
Bactrocera (Afrodacus) lucidus (Munro)
Bactrocera (Afrodacus) menanus (Munro)
Bactrocera (Afrodacus) nigrivenatus (Munro)
Bactrocera (Asiadacus) absoluta (Walker)
Bactrocera (Asiadacus) atypica White & Evenhuis
Bactrocera (Asiadacus) brachycera (Bezzi)
Bactrocera (Bactrocera) abdofuscata (Drew)
Bactrocera (Bactrocera) absidata Drew
Bactrocera (Bactrocera) aithogaster Drew
Bactrocera (Bactrocera) angustifasciata Drew
Bactrocera (Bactrocera) armillata (Hering)
Bactrocera (Bactrocera) atra (Malloch)
Bactrocera (Bactrocera) bidentata (May)
Bactrocera (Bactrocera) bifasciata (Hardy)
Bactrocera (Bactrocera) buinensis Drew
Bactrocera (Bactrocera) buloloensis Drew
Bactrocera (Bactrocera) caliginosa (Hardy)
Bactrocera (Bactrocera) citima (Hardy)
Bactrocera (Bactrocera) commina Drew
Bactrocera (Bactrocera) consectorata Drew
Bactrocera (Bactrocera) contermina Drew
Bactrocera (Bactrocera) contigua Drew
Bactrocera (Bactrocera) costalis (Shiraki)
Bactrocera (Bactrocera) daruensis Drew
Bactrocera (Bactrocera) diaphana (Hering)
Bactrocera (Bactrocera) dispar (Hardy)
Bactrocera (Bactrocera) dorsaloides (Hardy and Adachi)
Bactrocera (Bactrocera) enigmatica (Hardy)
Bactrocera (Bactrocera) exspoliata (Hering)
Bactrocera (Bactrocera) fergussoniensis Drew
Bactrocera (Bactrocera) finitima Drew
Bactrocera (Bactrocera) flavipennis (Hardy)
Bactrocera (Bactrocera) fuscohumeralis White & Evenhuis
Bactrocera (Bactrocera) grandifasciata White & Evenhuis
Bactrocera (Bactrocera) heppneri White
Bactrocera (Bactrocera) hispidula (May)
Bactrocera (Bactrocera) hyalina (Shiraki)
Bactrocera (Bactrocera) involuta (Hardy)
Bactrocera (Bactrocera) irvingiae Drew & Hancock
Bactrocera (Bactrocera) ismayi Drew
Bactrocera (Bactrocera) kanchanaburi Drew & Hancock
Bactrocera (Bactrocera) lacerata White & Evenhuis
Bactrocera (Bactrocera) latilineata Drew
Bactrocera (Bactrocera) luteola (Malloch)
Bactrocera (Bactrocera) maculigera Doleschall
Bactrocera (Bactrocera) megaspilus (Hardy)
Bactrocera (Bactrocera) mendosa (May)

ATTRACTION TO LURES UNKNOWN - 2 of 4

Bactrocera (Bactrocera) muiri (Hardy & Adachi)
Bactrocera (Bactrocera) murrayi (Perkins)
Bactrocera (Bactrocera) mutabilis (May)
Bactrocera (Bactrocera) neopropinqua Drew & Hancock
Bactrocera (Bactrocera) nesiotes (Munro)
Bactrocera (Bactrocera) nigroscutata White & Evenhuis
Bactrocera (Bactrocera) nigrovittata Drew
Bactrocera (Bactrocera) notatagena (May)
Bactrocera (Bactrocera) obliqua (Malloch)
Bactrocera (Bactrocera) obscurata (Meijere)
Bactrocera (Bactrocera) ochrosiae (Malloch)[1]
Bactrocera (Bactrocera) osbeckiae Drew & Hancock
Bactrocera (Bactrocera) pectoralis (Walker)
Bactrocera (Bactrocera) perfusca (Aubertin)
Bactrocera (Bactrocera) pernigra (Ito)
Bactrocera (Bactrocera) phaleriae (May)
Bactrocera (Bactrocera) popondettiensis Drew
Bactrocera (Bactrocera) propedistincta Drew
Bactrocera (Bactrocera) pulchra (Tryon)
Bactrocera (Bactrocera) pyrifoliae Drew & Hancock
Bactrocera (Bactrocera) quasipropinqua Drew & Hancock
Bactrocera (Bactrocera) raiensis Drew & Hancock
Bactrocera (Bactrocera) repanda Drew
Bactrocera (Bactrocera) resima (Drew)
Bactrocera (Bactrocera) rutila (Hering)
Bactrocera (Bactrocera) setinervis (Malloch)
Bactrocera (Bactrocera) strigata (Perkins)
Bactrocera (Bactrocera) terminaliae Drew
Bactrocera (Bactrocera) thailandica Drew & Hancock
Bactrocera (Bactrocera) tortuosa White & Evenhuis
Bactrocera (Bactrocera) toxopeusi (Hering)
Bactrocera (Bactrocera) venefica (Hering)
Bactrocera (Bulladacus) aceraglans White & Evenhuis
Bactrocera (Bulladacus) aceromata White & Evenhuis
Bactrocera (Bulladacus) obtrullata White & Evenhuis
Bactrocera (Bulladacus) warisensis White & Evenhuis
Bactrocera (Diplodacus) signatifera (Tryon)
Bactrocera (Gymnodacus) absona (Hering)
Bactrocera (Gymnodacus) amplexus (Munro)
Bactrocera (Gymnodacus) continua (Bezzi)
Bactrocera (Gymnodacus) hastigerina (Hardy)
Bactrocera (Gymnodacus) mesomelas (Bezzi)
Bactrocera (Gymnodacus) tillyardi (Perkins)
Bactrocera (Gymnodacus) unipunctata (Malloch)
Bactrocera (Heminotodacus) dissidens Drew
Bactrocera (Hemiparatridacus) abdoaurantiaca Drew
Bactrocera (Hemisurstylus) melanoscutata Drew
Bactrocera (Hemizeugodacus) abdomininigra Drew
Bactrocera (Hemizeugodacus) aglaiae (Hardy)
Bactrocera (Hemizeugodacus) arisanica (Shiraki)
Bactrocera (Hemizeugodacus) aurea (May)
Bactrocera (Hemizeugodacus) ektoalangiae Drew & Hancock
Bactrocera (Hemizeugodacus) tetrachaetus (Bezzi)
Bactrocera (Javadacus) aberrans (Hardy)
Bactrocera (Javadacus) javanensis (Perkins)
Bactrocera (Javadacus) maculifemur (Hering)
Bactrocera (Javadacus) nigrita (Hardy)
Bactrocera (Javadacus) pallescentis (Hardy)
Bactrocera (Melanodacus) nigra (Tryon)
Bactrocera (Melanodacus) satanellus (Hering)
Bactrocera (Melanodacus) terminifera (Walker)
Bactrocera (Nesodacus) atrichus (Bezzi)
Bactrocera (Notodacus) paraxanthodes Drew & Hancock
Bactrocera (Papuodacus) complicata White
Bactrocera (Paradacus) areolata (Walker)
Bactrocera (Paradacus) fulvipes (Perkins)
Bactrocera (Paradacus) magnicauda White & Evenhuis
Bactrocera (Paradacus) mindanaus (Bezzi)
Bactrocera (Paradacus) minima (Hering)
Bactrocera (Paradacus) perplexa (Walker)
Bactrocera (Paradacus) urens White
Bactrocera (Paratridacus) banneri White
Bactrocera (Paratridacus) coracina (Drew)
Bactrocera (Paratridacus) icelus (Hardy)
Bactrocera (Paratridacus) mesonotaitha Drew
Bactrocera (Parazeugodacus) abbreviata (Hardy)
Bactrocera (Parazeugodacus) bipustulata (Bezzi)
Bactrocera (Parazeugodacus) fulvifacies (Perkins)
Bactrocera (Parazeugodacus) matsumurai (Shiraki)
Bactrocera (Parazeugodacus) pendleburyi (Perkins)
Bactrocera (Queenslandacus) exigua (May)
Bactrocera (Semicallantra) nigricula Drew
Bactrocera (Sinodacus) emarginata (Perkins)
Bactrocera (Sinodacus) eurylomata (Hardy)
Bactrocera (Sinodacus) jiannana (Chao & Lin)
Bactrocera (Sinodacus) sepikae Drew
Bactrocera (Sinodacus) watersi (Hardy)
Bactrocera (Tetradacus) discipennis (Walker)
Bactrocera (Tetradacus) mesonotochra Drew
Bactrocera (Tetradacus) neopagdeni Drew
Bactrocera (Tetradacus) pagdeni (Malloch)
Bactrocera (Tetradacus) splendida (Perkins)
Bactrocera (Zeugodacus) ablepharus (Bezzi)
Bactrocera (Zeugodacus) ambigua (Shiraki)
Bactrocera (Zeugodacus) anchitrichota Drew
Bactrocera (Zeugodacus) assamensis White
Bactrocera (Zeugodacus) bezziana (Hering)
Bactrocera (Zeugodacus) biguttata (Bezzi)
Bactrocera (Zeugodacus) buruensis White
Bactrocera (Zeugodacus) calumniata (Hardy)
Bactrocera (Zeugodacus) connexa (Hardy)
Bactrocera (Zeugodacus) diaphoropsis (Hering)
Bactrocera (Zeugodacus) duplicata (Bezzi)
Bactrocera (Zeugodacus) exornata (Hering)
Bactrocera (Zeugodacus) flavipilosa (Hardy)
Bactrocera (Zeugodacus) flavopectoralis (Hering)
Bactrocera (Zeugodacus) freidbergi White
Bactrocera (Zeugodacus) fulvoabdominalis White & Evenhuis
Bactrocera (Zeugodacus) gavisa (Munro)
Bactrocera (Zeugodacus) hoedi White
Bactrocera (Zeugodacus) indentus (Hardy)
Bactrocera (Zeugodacus) lipsanus (Hendel)
Bactrocera (Zeugodacus) munda (Bezzi)
Bactrocera (Zeugodacus) neoelegantula White

Bactrocera (Zeugodacus) nigrifacies (Shiraki)
Bactrocera (Zeugodacus) okunii (Shiraki)
Bactrocera (Zeugodacus) platamus (Hardy)
Bactrocera (Zeugodacus) pura White
Bactrocera (Zeugodacus) rubella (Hardy)
Bactrocera (Zeugodacus) sandaracina Drew
Bactrocera (Zeugodacus) scutellina (Bezzi)
Bactrocera (Zeugodacus) signata (Hering)
Bactrocera (Zeugodacus) sumbensis (Hering)
Bactrocera (Zeugodacus) tappanus (Shiraki)
Bactrocera (Zeugodacus) timorensis (Perkins)
Bactrocera (Zeugodacus) trimaculata (Hardy)
Bactrocera (Zeugodacus) unilateralis Drew
Bactrocera (Zeugodacus) vargus (Hardy)
Dacus (Callantra) atrimarginatus White
Dacus (Callantra) axanthinus White & Evenhuis
Dacus (Callantra) bannatus (Wang)
Dacus (Callantra) bispinosa (Wang)
Dacus (Callantra) conopsoides (Meijere)
Dacus (Callantra) crabroniformis (Bezzi)
Dacus (Callantra) discophorus (Hering)
Dacus (Callantra) esakii (Shiraki)
Dacus (Callantra) feijeni White
Dacus (Callantra) icariiformis (Enderlein)
Dacus (Callantra) impar (Drew)
Dacus (Callantra) indecorus (Hardy)
Dacus (Callantra) infernus (Hardy)
Dacus (Callantra) insulosus Drew & Hancock
Dacus (Callantra) maculipterus White
Dacus (Callantra) murphyi White
Dacus (Callantra) nummularius (Bezzi)
Dacus (Callantra) pedunculatus (Bezzi)
Dacus (Callantra) petioliformus (May)
Dacus (Callantra) pictus (Hardy)
Dacus (Callantra) polistiformis (Senior-White)
Dacus (Callantra) pullus (Hardy)
Dacus (Callantra) satanas (Hering)
Dacus (Callantra) sinensis (Wang)
Dacus (Callantra) subsessilis (Bezzi)
Dacus (Callantra) vittatus (Hardy)
Dacus (Callantra) wallacei White
Dacus (Dacus) adustus Munro
Dacus (Dacus) alulapictus Drew
Dacus (Dacus) ambliquus Munro
Dacus (Dacus) aneuvittata (Drew)
Dacus (Dacus) armatus Fabricius
Dacus (Dacus) bequaeti Collart
Dacus (Dacus) bombastus Hering
Dacus (Dacus) chrysomphalus (Bezzi)
Dacus (Dacus) claricognatus (Munro)
Dacus (Dacus) clinophlebs Hendel
Dacus (Dacus) Collart*i* Munro
Dacus (Dacus) croceus Munro
Dacus (Dacus) cyathus (Munro)
Dacus (Dacus) disjunctus (Bezzi)
Dacus (Dacus) dubisitatus Munro
Dacus (Dacus) etiennellus Munro
Dacus (Dacus) flavicrus Graham
Dacus (Dacus) fumosus Collart
Dacus (Dacus) fuscinervis Malloch
Dacus (Dacus) ghesquierei Collart
Dacus (Dacus) guineensis Hering
Dacus (Dacus) hargreavesi Munro
Dacus (Dacus) kampalensis (Munro)
Dacus (Dacus) linearis Collart
Dacus (Dacus) melanaspis (Munro)
Dacus (Dacus) momordicae (Bezzi)
Dacus (Dacus) notalaxus Munro
Dacus (Dacus) phantoma Hering
Dacus (Dacus) schoutedeni Collart
Dacus (Dacus) setilatens Munro
Dacus (Dacus) sphaerostigma (Bezzi)
Dacus (Dacus) spissus Munro
Dacus (Dacus) stentor Munro
Dacus (Dacus) taurus Munro
Dacus (Dacus) theophrastus Hering
Dacus (Dacus) transitorius Collart
Dacus (Dacus) veracundus Collart
Dacus (Dacus) yangambinus Munro
Dacus (Didacus) abbabae Munro
Dacus (Didacus) abditus (Munro)
Dacus (Didacus) adenionis (Munro)
Dacus (Didacus) ancisus (Munro)
Dacus (Didacus) andriae (Munro)
Dacus (Didacus) arcuatus Munro
Dacus (Didacus) aspilus Bezzi
Dacus (Didacus) attenuatus Collart
Dacus (Didacus) bistrigulatus Bezzi
Dacus (Didacus) blepharogaster Bezzi
Dacus (Didacus) brevistriga Walker
Dacus (Didacus) carnesi (Munro)
Dacus (Didacus) cavalhoi (Munro)
Dacus (Didacus) ceropegiae (Munro)
Dacus (Didacus) cuspidatus (Munro)
Dacus (Didacus) elegans (Munro)
Dacus (Didacus) elutissimus Bezzi
Dacus (Didacus) engoninus (Munro)
Dacus (Didacus) fasciolatus Collart
Dacus (Didacus) ficicola Bezzi
Dacus (Didacus) fonsicanus (Munro)
Dacus (Didacus) fuscatus Wiedemann
Dacus (Didacus) fuscovittatus Graham
Dacus (Didacus) gypsoides Munro
Dacus (Didacus) hainanus (Wang and Zhao)
Dacus (Didacus) inclytus (Munro)
Dacus (Didacus) inopinus Munro
Dacus (Didacus) jubatus (Munro)
Dacus (Didacus) keiseri (Hering)
Dacus (Didacus) lounsburyi Coquillett
Dacus (Didacus) maprikensis Drew
Dacus (Didacus) mirificus (Munro)
Dacus (Didacus) mulgens Munro
Dacus (Didacus) nanus Collart
Dacus (Didacus) opacatus Munro
Dacus (Didacus) opinatus Munro
Dacus (Didacus) ortholomatus (Hardy)
Dacus (Didacus) ostiofaciens Munro
Dacus (Didacus) pamelae (Munro)
Dacus (Didacus) panpyrrhus (Munro)
Dacus (Didacus) pintadus (Munro)

Dacus (Didacus) pullescens Munro
Dacus (Didacus) rugatus Munro
Dacus (Didacus) serratus (Munro)
Dacus (Didacus) siliqualactis Munro
Dacus (Didacus) sphaeristicus Speiser
Dacus (Didacus) tenebricus Munro
Dacus (Didacus) trigonus Bezzi
Dacus (Didacus) tubatus Munro
Dacus (Didacus) umbrilatus Munro
Dacus (Didacus) vansomereni Munro
Dacus (Didacus) venetatus Munro
Dacus (Didacus) viator Munro
Dacus (Didacus) xanthaspis (Munro)
Dacus (Didacus) zavattarianus (Hering)
Dacus (Leptoxyda) annulatus Becker
Dacus (Leptoxyda) apostator (Hering)
Dacus (Leptoxyda) apoxanthus Bezzi
Dacus (Leptoxyda) bifasciatus (Hering)
Dacus (Leptoxyda) chamun (Munro)
Dacus (Leptoxyda) chapini Curran
Dacus (Leptoxyda) erythraeus Bezzi
Dacus (Leptoxyda) externellus (Munro)
Dacus (Leptoxyda) freidbergi (Munro)
Dacus (Leptoxyda) hamatus Bezzi
Dacus (Leptoxyda) hapalus (Munro)
Dacus (Leptoxyda) hyalobasis Bezzi
Dacus (Leptoxyda) iaspideus Munro
Dacus (Leptoxyda) inflatus Munro
Dacus (Leptoxyda) inornatus Bezzi
Dacus (Leptoxyda) interjectus (Munro)
Dacus (Leptoxyda) longistylus Wiedemann
Dacus (Leptoxyda) macer Bezzi
Dacus (Leptoxyda) marshalli Bezzi
Dacus (Leptoxyda) maynei Bezzi
Dacus (Leptoxyda) meladassus (Munro)
Dacus (Leptoxyda) mochii Bezzi
Dacus (Leptoxyda) obesus Munro
Dacus (Leptoxyda) persicus Hendel
Dacus (Leptoxyda) phloginus (Munro)
.
Dacus (Leptoxyda) purpurifrons Bezzi
Dacus (Leptoxyda) pusillator (Munro)
Dacus (Leptoxyda) retextus Munro
Dacus (Leptoxyda) rubicundus Bezzi
Dacus (Leptoxyda) rufoscutellatus (Hering)
Dacus (Leptoxyda) rufus Bezzi
Dacus (Leptoxyda) ruslan (Hering)
Dacus (Leptoxyda) scaber Loew
Dacus (Leptoxyda) seguyi (Munro)
Dacus (Leptoxyda) semisphaerus Becker
Dacus (Leptoxyda) sicatoluteus (Munro)
Dacus (Leptoxyda) temnopterus Bezzi
Dacus (Leptoxyda) triater Munro
Dacus (Leptoxyda) woodi Bezzi
Dacus (Leptoxyda) xanthopus Bezzi
Dacus (Leptoxyda) zavattarii (Hering)
Dacus (Metidacus) adenae (Hering)
Dacus (Metidacus) amberiens (Munro)
Dacus (Metidacus) bidens (Curran)
Dacus (Metidacus) delicatus Munro
Dacus (Metidacus) herensis (Munro)
Dacus (Metidacus) lotus (Bezzi)
Dacus (Metidacus) partus (Munro)
Dacus (Metidacus) pergulariae Munro
Dacus (Metidacus) phimis (Munro)
Dacus (Metidacus) purus (Curran)
Dacus (Metidacus) radmirus Hering
Dacus (Metidacus) rutilus Munro
Dacus (Metidacus) stylifer (Bezzi)
Ichneumonopsis burmensis Hardy
Monacrostichus citricola Bezzi
Monacrostichus malaysiae Drew & Hancock

[1] Cunningham 1989 and Drew 1974 both cite that *B. ochrosiae* (Malloch) is attracted to cuelure, but Drew (personal communication) expresses his doubts that the earlier citations are accurate

Note: Although the literature may indicated that a given species is attracted to one or several known lures or attractants, quite often there is no indication to what degree that species may be attracted. It should not be assumed that all species listed above respond in the same fashion to the lure. In fact, it would be safer to assume that the response can be quite varied in relation to the actual population that exists. Lure or attractants can be extremely powerful in attracting certain species. Those species that are not attracted to any known lure would be candidates for area-wide control using the SIT.

Sources:

Cunningham, R. T. 1989. Parapheromones. *In* A. Robinson and G. H. S. Hooper. [Eds.] 1989. Fruit Flies: Their Biology, Natural Enemies and Control - World Crop Pests, Volume 3A. pp. 221-230. Elsevier, The Netherlands, pp. 372.

Drew, R. A. I. 1974. The responses of fruit fly species in the South Pacific area to male attractants. J. Aust. Entomol. Soc., 13:267-270.

Drew, R. A. I. 1989. The tropical fruit flies of the Australasian and Oceanian regions. Mem. Queensland Mus. No. 26.

Drew, R. A. I.; Hancock, D. L.; Romig, M. C. 1999. New species and records of fruit flies (Diptera: Tephritidae: Dacinae) from north Queensland. Australian Entomologist 26 **(1)**: 1-12.

Drew, R. A. I.; Hooper, G. H. S. 1981.The responses of fruit fly species in Australia to various attractants. J. Aust. Entomol. Soc., 20:201-205.

Hancock, D. L. 1985. New species and records of African Dacinae. Arnoldia Zimb. 9:299-314.

Lux, S.; White, I. M. ICIPE Fruit Fly Initiative (http://nbo.icipe.com)

White, I. M.; Elson-Harris, M. M. 1992. Fruit Flies of Economic Significance: Their Identification and Bionomics. CABI International, Wallingford, UK, pp. 601

White, I. M.; Hancock, D. L. 1997. The *Bactrocera* And *Dacus* Species Of The Indo-Australasian Regions (CD-ROM). CAB International, Wallingford, UK.

Annex H - Existing Fruit Fly Mass-Rearing Facilities

Fruit Fly Mass-Rearing Facilities

COUNTRY	LOCATION/	Approx. operating since	SPECIES AND STRAIN	Approx. weekly production potential (million pupae) MALE +FEMALE	Approx. weekly production potential (million pupae) MALE ONLY	Minimum Absorbed Dose (Gy)
Argentina	**San Juan, San Juan**	**1982**	***Ceratitis capitata* *San Juan (bisexual)***	**5 - 15**		**120**
Argentina	**Mendoza, ISCAMEN**	**1992**	C. capitat ***SEIB 6-96 (gss,wp) 1995***	**300**		**120**
Australia	**Perth, W.A.**	**1978-1985**	C. capitata ***PERCVQ (bisexual)***	**10 - 15**		**180(Nitrogen)**
Australia	**Perth, W.A.**	**1999** **(*B. tryoni* facility reopened for medfly)**	***C. capitata* *VIENNA 7/Mix99 (gss, wp+tsl)***		**10**	**120 (air)** **140 (N2)** **recommended**
Austria*	**Seibersdorf, Vienna**	**1960's**	***C. capitata*** *Large collection of sexing and mutant strains* ***(see Table 2)***	**5-10**		**90 - 95**
Brazil	**Piracicaba, Sao Paolo**	**1997**	***C. capitata* *normal (bisexual)***	**<1**		**120**
Chile	**Arica, Region I**	**1993**	***C. capitata* *SEIB 6-96 (gss,wp)***		**45**	**100 for Argentina** **112 for Chile-Peru**
Costa Rica	**San José, Univ. Costa Rica.**	**1960s**	***C. capitata* *Local (bisexual)***	**5 - 10**		

COUNTRY	LOCATION/	Approx. operating since	SPECIES AND STRAIN	Approx. weekly production potential (million pupae) MALE +FEMALE	Approx. weekly production potential (million pupae) MALE ONLY	Minimum Absorbed Dose (Gy)
Greece	**Heraklion, Crete**	**1993**	***C. capitata*** ***SEIB 6-98(gss,wp)*** ***SEIB 7-99(gss,wp)***	 **1 - 2** **9**		**95**
Guatemala	**Saint Miguel/Petapa**	**1984**	***C. capitata*** ***ANTIGUA (bisexual)***	**300-400**		
Guatemala	**El Pino, Guatemala**	**1996**	***C. capitata*** ***PETAPA + ANTIGUA (bisexual)***	**200**		**145 for export** **90 for local use**
Guatemala	**El Pino, Guatemala**	**1996**	***C. capitata*** ***VIENNA 4/Tol-94 (gss, wp+tsl)***		**450**	**145 for export** **90 local use**
Guatemala	**El Pino, Guatemala**	**1997**	***C. capitata*** ***VIENNA 7-97(GSS, WP+TSL)***		**450**	**145 for export** **90 local use**
Lebanon	**Beirut**	**1999**	***C. capitata*** ***VIENNA 4/Tol-94 (gss/tsl)***		**3**	
Mexico[**]	**Metapa, Chiapas**	 **1979-1984** **1984-1994** **1994-1999**	***C. capitata*** ***Costa Rica (bisexual)*** ***Guatemala (bisexual)*** ***Guatemala (bisexual)***	 **400 - 500** **400 - 500** **400 - 500**		**145**
Peru	**La Molina, Lima**	**1960's;** **reopening on year 2000**	***C. capitata*** ***VIENNA 7-97*** ***(gss, wp+tsl)***		**120**	
Portugal	**Madeira**	**1994**	***C. capitata*** ***VIENNA 6 - 96*** ***(gss, wp+tsl)***		**40**	**120**

COUNTRY	LOCATION/	Approx. operating since	SPECIES AND STRAIN	Approx. weekly production potential (million pupae) MALE +FEMALE	Approx. weekly production potential (million pupae) MALE ONLY	Minimum Absorbed Dose (Gy)
South Africa	**Stellenbosch**	**1999**	***C. capitata VIENNA 7/Mix-99 (gss, wp+tsl)***		**5 - 10**	**126.17**
USA	**Waimanalo, Hawaii, USDA**	**1991**	***C. capitata MAUI-93 (bisexual)***	**200 - 300**		**120**
USA	**Honolulu, Hawaii, CDFA**	**1970's**	***C. capitata HI-LAB (bisexual)***	**70 - 150**		**120**
USA	**Waimanalo, Hawaii, CDFA**	**1996-1999 (closed)**	***C. capitata HI-LAB (bisexual)***	**200 - 300**		**120** (USDA irradiator)
Australia	**Perth, W.A.**	**1989 -90**	***B. tryoni (bisex)***	**40**		**180 (Nitrogen)**
Australia	**Campden, NSW**	**1996**	***B. tryoni (bisex)***	**20**		**70 - 75**
Costa Rica	**OIRSA, San José**	**1960s**	***A. obliqua***	**<1**		
Greece	**Demokritos, Athens**	**1970s**	***B. olea***	**< 1**		
Japan	**Naha, Okinawa**	**1973-79 1979-88 1988-1990 1999**	***B. cucurbitae***	**5 50 280 50 - 100**		**50 - 70**
Mexico	**Metapa, Chiapas**	**1994**	***A. ludens***	**200 - 250**		**80**
Mexico	**Metapa, Chiapas**	**1994**	***A. obliqua***	**50**		**80**
Mexico	**Metapa, Chiapas**	**1994**	***A. serpentina***	**5 - 10 expected**		
Pakistan	**Tandojam, Sind**	**1980's**	***B. zonata***	**1 - 3**		
Peru[30]	**Piura**	**1999**	***A. fraterculus***	**1 - 2**		

COUNTRY	LOCATION/	Approx. operating since	SPECIES AND STRAIN	Approx. weekly production potential (million pupae) MALE +FEMALE	Approx. weekly production potential (million pupae) MALE ONLY	Minimum Absorbed Dose (Gy)
Philippines	**Quezon City, Luzon Manila**	**1980's**	***B. philippinensis***	**1 - 20**		**50**
South Africa	**Stellenbosch**	**1990's**	***C. rosa***	**1 - 3**		
Thailand	**Pathumatanee and other locations**	**1987**	***B. dorsalis***	**15 - 35** expected 100 in year2000		**90**
USA	**Gainesville, FL**	**1987**	***A. suspensa***	**20 - 50**		**70**
USA	**Mission, TX**	**1986**	***A. ludens***	**18 - 40**		**70**
USA	**Honolulu, Hawaii**	**1956**	***B. cucurbitae***	**3**		**100 - 120**
USA	**Honolulu, Hawaii**	**1956**	***B. dorsalis***	**1 - 5**		**100 - 120**
USA	**Weslaco, TX**	**1992**	***A. obliqua***	**< 1**		**NI***
USA	**Weslaco, TX**	**1992**	***A. serpentina***	**< 1**		**NI***
USA	**Honolulu, Hawaii**	**1984-1990**	***B. latifrons***	**< 1**		

* Hendrichs et al. (1995), J. Appl. Entomol. 119,371-377.

** Schwarz et al., 1985.Fla. Entomol. 68 (3).467-477.

Annex I - Slovakia Feasibility Project for Mass-Rearing Facility

BACKGROUND AND PURPOSE

There are several sterile insect mass production facilities operating successfully in various parts of the world and others being planned. These facilities are designed to support specific pest control and eradication programmes in their host countries and, in some cases, to provide sterile insects for similar programmes in other countries. The expanding use of the environmentally friendly pest control method known as the Sterile Insect Technique (SIT) - also known as "birth control for insects" - is gaining commercial recognition as a safer and more cost-effective alternative to the widespread use of insecticides.

Throughout the Mediterranean region and Africa, there is a great demand for sterile insects to control or eradicate such pests as fruit flies (in particular the Mediterranean fruit fly), codling moths, gypsy moths, and the tsetse fly. There is also great potential for the application of this technology to other pests. However, no sterile insect mass rearing facilities exist anywhere in the region with sufficient capacity to meet the demand.

The purpose of the proposed study is to determine the feasibility of building and operating a commercially viable sterile insect mass rearing facility in the Slovak Republic, in order to meet the demand for sterile insects throughout the region while creating opportunities for employment, research, technology development, and economic growth in the host country.

Plan Feasibility Study (Jan – Sep 1999)

- ♦ Identify project manager and core study team (Jan-Mar 1999)
- ♦ Train project manager (Apr-Jun 1999)
- ♦ Plan scientific visits of Slovak experts (Jul 1999)
- ♦ Expert planner visit to Slovakia (Jul 1999)
- ♦ Design study, identify resource requirements and budget (Jul 1999)
- ❑ Submit study plan and budget to IAEA (Aug 1999)
- ❑ IAEA award contract and provide funding (Sep 1999)

Carry Out Feasibility Study (Oct 1999 – Jul 2000)

Develop Sales Projections (Oct – Dec 1999)

- ♦ Identify insect species (products) and potential markets
- ♦ Design ***market survey*** to
  - *Verify customer requirements* products, quantities, delivery schedules
  - *Evaluate competition* other technologies and current costs; other SIT suppliers and current or historical prices; shipping cost comparisons

- *Assess the feasibility of competing successfully*

♦ Perform market survey

♦ Compile and analyze market survey results

♦ Perform market risk assessment (business impediments and solutions)

❑ Predict sales: products, quantities, and timeframes for delivery (Dec 1999)

Assess Technical Feasibility (Sep – Dec 1999)

♦ **Select Site** (donation, lease or purchase)

- Develop selection criteria
- Identify alternative sites
- Evaluate site feasibility based on selection criteria

❑ Recommend most feasible alternative (Oct 1999)

♦ **Plan Facility**

- Analyze existing facilities in other countries
- Develop conceptual plan for facility, including construction type, schedule and cost estimates
- Develop equipment list and acquisition plan, including supply sources and cost estimates (with special attention to radiation source and related equipment)

❑ Estimate design, construction and equipment costs and completion date (Dec 1999)

♦ **Plan Organization & Staffing**

- Analyze SIT organizations in existing facilities
- Develop organizational plan and identify management and staff requirements and sources

❑ Estimate all personnel costs (differentiate between direct and indirect) (Dec 1999)

♦ **Plan Operations**

- Analyze existing production operations & maintenance in other countries
- Based on sales projections, develop production schedules
- Develop supply list and acquisition plan, including supply sources, delivery schedules, and cost estimates

❑ Determine feasible startup schedule for testing of systems and training

❑ Determine feasible startup date for commercial production (Dec 1999)

Perform Economic Analysis (Jan – Apr 2000)

♦ Develop amortization schedules for facilities, equipment, and all other costs incurred prior to commercial startup

- ❑ Estimate full cost of facility as of commercial startup (includes operating costs during testing of systems and training of staff) (Apr 2000)
- ♦ Develop model to compute cost of production for each product at various production levels, including fixed, variable, G&A, and overhead costs
- ♦ Develop model to determine product prices at various production levels, based on market factors, production costs, and target profit margins
- ❑ Apply economic models to predict break-even production levels at various prices and break-even prices at various production levels for each product
- ❑ Assess the economic feasibility (profitability) of the enterprise, including recommended pricing and estimated profits at various production levels (Apr 2000)

Prepare Financial Plan (Jan – Apr 2000)

- ♦ Identify potential sources of funding for the startup investment and prepare cash flow forecast
- ♦ Prepare short and long term pro-forma income statements and balance sheets for the investment (5 to 10 years)
- ❑ Prepare a break-even analysis to demonstrate when the investment will be fully recovered, based on the above projections (Apr 2000)

Assess Environmental Impact (Jan – Apr 2000)

- ♦ Pest risk assessment for reared insects (bio-security)
- ♦ Waste management and recycling (water, diet, other biological and non-biological)
- ♦ Radiation risk assessment
- ♦ Other environmental risk assessment
- ❑ Prepare an environmental impact statement (Apr 2000)

Assess Socioeconomic Impact (Jan – Mar 2000)

- ♦ Assess impact on labor market and socioeconomic conditions of the surrounding community
- ♦ Assess the need for a public relations campaign
- ❑ Prepare a socioeconomic impact statement (Mar 2000)

Assess Regulatory, Legal and Political Impact (Apr – Jun 2000)

- ♦ Import/export restrictions (Customs, SPS, Atomic Energy, etc.)
- ♦ Other potential impediments
- ❑ Assess impact and propose a plan to overcome potential impediments (Jun 2000)

Summarize Feasibility and Recommend Appropriate Action (Jun - Jul 2000)

- ❑ **Deliver feasibility study report (Jul 2000)**

EVALUATION OF THE PEACH FRUIT FLY PROBLEM IN EGYPT

WITH RECOMMENDATIONS FOR ITS CONTROL AND ERADICATION, INCLUDING A LIMITED COST-BENEFIT ANALYSIS

A report on a mission to Egypt June 11 to June 24 1999

Project code: C3-INT/0/069 13 01

Abdullah Joomaye, Jonathan Knight and William Routhier

EXECUTIVE SUMMARY

Peach fruit fly is well established and is probably responsible for high losses in Egyptian fruit crops. However, the level of awareness of the problem is low due to the similarity of the damage to that of Medfly. The lack of awareness exists at many levels and has probably prevented the government establishing a cohesive and effective strategy for the containment and control of this pest. The detection of peach fruit fly infestation in export crops will affect Egypt's ability to export citrus and other commercial hosts to many countries including Europe.

At present the problem appears to be localized in Egypt with some areas of the country apparently still free from infestation. If left unchecked there is a high probability that presently uninfested areas within Egypt, neighbouring countries and the rest of Africa will become infested.

Since the peach fruit fly poses a threat to many of Egypt's export markets it a more immediate threat to the welfare of the industry than the Medfly and for this reason is likely to warrant priority treatment to prevent further spread and protect currently fly-free areas.

It is important that support from suitable donor agencies is provided in the form of traps and attractants, identification training *etc*. to surrounding countries for the detection and control of peach fruit fly as required.

Egypt should seek to strengthen its pest exclusion and quarantine measures to avoid the introduction of any additional exotic pests and implement internal quarantine to prevent the movement of pests between affected and pest free areas.

The methods available for the detection and control of this pest are well proven, effective and relatively simple to implement. The use of a combination of bait application technique, male annihilation technique and sterile insect technique should be capable of eradicating the peach fruit fly if implemented correctly. The cost-benefit analysis undertaken indicates that there is good reason for the Egyptian government to take prompt action.

PROBLEM STATEMENT

Peach fruit fly (*Bactrocera zonata*) is a recently introduced exotic fruit fly species that has established and currently infests significant areas in Egypt. It causes an estimated $177 million of damage each year and has the potential to colonize most countries bordering the Mediterranean and the rest of mainland Africa. It also has the potential to prevent the efficient development of the additional 1.5 million feddans presently being considered.

Life History

The time of the first introduction is somewhat obscure (see Appendix 1). The climate of the countries bordering the Mediterranean with warm summers and mild winters are favourable to the peach fruit fly development allowing many generations per year under warm summer conditions. The life cycle is completed in 25-40 days. Newly emerged flies have to feed on proteinaceous material in order to become sexually mature and mate. Mature males are highly attracted to the aggregate pheromone methyl eugenol.

The female deposits 10-100 eggs per puncture and can lay up to 600 eggs in her lifetime. Eggs hatch in 1-5 days and larvae feed throughout the fruit for 10-15 days subsequently pupating in the soil. Pupation lasts for 10-15 days after which the adult emerges. Sexual maturation of the adults can take another 10-19 days and mating occurs in a lek after which egg laying commences.

Crops Attacked

The Peach fruit fly attacks a wide range of plants including the following commercial crops; Peach, Guava, Mango, Date Palm, Apples, Bitter Gourd, Okra, Pomegranate, Papaya, Common Fig, Quince, Sweet and Bitter Orange possibly Melons and Water Melons and numerous ornamentals (Appendix 2 contains a list of species names). There is considerable scope for increasing its host range as it colonises new environments. Therefore, additional hosts may be discovered over time in Egypt. Mission personnel extracted Bactrocera larvae from White Sapote (*Casimiroa edulis*, an unlisted host) from the Zamalek district in Cairo which were confirmed later as peach fruit fly by a systematic specialist.

Extent of Damage

The peach fruit fly is so destructive that intensive controls must be in place to grow the susceptible crops commercially. In other regions of the world it is known to displace other Dacine species. In the near east region a conservative estimate of the potential crop loss from Mediterranean fruit fly is $298 million per year; an additional $75-100 million could occur through the action of the peach fruit fly. However, these figures do not adequately take into consideration the costs associated with trade restrictions on crops nor those associated directly and indirectly with production, harvesting, marketing, loss of planed increased production and the environment. Agriculture plays a key role in the economy of the near east region, for example, it accounts for 33% of the gross domestic product of the Syrian Arab Republic and 20% in Egypt. More than one third of the labour forces of the Syrian Arab Republic and Egypt are employed in agriculture. Efforts are being made to increase the export of fruits in the region and Egypt has significant plans to increase production through large irrigation schemes in Sinai, Aswan and the area south west of Cairo. As an example Israel spends $1.5 million on cold treatments to address the quarantine regarding Medfly. Peach fruit fly is not established in any other region of the Mediterranean or Africa so quarantine concerns are likely to be much more significant for Egypt.

Distribution and Population Dynamics of Peach Fruit Fly in Egypt.

Peach fruit fly has the potential to establish over an area of approximately 35,000 km^2 of rain-fed or irrigated lands in Egypt. Primary hosts include many commercial species which cover an area approximately 3,900 km^2 and there are schemes in progress to more than double this area in the next few years. The estimated levels of infestation may reach up to 30% even with multiple pesticide treatments and can result in total loss in the absence of treatment. Peach fruit fly is present year round in most of the commercial host growing areas the presence of susceptible host fruits in combination with local climatic conditions influences seasonal population fluctuations. Peach fruit fly populations are building up slowly from early April reaching high levels in July which persist well in to the autumn. Some population reduction can be expected into the winter months.

Objectives

There were multiple objectives for this mission determined by the terms of reference set by IAEA. In brief, the objectives are as follows (Appendix 3 contains the Duties as defined by IAEA)

1. Assess the incidence, distribution and severity of peach fruit fly infestation.
2. Identify pest pathways, pest free areas and recommend quarantine measures.
3. Develop options to delimit, contain and control peach fruit fly infestations.
4. Estimate resources and costs required for options developed in 3 above.
5. Provide training for Ministry of Agriculture personnel.
6. Provide general guidance on identification of peach fruit fly.

7. Develop a general work plan for control of peach fruit fly.

The following options were identified as a result of the above process.

1. Do nothing
2. Export quarantine measures only
3. Local Control
4. National Suppression
5. Suppression and protection of existing pest free zones
6. Suppression, pest free zones and eradication in localised areas
7. Countrywide eradication

Do Nothing (No Action)

This option would result in the inevitable spread of peach fruit fly to areas of Egypt currently free of the pest and in all probability to neighbouring countries and beyond. There would also be reduction in yields and tree loss, serious environmental impacts from the indiscriminate use of pesticides and increased incidence of vermin from the large quantities of rotting fruit. Most importantly, if no quarantine is established, existing export markets and also the production from the three planned agricultural areas will be lost. If a sufficient quantity of quality fruit cannot be produced locally there will be an increase of imports to satisfy this market.

Export quarantine measures only

In order to preserve some or all of existing export markets either voluntary or enforced, quarantine measures will be needed on produce to foreign countries. This process will increase costs. Quarantine measures could include, chemical treatments, physical treatment (heat and cold), irradiation and maintenance of pest free zones (see suppression and protection of existing pest free zones). This would require the construction of extensive facilities at the point of export. Compliance agreements with producers, shippers and all handlers would need to be in place to maintain and guarantee the pest free status of the produce.

Local Control

Individual control by growers using bait application technique (BAT) can improve quality and increase quantity by limiting the loss as a result of peach fruit fly infestation. It may also reduce environmental damage by limiting the casual use of insecticides resulting in improved food safety and reduced operator health impacts.

The costs of this strategy come from increased used of BAT, increased mechanical control (clearance of all dropped fruit and bagging), development and planting of resistant species and varieties, early harvest and conversion of orchards to single species or plantings that prohibit the year round development of peach fruit fly. Costs would also be incurred through the investigation of potential parasite complexes for introduction into Egypt for the control of peach fruit fly.

National Suppression

The benefits associated with this option are largely the same as the local control however, additional benefits come from the guaranteed implementation of the BAT over the entire area and possible reduced costs due to economies of scale. This option will also reduce risk to importing countries. Additional costs include a nationalised trapping programme to decide when and where to treat.

Suppression and protection of existing pest free zones

The benefits of protecting existing pest free zones are; reduced pesticide use, possibility of exports without quarantine treatments and the increases in quality and quantity of fruit. In order for this strategy to be successful these areas need to be isolated through internal quarantine, extensive trapping must be maintained throughout the pest free zone, and any spot infestations must be eradicated as soon as they are detected. National suppression programmes should help prevent the accidental introduction of peach fruit fly into the fly free zones.

Fruit entering the pest free zone from infested areas must be free of peach fruit fly either as a result of quarantine treatments or having been grown in another pest free zone. Fruit in transit must be moved in sealed containers to prevent flies escaping and checkpoints must be established to enforce the quarantines.

Detailed trapping records should be maintained area wide for examination by importing countries.

A detection programme must be established to identify incipient infestations using a minimum of 2 Jackson and 2 McPhail traps per km^2. Traps will need to moved seasonally and maintained in trees with ripening fruit. An emergency response team should be trained, equipped and available to respond to any incursions of peach fruit fly within 1-2 days of detection. Response should include BAT and male annihilation technique (MAT) to eradicate any infestation before it has an opportunity to become established. Trap density in the eradication areas should be increased five fold to 10 Jackson traps and 10 McPhail traps per km^2 in the 25 km^2 surrounding the site.

Suppression, pest free zones and eradication in localised areas

The benefits will largely be the same as the previous option but additional benefits will come from the eradication of peach fruit fly from existing areas of infestation and their subsequent pest free status. This will increase the area for the production of greater quantities of quality fruit. In addition, there will be a decreased probability of infestation spreading to other areas within Egypt and to other countries, especially from the upper Nile into the rest of Africa. If used as a pilot programme, an additional benefit may be the development of techniques, infrastructure, training and experience for the implementation of larger scale eradication programmes.

The cost of eradication of the peach fruit fly from currently infested zones will be significant depending on the methodology chosen (the size of the area, its isolation, the speed of implementation, etc.).

A detection programme, similar to that used in the suppression and the protection of fly free zones option, should be established prior to the implementation of the eradication. Eradication in areas of any significant size should include three BAT treatments followed by two generations of MAT. For each area there would be a need to identify and select the most appropriate MAT methodology (impregnated killing blocks or direct application to vertical surfaces e.g. tree trunks). Where the risk of reintroduction or skips exist, sterile insect technique (SIT) should then be implemented for 2 generations. Eradication could be confirmed after two generations of negative trapping.

Countrywide eradication

Benefits associated with this option are potentially very large. The quantity and quality of fruit for all markets are improved, the existing pest free areas are maintained and areas being developed will remain pest free. There will be no additional export restrictions on the fruit to overseas markets and there will be no need for long term internal quarantine. There will be reduced pesticide use and associated benefits (food safety, environmental contamination and operator health). The risk of the peach fruit fly spreading from Egypt to other countries around the Mediterranean and Africa will be eliminated. The infrastructure established in this programme could be of significant use in any future programme to eradicate Medfly.

To successfully implement this option it will be necessary to do the following:

- Exterior quarantine to prevent the reintroduction of peach fruit fly and to exclude other fruit flies
- Interior quarantine to prevent reinvasion of previously cleared areas
- Quarantines to prevent infested fruit leaving Egypt and entering other "at risk" countries
- National suppression programme and strategy
- National detection programme for peach fruit fly and other fruit flies
- Update existing pest risk analyses to identify potential threats from other countries
- Develop a sterile insect rearing facility
- Implement sequential eradication strategy starting from the most isolated areas

To develop this strategy it is recommended that a pilot programme is established to gain experience of the techniques, establish infrastructure and assess its feasibility within Egypt.

COST BENEFIT ANALYSIS OF DIFFERENT CONTROL OPTIONS

The information used in calculating the cost benefits of the different schemes and some of the assumptions made are detailed in Appendix 4.

The following terms are used in estimating the likely economic success of the project.

Benefit Cost ratio (BC) This figure shows the ratio between the costs incurred by the project and the calculated benefits coming from it. Thus the larger figure the greater the benefits coming from the project and the hence bigger return on the investment.

Internal Rate of Return (IRR) This figure can be thought of as the interest rate received on the money invested in the project. It has special relationship with the NPV (see below) in that when the discount rate is the same as the internal rate of return the NPV is zero. Therefore the higher the IRR the greater the return on the investment.

Net Present Value (NPV) This figure gives an indication of the value of the project less any investments adjusted for the prevailing discount rate. If the figure is positive then overall the project will run at a profit, if negative a loss will be made.

Key assumptions made in the analysis

- All the productive areas of the country were infested with the peach fruit fly and were suffering losses as a result. In the absence of reliable information to the contrary this was considered the safest option.
- The discount rate was 12.5%
- Current controls were not targeted at peach fruit fly but at Medfly. Thus control would continue into the future even if the peach fruit fly was eradicated. Because of this no benefits were gained from the decrease in pesticide use.
- Due to lack of information there was no allowance made for increases in cropping areas which may occur over the next 5 years or so resulting from land reclamation/irrigation schemes currently underway in Sinai, Aswan and an area south west of Cairo. If peach fruit fly was to enter these areas losses would be considerably greater as would the costs of control.
- The total potential productive area of the country is approximately 35,000 km^2 made up of 3,912km^2 of commercial orchards, 2,061 km^2 of urban areas and 29,027km^2 of other areas containing low densities of peach fruit fly hosts..
- Control would be implemented over an area of approximately 6000 km^2 each year with an area of 2,000 km^2 being treated at any one time. This results in a programme lasting 4 years.
- Control begins in the upper Nile valley and in the outlying regions such as Sinai and the oases to the SW of Cairo and progresses toward the delta region via ElFaiyoum.
- Losses due to peach fruit fly are greater than from Medfly. Only the additional loss is taken to be a benefit if it is eliminated. Losses to Medfly will still exist.

Export quarantine measures only

The cost benefit analysis for this option assumed that it would require the implementation of a national trapping programme to monitor and administer the fly free zones. In addition, there would be expenditure on an expanded and improved quarantine service. Since there would be no immediate benefits from this strategy the Net Present Value (NPV), Benefit Cost Ratio (BC) and Internal rate of Return (IRR) are all unfavourable. However, if the area of production is set to increase by 1.5 million acres then the potential losses in this new area could be around $150 million per annum which could be included as a benefit of the action taken. There would also be the added benefits of low pesticide usage to both humans and the wider environment. This strategy also protects the export market which for oranges and peach is worth about $0.5 million. If this strategy was implemented correctly it would result in savings over the long term not just through the management of the peach fruit fly but through the exclusion of other new exotic pest species.

NPV (12.5%) (million US$)	Benefit cost ratio	Internal rate of return	Total cost over 6 years (million US$)
-71.217	0.000	-100.000	104.320

BAT Suppression and protection of existing pest free zones

This option requires the use of bait treatment, a trapping programme and quarantine. It will have the benefit if protecting new areas of production and will limit the damage done to existing fruit crops. The cost benefit analysis shows that the NPV is 336 million dollars over the 6 year period with a favourable benefit cost ratio.

NPV (12.5%) (million US$)	Benefit cost ratio	Internal rate of return	Total cost over 6 years (million US$)
245.986	2.801	NA	233.54

Countrywide eradication

Four different strategies were considered for the countrywide eradication. These were using BAT and MAT only (as described previously), using BAT and MAT but doubling the time period for MAT to ensure that eradication is achieved and a combination of BAT, MAT and SIT. The last option also has two different methods. The first is to use BAT, Mat and SIT in all regions that are treated. The second option starts the SIT treatment in the second year. The reason for this is that it is felt that it will be possible to achieve eradication in the upper Nile with just BAT and MAT as the areas are relatively well isolated and re-invasion should be easier to control. SIT is then used in the Faiyoum and Delta regions where the areas are much greater and any errors are more likely to result in a breakdown in the control.

The table below illustrates that all the options have favourable economic indicators although the options without SIT are considerably more attractive financially. However, the options with SIT have the benefit of a ‘dynamic’ component, that of active flies, that can help to mitigate against errors in the earlier BAT and MAT phases. It is for this reason that this is the preferred option. This still leaves the problem of whether to ‘play safe’ and use SIT in all areas or restrict the use of SIT to the large areas or the Faiyoum and the Delta. In order to make this decision a pilot programme using just BAT and MAT on the west bank of the Suez canal or similar region would provide valuable information on the feasibility of using SIT only in the large areas.

Strategy	NPV (12.5%) (million US$)	Benefit cost ratio	Internal rate of return	Total cost over 6 years (million US$)
BAT & MAT Only	344.214	9.977	NA	55.816
BAT & MAT (x2)	341.416	9.298	NA	59.930
BAT, MAT & SIT	207.791	2.189	118.728	251.678
BAT, MAT & SIT Yr 2	260.027	3.122	NA	191.391

CONCLUSIONS

- Peach fruit fly is well established in the delta, lower, middle and upper Nile, up to the Suez canal in the east but no flies have yet been detected in the North Sinai or Oases to the west of the Nile. Flies have been reported in both primary and secondary host including dates and figs.
- There appears to be no constraints on the movement of fruits and vegetables between infested and non-infested areas. There is a need for updated pest risk analyses. Countries receiving goods from Egypt are at risk.
- Peach fruit fly detection in Egypt is limited to scattered traps using non-toxic methyl eugenol plugs. Egypt lacks the capability to identify other exotic species of fruit flies that may be picked up in their detection trapping arrays.
- Permanent planting of mixed fruit fly hosts in Egypt allow for rapid development and expansion of peach fruit fly.
- Control methodology, using killing bags and bait spraying of tree trunks, has a limited effect on the control of fruit fly.
- There appears to be no parasite complex in existence and therefore, is not suppressing peach fruit fly populations.
- The Egyptian Government lacks a full awareness that the peach fruit fly has been introduced or the crop losses that are occurring. This prevents the government from establishing a cohesive and sensible National strategy aimed at containment and control.
- There is a lack of expertise in the areas of the MAT, the BAT, the SIT, insect identification and internal quarantine implementation.
- Production, damage and price information does not appear to have been collated for peach fruit fly and proved to be difficult or impossible to obtain.
- As a result of the consultants mission a greater awareness and understanding of the peach fruit fly problem in Egypt has been raised particularly among officials within the Ministry of Agriculture (Under Secretary for Plant Protection - Khalil El Malky), the Plant Protection Research Institute (Director - Dr Mahmoud El Naggar), and the FAO (Regional Representative - Dr Mahmoud Taher).

RECOMMENDATIONS FOR COUNTERPART INSTITUTION AND NATIONAL COUNTERPART

Most Urgent

- Develop a national strategy for the control, containment or eradication of peach fruit fly. (PPRI and Ministry of Agriculture)
- Continue and expand the existing trapping programme but replacing the ME plugs used currently with ME wicks plus toxicant. (PPRI)
- Add Cuelure and McPhail traps to the national detection system. (PPRI)
- Protect any areas, not currently infested with peach fruit fly, using internal quarantine measures and a standardised surveillance programme. (Central Administration for Plant Quarantine & Ministry of Agriculture)
- Set up an emergency response team to eradicate any incipient infestation in the currently peach fruit fly free zones. (Ministry of Agriculture)

High Priority

- Identify two individuals to be trained in the taxonomy of fruit flies as soon as possible. (PPRI)
- Standardise distribution and record keeping according to manuals provided. (PPRI)
- Update quarantine pest list and initiate pest risk analyses immediately. (Central Administration for Plant Quarantine)
- Implement simple public relation campaign creating awareness of the risk of exotic pest importation. For example, the siting of amnesty bins at all ports of entry. (Ministry of Agriculture & Central Administration for Plant Quarantine)
- Reinforce point of entry inspections and monitor implementation. (Central Administration for Plant Quarantine)
- Modify suppression techniques to include foliar applications and killing bags with a greatly increased surface area. (PPRI)

Medium term

- Annual assessment of crop production, crop protection and crop loss information should be undertaken. (PPRI, Ministry of Agriculture & Ministry of Statistics)
- Encourage the planting of resistant varieties of fruits and encourage the use of avoidance techniques. (Ministry of Agriculture)
- Encourage the establishment of any additional parasite complexes available for the suppression of fruit flies. (PPRI)

RECOMMENDATIONS FOR IAEA AND FAO

IAEA Recommendations

- Considering the large investment made to date by Member states and the Agency to control and eradicate the Medfly from the Near East and Maghreb Regions, IAEA should distribute traps and attractants to those countries where TC projects are underway as a means of early detection of peach fruit fly
- IAEA should distribute copies of the USDA Emergency Action Plan for peach fruit fly to Member States in the Mediterranean where fruit fly projects are currently conducted.
- IAEA should assist Member States in conducting emergency measure if peach fruit fly is detected in new locations where fruit fly projects are currently conducted.
- Egypt should submit a proposal for a National TC Project to protect and maintain the new production areas in the Sinai from peach fruit fly invasion, especially the 70,000 ha area newly planted with peaches in El Arish. This would extend protection to those investments already made by IAEA and the Member States in the Gaza Strip, Israel and Jordan.

FAO Recommendations

- Continue to provide technical and material support to include a variety of traps and attractants to assess the distribution and composition of the true fruit fly complex established in Egypt.
- Inform other countries susceptible to peach fruit fly infestation about its presence in Egypt and what measures are being taken to control its spread.
- Assist the Egyptian government to identify costs of control options and coordinating contributions from donor countries and agencies.
- Identify a suitable institution to provide fruit fly identification training to Egypt and neighbouring countries
- Assist Egypt to prepare a FAO/TCP proposal for support of surveillance and protection of peach fruit fly free areas, particularly Sinai and the newly developed areas covering 1.5 million feddans.

FAO and IAEA Joint Recommendations

- Develop a regional strategy for early detection, containment, control and/or eradication of peach fruit fly.
- To create a greater awareness of the pest, a special conference should be held somewhere within the Mediterranean so that the mission findings can be brought to the attention of the authorities in other countries. FAO, together with IAEA, could distribute a small quantity of trapping materials, provide half a day of training on the installation and servicing of traps and information about sources of trapping materials.

APPENDIX 1 HISTORY OF FINDS

The following are abstracts from e.mail message sent between Ian White and others prior to the mission. It gives an indication of the uncertainty regarding the time of first arrival of this pest in Egypt.

"The new record that I had wanted to pass to you was that of Bactrocera zonata from Egypt. As far as I am aware this is a new record of this Asian pest species although I have seen a mention of it in an IAEA document on fruit fly control in the Maghreb (by W. Klassen in 1992) but I assume that was based on the fact that Efflatoun (Trupaneidae of Egypt, c.1927) included zonata based on the fact that even in the 1920s it was regarded as a serious potential threat to Egyptian horticulture."

"The letter states "concerning one of fruit flies had been found for the first time infesting guava fruits." They clearly knew they had something 'new'. They continue, "The insect was obtained from infested guava fruits in Agamy and Sabahia districts near Alexandria City in 15/8/97 and 19/9/97, respectively.""

"Bactrocera (Bactrocera) zonata (Saunders) - A very common south-Asian species whose males may be trapped using methyl eugenol bait. Found in Bangladesh, India, Laos, Mauritius (introduced), Myanmar, Pakistan, Sri Lanka, Thailand, Vietnam. Eradicated from California. Introduced to Egypt (identified early 1998). Known as a pest of peach (Prunus persica) and sugar-apple (Annona squamosa) in India, and common guava (Psidium guajava) and mango (Mangifera indica) in Pakistan. Recorded from several other fruits. We have previously seen this species from the Alexandria area (early 1998). There has been some debate as to the identity of the flies associated with guava at Giza that is worthy of some discussion. Abuel-ela, Hashem & Mohamed (in press - [name of journal not known]) have recently reported B. pallida (Perkins & May) from guava in the Giza Governorate. B. pallida is a non-pest species previously only known from the Atherton Tableland of Queensland. Illustrations provided by Abuel-ela et al. are also a good fit for B. zonata and lack diagnostic features of B. pallida. The authors also refer to an unpublished thesis in which the supposedly same species had been identified as B. zonata; the thesis indicates that "zonata" has been known in Egypt since before 1979 but the record had gone unreported.

Your specimens are clearly B. zonata (identified by experience with this very common pest species; verified by checking with a computerised diagnostic system that contains descriptions of over 580 species of Dacinae and comparison with specimens). Your specimens differ from B. pallida in several respects, including their lack of a complete costal band and the lack of a dense area of microtrichia in the narrow (sub-basal) part of cell br; those features place these two species in quite different species groups. We are unable to verify the existence of B. pallida outside of Australia."

Jorge Hendrichs of the IAEA supervised fruit fly detection activities within Egypt from 1984-86 as part of the IAEA-sponsored MISRMED Program. For 1 ½ years, trapping with Jackson (baited with TML, cuelure, and ME) and McPhail traps plus extensive fruit sampling was conducted in all Governorates. There were 5 operational centres that each had 20 vehicles dedicated to surveillance. During that 1 ½ years, the only fruit flies detected were Medfly, *Dacus longistylus*, *Dacus ciliatus*, and *Bactrocera oleae*.

APPENDIX 2 LIST OF HOST SPECIES

Peach	*Prunus persica*
Mango	*Mangifera indica*
Fig	*Ficus carica*
Guava	*Psidium guajava*
Sapote	*Achras sapote*
Ber	*Zizyphus jujuba*
Citrus	*Citrus* sp.
Bael	*Aegle marmelos*
Bottle gourd	*Lagenaria vulgaris*
Tomato	*Lycopersicon esculentum*
Long melon	*Cucumis utilissimus*
Tori	*Luffa* sp.
	Careya arborea
Brinjal	*Solanum melogena*
	Basolia latifolia
Custard apple	*Anona squamosa*
Pomegranite	*Puncia granatum*
Apple	*Malus domestica*
Pear	*Pyrus communis*
Dates	*Phoenix dactylifera*
Okra	*Abelmoschus esculentus*
Papaya	*Carica papaya*
Paradise apple	*Malus pumilla*
Phalsa	*Grewia asiatica*
Quince	*Cydonia oblonga*

Possible hosts

melon	*Cucumis melo*
watermelon	*Citrullus lanatus*
Squash	*Cucurbita* spp.

APPENDIX 4

Cost Benefit Figures

The following pages contain information used in the cost benefit analysis and also some of the assumptions made in deriving the costs and benefits of any control scheme.

Production and price information

Information for production (1998) obtained from Egyptian Government and FAO databases. Prices are procurement prices converted to farm gate for 1997 (farm gate price = 0.8 x procurement price) obtained from Ministry of Supply, Egyptian Government.

	AREA (HA)	AVERAGE YIELD (Tonnes/ha)	PRODUCTION ('000 Tonnes)	PRICE (US$/Tonne)	VALUE (US$ million)
CROP				Farm gate prices	
Oranges all types home	126884.500	17.529	2224.158	156.320	347.680
Oranges all types export	3061.000	17.529	53.656	323.400	17.352
Apple	26000.000	15.769	409.994	936.000	383.754
Pear	5800.000	10.345	60.001	583.000	34.981
Peach home*	35997.000	4.363	157.055	489.000	76.800
Peach export	287.000	4.363	1.252	600.000	0.751
Apricot	3000.000	1.500	4.500	901.000	4.055
Mango	23500.000	9.830	231.005	1334.000	308.161
Guava	11428.000	21.225	242.559	296.000	71.798
Fig	23200.000	9.332	216.502	485.000	105.004
Dates	29000.000	25.862	749.998	403.000	302.249
Almond	6590.000	7.200	47.448	200.000	9.490
Squash**	26202.000	17.980	471.112	382.000	179.965
Water melon**	44292.000	25.050	1109.515	228.000	252.969
Cantaloupe**	14953.000	23.700	354.386	336.000	119.074
Other Melons**	6273.000	25.250	158.393	200.000	31.679
Okra	4744.000	14.700	69.737	350.000	24.408
Total	391211.500				2270.169

* Total of 70,000 ha of peaches in El Arish but not all trees are productive yet
** Indicates potential host

ESTIMATES OF POTENTIAL LOSS BY CROP TYPE FOR THE WHOLE OF EGYPT.

CROP	POTENTIAL LOSS (% est)	ACTUAL LOSS (% est)	ACTUAL YIELD (Tonnes/ha)	POTENTIAL LOSS (T/ha est)	PRICE (US$/Tonne)	POTENTIAL LOSS (US$ million)	Actual loss with control ($ million)
Orange home	12.000	6.000	17.529	2.238	156.320	44.385	22.192
Oranges all types export	12.000	6.000	17.529	2.238	323.400	2.215	1.108
Apple	10.000	5.000	15.769	1.660	936.000	40.395	20.198
Pear	10.000	5.000	10.345	1.089	583.000	3.682	1.841
Peach	40.000	20.000	4.363	2.182	489.000	38.400	19.200
Peach export	40.000	20.000	4.363	2.182	600.000	0.376	0.188
Apricot	75.000	37.000	1.500	1.786	901.000	4.827	2.381
Mango	40.000	20.000	9.830	4.915	1334.000	154.080	77.040
Guava	40.000	20.000	21.225	10.613	296.000	35.899	17.949
Fig	3.000	1.500	9.332	0.284	485.000	3.198	1.599
Dates	3.000	1.500	25.862	0.788	403.000	9.206	4.603
Almond	1.000	0.500	7.200	0.072	200.000	0.095	0.048
Squash	3.000	1.500	17.980	0.548	382.000	5.481	2.741
Water melon	3.000	1.500	25.050	0.763	228.000	7.705	3.852
Cantaloupe	3.000	1.500	23.700	0.722	336.000	3.627	1.813
Other Melons	3.000	1.500	25.250	0.769	200.000	0.965	0.482
Okra	3.000	1.500	14.700	0.448	350.000	0.743	0.372
TOTAL						**355.278**	**177.607**

Annex K - Relevant Contact-Address List

I - International Financial Institutions

International Fund for Agricultural Development (IFAD)
107, Via del Serafico,
Rome
00142 - Italy.
Tel: (3906)54591
Fax: (3906)5043463
E-mail ifad@ifad.org
Internet: http://www.ifad.org/ifadeval/

The Japan Bank for International Cooperation
1, Ohtemachi 1 -Chome Chiyoda-Ku
Tokyo 100-8144
Japan
Tel: 03-5218-3100 (Press & External Affairs)
Tel: 03-5218-3101 (Public Information)
13Fl., Aqua Dojima East 4-4,
Dojimahama I-Chomi
Kita-Ku, Osaka 530-0004
Japan
Tel: 06-6346-4770

European Investment Bank (EIB)
100 Boulevard Konrad Adenauer
P.O. Box 2950
L-2950 Luxembourg
Luxembourg
Tel: [352]4-3791
Fax: [352]43-7704
H320 Video-conf-[352]43-9367
Internet: www.eib.org

The Common Fund for Commodities
Willemshuis
Stadhouderskade 55
Postbus 74656,
1070 BR Amsterdam,
The Netherlands
Tel: 31 20-575 4949
Fax: 34 20 676 0231
Telex: 12331 CFC NL
E-Mail: mdr@common-fund.org

Sectorial Commission for the Common Market of the South - Uruguay
Convencion 1366 Piso 4
Edif. Galería Caubarrere
Montevideo I I 100
Uruguay
Tel: [598](2)901-5556
[598](2)908-1025
Fax: [598](2)902-3655
E-mail: comisec@adinet.com.uy
Internet: www.comisec.gub.uy

World Bank - International Bank for Reconstruction and Development
1818 H St N.W.
Washinghton, DC 20433
USA
Tel: 00 1202 4771234
Fax: 00 1 202 4778164
Telex: WORLDBK 248423 OR 64145
Internet: http://www.worldbank.org

European Bank for Reconstruction and Development (EBRD)
One Exchange Square
London EC2A 2JN
England
Tel: [44](171)3 3 8-6000
[44](171)496-6000
Fax: [44](171)338-6100
Telex: 8812161 EBRD L G
http://www.ebrd.com/english/index.htm

Kuwait Fund for Arab Economic Development
P.O. Box 2921
Al-Hilali Street
Safat 13030
Kuwait
Tel: [965]246-8800
Fax: [965]241-9090 to 92
[965]243-6289
Telex: 22025 ALSUNDUK
22613 KFAED KT
Cable: ALSUNDUK
E-mail: info@kuwait-fund.org

Islamic Development Bank (IIDB)
P.O.Box 5925
Jeddah - Saudi Arabia,
Tel: 009662-6361400,
Fax: 009662-6366871
E-mail: idb.archives@mail.oicisnet.org
Internet: http://www.isdb.org/

Arab Bank for Agriculture Development (AOAD)
Street No. 7
P.O. Box 474
Al-Amarat
Khartoum
Sudan
Tel: [249](11)47-2176
[249](11)47-2183
Fax: [249](11)47-1402
Telex: 22554 AOAD SD
Cable: AOAD KHARTOUM

African Development Bank (ADB)
01 BP 1387
Abidjan 01
Côte d'Ivoire
Tel: 00 225 204444
Fax: 00 225. 217753
Cable: AFOEV ABIDJAN

Asian Development Bank
6 ADB Avenue,
Mandaluyong
PO Box 789
1099 Manila
Philippines
Tel: 00 63 2 7113851
Telex: 29066, 42205, 63587
Cable: ASIANBANK MANILA
Fax: 0063 2 7417961 or
00 63 2 6316816

Inter-American Development Bank (IADB)
1300 New York Avenue
Washinghton DC 20577
USA
Tel: 00 1 202 623 1000
Fax: 00 1 202 789 2835

The OPEC Fund for International Development
Parkring 8
P.O. Box 995
A-1010 Vienna
Austria
Tel: [43](1)51-5640
Fax: [43](1)513-9238
Telex: 131734 FUND A
134831 FUND A
Cable: OPECFUND

CLAM
Plaza de España 18-11, No 4
28008 Madrid
Spain
Tel: (34) 915 414 461 or 915 481375
Fax: (34) 915 481621
E-mail: secretariatgeneral@clamcitrus.org

California Citrus Research Board
323 W. Oak
Visalia, Ca 93291
USA
Tel: 00 1559 7380246
Fax: 00 1559 7380607
E-mail: batkin@psnw.com

Association Espanola de Industria y Comercio Exportador de Aceite de Oliva
José Abascal 40
28003 Madrid
Spain
Tel: 34 1446 88 12/16/50
Fax: 34 1593 19 18
E-mail: asoliva@ctv.es
Internet: http://www.asoliva.es/

Aceites Coosur S.A
Los Madrazo,
36-38 5^{o} dcha.
28014 – Madrid
Spain
Tel.: 34-91-360 55 20;
Fax: 34-91-523 05
e-mail: export@coosur.com
Internet: http://www.coosur.com/

Greek Association of Industries and Processors of Olive Oil - SEVITEL,
15a, Xenofontos str.
Athens 10557
Greece
Tel. 3238856
Fax 3246408
E-mail: sevitel@oliveoil.gr

The International Olive Oil Council (IOOC)
Principe de Vergara 154
28002 Madrid
Spain
Tel: [34](91)563-3638
Fax: [34](91)563-1263
E-mail: iooc@mad.servicom.es

International Coffee Organization (ICO)
22 Berners, Street
London W1P 4DD
England
Tel: [44](171)580-8591
Fax: [44](171)580-6129
e-mail: info@ico.org

III - Major Supermarkets and Buyers of Mediterranean Product

ASDA Group PLC:
Internet: http://www.asda.co.uk/index.html

TESCO: Head Office
Tesco Stores Ltd.
P.O. Box 18.,
Delamare Road,
Cheshunt,
Hertfordshire.EN8 9SL
England
Tel: +44 (0)1992 632222
Fax: +44 (0)1992 630794
Internet: http://www.tesco.co.uk/indexn.htm

WALMART
Tel: 1-800-WMONLINE
E-mail : letters@wal-mart.com
Internet: http://www.wal-mart.com

SAFEWAY Inc.
5918 Stoneridge Mall Road
Pleasanton, CA 94588
Phone: (925) 467-3000
Fax: (925) 467-332

CARREFOUR
Direction Generale
6, Avenue Raymond Poincare
B.P. 419.16
75769 Paris cedex
France
Tel: 33 (0) 153701900
info@caffefour.com

IV- Agriculture Research Institutes/ Agencies

The Agricultural Research Service (ARS)
Jamie L. Whitten Building, 302-A
14th & Independence Ave., SW
Washington, D.C. 20250
USA
Tel: 202-720-3656
Fax: 202-720-5427
E-mail: admars@ars.usda.gov

EMBRAPA/CNPTIA:
Caixa Postal (Mail Box) 6041
CEP 13.Q83-970 Campinas SP
Brazil
E-mail: cnptia@cnptia.embrapa.br

V - Plant Protection Organizations

California Department of Food and Agriculture (CDFA)
CDFA Office of Public Affairs
1220 N Street.4 100
Sacramento, CA 95814
Tel: (916) 654-0462
Fax: (916) 657-4240
E-mail: cdfapubficaffairs@cdfa.ca.gov

Moscamed - Guatemala
USDA-APHIS-IS
4 Avenida 12-62, Zona 10
Guatemala CA 01010
Guatemala
Tel: 005023343009 ext. 05046
Fax: 005023343009
E-mail: medfly@guate.net

Medfly Program Mexico and Central America
USDA/APHIS/IS, Unit 3319
American Embassy-Guatemala City
APO AA 34024-3319
USA
Tel: 00 502 3312156; 3312036; 3322037;
3322153
Fax: 00 502 333 5446
E-mail: gtween@guate.net

Moscamed-Mexico
Direction General de Sanidad Vegeta
Guillermo Perez Valenzuela 127
04000 Mexico, D.F.
Mexico
Tel: 0052962515542
Fax: 005296250802
E-mail: moscafrut@laneta.apc.org

United States Department Of Agriculture Animal & Health Inspectton Service Plant Protection & Quarantine
4700 River Road Unit 134
Riverdale; Maryland 20737 - 134
USA
Tel: 00 1-301-734-47
Fax: 00 1-301-734-8584
Email: Michael.B.Stefan@usda.gov

Asia and Pacific Plant Protection Commission
FAO Regional Office for Asia and the Pacific
Maliwan Mansion
39 Phra Atit Road
Bangkok 10200
Thailand
Tel: +66 2 2817844 ext 268
Fax: +66 2280 0445
Telex: 82815 FOODAG TH
Cable: FOODAGRI Bangkok
E-mail: chongyao.shen@fao.org

Asia-Pacific Crop Protection Association
14th floor, Rasa Tower
555 Paholyothin Road,
Bangkok 10900,
Thailand
Tel: + 66 (2) 937-0487/90
Fax: + 66 (2) 937-0491
E-mail: info@apcpa.org

Pacific Plant Protection Organization
Department of Primary Industries and Energy
GPO Box Canberra
ACT 2601
Australia
Tel: +612 62725250
Fax: +612 62723307
E-mail: bob.ikin@daffgov.au

European and Mediterranean Plant Protection Organization (OEPP/EPPO)
1, rue le Nôtre
75016 Paris, France
Tel: +33 145 20 77 94
Fax: +33 142 24 89 43
E-mail: hq@eppo.fr
Internet: www.eppo.org

Organismo Internacional Regional De Sanidad Agropecuaria (OIRSA)
Calle Ramón Belloso
Col. Escalon
San Salvador
El Salvador
Tel: +503 2232391
Fax: +503 2982119
E-mail: oirsa@nsl.oirsa.org.sv
Internet: www.oirsa.org.sv

Comunidad Andina (CAN)
Casilla Postal 18-1177
Lima 18
Peru
Tel: +512212222
Fax: +512213329
Telex: CA 20104 PE
E-mail: Sanidad@junda.org.pe
Internet: www.comunidadandina.org

Comité Regional de Sanidad Vegetal del Cono Sur (COSAVE)
Edificio de la Dirección de Extensión Agraria
Ruta Martiscal Estrigarribia, 1 piso - bloque B
San Lorenzo,
Paraguay
Tel: +595 21574343
Fax: +595 21 574343
E-mail: st@cosave.org.py
Internet: www.cosave.org.py

Caribbean Plant Protection Commission (CPPC)
FAO Sub-Regional Office for the Caribbean
P.O. Box 631-C
Bridgetown,
Barbados
Tel: +246 4267110
Fax: +246 4276075
Cable: FOODAGRI BRIDGETOWN
E-mail: gene.pollard@field.fao.org

North American Plant Protection Organization (NAPPO)
Agriculture and Agrifood Canada
59 Camelot Drive
Nepean
Ontario K1A 0Y9
Canada
Tel: +1613-225 2342
Fax: +1613-228 6618
E-mail: imcdonell@em.agr.ca
Internet: www.nappo.org

Interafrican Phytosanitary Council (IAPSC/CPI)
P.O. Box 4170
Nlongkak
Yaoundé
Cameroon
Tel : +237 22 25 28
Fax: +237 22 4754
Telex: TECOUARC 8460 KN
Cable: TECHNAFRIQUE YAOUNDE

Servicio Nacional de Sanidad y Cualidad Agroalimentaria (SENASA-ARG)
Administración Central
Av. P. Colón 367
Cap. Fed.
Argentina
Tel: 331-6041/9
342-1029
Fax: 345-4110/12
E-mail: infomati@inea.com.ar

SENASA-PERU
Av. Salaverry S/N Edificio Ministerio del Trabajo
Sector Jesus Maria, 10
Lima
Peru
Tel: 51 14 4353316
Fax: 51 14 4353316

Servicio Agricola y Ganadero (SAG)
Ministry of Agriculture.
Av. Bulnes 140 Piso 3
Departamento Protección Agricola
Sub-Departamento Defensa Agricola
Santiago
Chile
Phone: [56] (2) 696-8500, or 698-2244 ext. 333

VI- Government Body/Government Development Agency.

Canadian International Development Agency
200 Promenade du Portage
Hull, Quebec
Canada
K1A 0G4
Tel: (819) 997-7951
Fax: (819) 953-3352
http://www.acdi-cida.gc.ca/index-e.htm

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
Germany
Tel: +49 6196 79-0
Fax: +49 6196 79-1115

U.S. Agency for International Development (USAID)
Information Center
Ronald Reagan Building
Washington, D.C. 20523-0016
Tel: 202-712-4810
Fax: 202-216-3524
Internet: http://www.info.usaid.gov/contacts.htm

Japan International Cooperation Agency (JICA)
Shinjuku Mines Tower,
2-1-1, Yoyogi,
Shibuya-Ku,
Tokyo
Japan
Tel: 03(5352)5311-5314

European Union (EU)
General Secretariat of the Council of the European Union
Rue de la Loi 175
B-1048 Bruxelles
Tel.: (32-2) 285 65 89
Fax : (32-2) 285 83 75
Internet: http://europa.eu.int/

EU Scienticand Technological Cooperation with Developing Countries
DG XII/B
Tel: (32-2) 295 28 08
Fax: (32-2) 296 62 52
E-mail: inco-dc@dgl2.cec.be
http://europa.eu.int/en/comm/dgl2/intcol.html

EU Cooperation with Central and Eastern Europe
DG XII/B
Tel: (32-2) 296 14 12
Fax: (32-2) 296 59 36
E-mail: michele.genovese@dg12.cec.be

EU Cooperation with Industrialised Countries Outside Europe
DG XII/B
Tel: (32-2) 295 36 96
Fax: (32-2) 296 98 24
E-mail: louis.bellemin@dg12.cec.be

Organisation for Economic Cooperation and Development (OECD)
Château de la Muette
2, rue André-Pascal
75775 Paris CEDEX 16
France
Tel: [33]14524-8200
Fax: [33]14524-8500
E-Mail: news.contact@oecd.org
Internet: www.oecd.org

Secretariat for Central American Economic Integration
4a. Avenida 10-25, Zona 14
1237, Guatemala 01901
Ciudad de Guatemala
Guatemala
Tel: [502]368-2151 to 54
Fax: [502]368-1071
[502]337-3750
E-Mail: info@sieca.org.gt
Internet: www.sieca.org.gt

South Asian Association for Regional Cooperation (Saarc)
SAARC Secretariat
P.O. Box 4222
Tri Devi Marg
Thamel
Kathmandu
Nepal
Tel: [977](1)22-1785/1794
Fax: [977](1)22-7033/3991
Telex: 2561 SAARC NP
E-Mail: saarc@mos.com.np
Internet: www.south-asia.com/saarc

Asian And Pacific Centre for Transfer of Technology (APCTT)
Adjoining Technology Bhavan Complex
Off New Mehrauli Road
P.O. Box 4575
New Delhi 110 016
India
Tel: [91](11)685-6276
[91](11)685-6255
Fax: [91](11)685-6274
Telex: 31-73271 APCT IN
Cable: APICETITI
E-mail: postmaster@apctt.org;
infocentre@apctt.org
Internet: www.apctt.org

International Organization for Biological and Integrated Control of Noxious Animals and Plants: West Paleartic Region Section (OILB)
I.N.R.A. Laboratoire de recherches sur la Flore pathogéne du Sol
17, rue Sully
BP 1540
F-21034 Dijon Cedex,
France
Tel: +33 03 80 63 30 41
Fax: +33 03 80 63 32 26
E-mail: ala@dijon.inra.fr

Inter-American Instute for Cooperation on Agriculture (IICA)
Apartado 55
2200 Coronado
San José
Costa Rica
Tel: [50 6]229-0222
[50 6]216-0222
Fax: [50 6]216-0233
[50 6]229-2659
E-Mail: iica@ac.cr

Asociación Latinoamericana de Integración (ALADI)
General Secretariat
Casilla de Correos 577
Calle Cebollati 1461
Código Postal 11000
Montevideo, Uruguay
Tel: [598](2)400-1121 to 28
Fax: [598](2)409-0649
Cable: ALADI
E-Mail: aladi@chasque.apc.org

VIII - Public International Organizations

The International Atomic Energy Agency
Joint FAO/IAEA Division
Insect Pest Control Section
P.O. Box 100
Wagramer Strasse 5
A-1400 Vienna Austria
Tel: 43 12600
Fax: 43 126007
E-mail: Official.Mail@iaea.org
http://www.iaea.org/programmes/nafa/d4/index.htm

Seibersdorf Laboratories
Entomology Unit
A-2444 Seibersdorf
Austria
Tel.: +43 12600 + Ext
Cables: Inatom Vienna
Telex: 112645 atom a
Fax: +43 126 00 28 222
http://www.iaea.org/programmes/nafa/dx/about/lab/lab_5.html

Food And Agriculture Organization of the United Nations (FAO)
Viale delle Terme di Caracalla,
00100 Rome
Italy
Tel: +39 06 5705 1
Fax: +39 06 5705 3152
Telex: 625852/625853/610181 FAO I
Cables: FOODAGRI ROME
E-mail: FAO-HQ@fao.org
Internet: http://www.fao.org/

The United Nations Industrial Development Organzation (UNIDO)
Vienna International Centre
P.O. Box 300
A-1400 Vienna
Austria
Tel: (+43 1) 26026
Fax: (+43 1) 26926 69
Internet: http://www.unido.org/

United Nations Development Programme (UNDP)
One United Nations Plaza
New York, NY 100 17
USA
Tel: [1](212)906-5000
Fax: [1](212)826-2057
Telex: 236286.
Cable: UNDEVPRO
Internet: www.undp.org
E-mail: Webmaster@undp.org

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)
United Nations Building
Rajadamnern Avenue
Bangkok 10200
Thailand
Tel: [66](2)288-1234
Fax: [66](2)288-1000
Cable: ESCAP BANGKOK
E-mail: library-escap@un.org
Internet: www.unescap.org

United Nations Economic Commission for Africa (UNECA)
Africa Hall
P.O. Box 3001
Addis Ababa
Ethiopia
Tel: [251](1)51-7200
[251](1)51-1231
Fax: [251](1)51-4416
(New York) [1](212)963-4957
Telex: 21029 ECA ET
Cable: ECA ADDISABABA

United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
Edificio Naciones Unidas
Casilla 179-D
Avenida Dag Hammarskjöld
Santiago
Chile
Tel: [56](2)210-2000
Fax: [56](2)208-0252
[56](2)208-1946
Telex: 340295 UNSTGO CK
Cable: UNATIONS
E-mail: cpisantiago@eclac.cl
Internet: www.eclac.org

United Nations Environment Programme (UNEP)
UN Office at Nairobi
United Nations Avenue, Gigiri
P.O. Box 3055,
Nairobi,
Kenya
Tel: 00 254; 621234
Fax: 00 254 2 623928
Cable: UNITERRA NAIROBI
E-mail: eisinfo@unep.org

Annex L - Member States of IAEA, FAO, IPPC, WTO

Afghanistan ✷✧
Albania ✷✧
Algeria ✷● ✧
Angola ✷○✧
Antigua and Barbuda ✧
Argentina ✷●✧
Armenia ✷✧
Australia ✷●○✧
Austria ✷●○✧
Azerbaijan ✧
Bahamas ●✧
Bahrain ●○✧
Bangladesh ✷●○✧
Barbados ●○✧
Belgium ✷●○✧
Belize ●○✧
Benin ✷○✧
Bhutan ●✧
Bolivia ✷●○✧
Bosnia and Herzegovina ✷✧
Botswana ○✧
Brazil ✷●○✧
Brunei Darussalam ○
Bulgaria ✷●○✧
Burkina Faso ✷●○✧
Burundi ○✧
Cambodia ✷●✧
Cameroon ✷○✧
Canada ✷●○✧
Cape Verde ●✧
Central African Republic ○✧
Chad ○✧
Chile ✷●○✧
China ✷✧
Colombia ✷○●✧
Comoros ✧
Congo, Dem. Rep. of ○✧
Congo, Republic of ○✧
Cook Islands ✧
Costa Rica ✷●○✧
Cote d'Ivoire ✷○✧
Croatia ✷●✧
Cuba ✷●○✧
Cyprus ✷●○✧
Czech Republic ✷●○✧
Denmark ✷●○✧
Djibouti ○✧
Dominica ○✧
Dominican Rep. ✷●○✧
Ecuador ✷●○✧
Egypt ✷●○✧
El Salvador ✷●○✧
Equatorial Guinea ●✧
Eritrea ✧
Estonia ✷✧
Ethiopia ✷●✧
European Union○
Fiji ○✧
Finland ✷●○✧
France ✷●○✧
Gabon ✷○✧
Gambia ○✧
Georgia ✷✧
Germany ✷●○✧
Ghana ✷●○✧
Greece ✷●○✧
Grenada ●○✧
Guatemala ✷●○✧
Guinea● ✧
Guinea-Bissau ○✧
Guyana ○●✧
Haiti ✷○●✧
Honduras ○●✧
Honk Kong, China ○
Hungary ✷○●✧
Iceland ✷○✧
India ✷○●✧
Indonesia ✷○●✧
Iran, Islamic Rep. of ✷●✧
Iraq ✷●✧
Ireland ✷○●✧
Israel ✷○●✧
Italy ✷○●✧
Jamaica ✷○●✧
Japan ✷○●✧
Jordan ✷●✧
Kazakhstan ✷✧
Kenya ✷○●✧
Kiribati ✧
Korea, Democaratic People's Republic of ✧
Korea, Rep. of ✷○●✧
Kuwait ✷○✧
Kyrgyz Republic ○✧
Laos ●✧
Latvia ✷○✧
Lebanon ✷●✧
Lesotho ○✧
Liberia ✷●✧
Libyan Arab Jamahiriya ✷●✧
Lichtenstein ✷○
Lithuania ✷✧
Luxembourg ✷○●✧
Madagascar ✷○✧
Macau ○
Macedonia, former Yugoslav Rep. ✧
Madagascar ○
Malawi ○●✧
Malaysia ✷○●✧
Maldives ○✧
Mali ✷○●✧
Malta ✷○●✧
Marshall Islands ✷✧
Mauritania ○✧
Mauritius ✷○●✧
Mexico ✷○●✧
Moldova ✧
Mongolia ✷○✧
Morocco ✷○●✧
Mozambique ○✧
Myanmar ✷○✧
Namibia ✷○✧
Nepal ✧
Netherlands ✷○●✧
Netherlands Antilles ○
New Zealand ✷●✧
Nicaragua ✷○●✧
Niger ✷●○✧
Nigeria ✷○●✧
Niue ✧
Norway ✷○●✧
Oman ●✧
Pakistan ✷○●✧
Panama ✷○●✧
Papua New Guinea ○●✧
Paraguay ✷○●✧
Peru ✷○●✧
Philippines ✷○●✧
Poland ✷○●✧
Portugal ✷○●✧
Qatar ✷○✧
Romania ✷○●✧
Russian Federation ✷●
Rwanda ○✧
Saint Kitts and Nevis ○●✧
Saint Lucia ○✧
St. Vincent and the Grenadines ○✧
Samoa ✧
Sao Tome and Principe ✧
Saudi Arabia ✷✧
Senegal ✷○●✧
Seychelles ●✧
Sierra Leone ✷○●✧
Singapore ✷○
Slovak Republic ✷○✧
Slovenia ✷○●✧
Solomon Islands ○●✧
Somalia ✧
South Africa ✷○●✧
Spain ✷○●✧
Sri Lanka ✷○●✧
Sudan ✷●✧
Suriname ○●✧
Swaziland ○●✧
Sweden ✷○●✧
Switzerland ✷○●✧
Syria ✷✧
Tajikistan ✧
Tanzania, United Rep. of ✷○✧
Thailand ✷○●✧
Togo ○●✧

Tonga ✧
Trinidad and Tobago ○✧
Tunisia ✸○●✧
Turkey ✸○●✧
Turkmenistan ✧
Uganda ✸○✧

United Arab Emirates ✸○✧
United Kingdom ✸○●✧
United States of America ✸○●✧
Uruguay ✸○●✧
Vanuatu ✧

Venezuela ✸○●✧
Viet Nam ✸✧
Yemen ✸●✧
Yugoslavia ✸●✧
Zambia ✸○●✧
Zimbabwe ✸○✧

LEGEND

● IPPC Contracting Parties
○ Members of WTO
✧ Members of FAO
✸ Members of IAEA

Sources

1. EPPO Reporting Service 99/145, No. 9 (Sept. 1 1999)
2. http://www.iaea.or.at/worldatom/About/member.shtml
3. http://www.fao.org/unfao/bodies/member-e.htm

Annex M - Strategy for Sub-Regional Program in Central America

SUBREGIONAL STRATEGY FOR A PRE AND POST HARVEST CONTROL OF FRUIT FLIES IN FRUIT PRODUCTION AND TRADE CENTRAL AMERICA, DOMINICAN REPUBLIC, MEXICO AND PANAMA

INTRODUCTION

Countries of the Central American sub-regions, because of their latitude, climate and fruit varieties, have great potential for year-round production and export of tropical fruits. Besides the traditional banana, high-value tropical fruit production has been expanding during recent decades in response to the large demand for high-quality fresh fruit. Consumers in developed countries, in particular the large nearby US market, are demanding "natural" quality food products that are available throughout the entire year. In addition a growing middle class in the sub-region has increasing purchasing power and consuming more fruit. The consumption of local fruit is also being promoted to improve the nutrition and diet of a rapidly increasing population.

Despite the recent, successful conclusion of international trade agreements, the marketing of tropical fruit from the sub-region is still hampered by non-tariff trade barriers, particularly the presence of a number of economically important fruit fly species. Few insects have a greater impact on marketing and trade of agricultural produce than tephritid fruit flies. Certain fruit importing countries, notably the United States and Japan, usually spend millions of dollars to enforce quarantine regulations to prevent the introduction of these exotic fruit fly pests and to maintain surveillance networks to detect and eliminate outbreaks of such pests.

The fruit fly problem represents a major impediment that must be overcome in the fly-infested countries of the sub-region. Fruit producers bear incalculable losses, including direct economic losses due to fruit fly damage, and costs associated with pre-harvest pest control. Other direct costs are associated with the need for post-harvest treatments, applied before or during shipment, to satisfy quarantine regulations in importing countries. They also suffer indirect losses when unable to qualify for export markets.

As a consequence of these large direct and indirect losses suffered by fruit industries in developing countries, there has been a trend in various areas of the sub-region towards more coordinated area-wide, integrated fruit fly management programs. Their objective is to overcome the often ineffective and non-sustainable pre-harvest control of flies resulting from uncoordinated actions by individual producers, through the establishment of Low Fly Prevalence Areas (LFPA). The fact that these campaigns are organized and co-financed by governmental authorities and producers confirms the growing economic and political influence of fruit growers.

However, high-quality fruit originating from Fruit Fly Low Prevalence Areas still has to undergo post-harvest quarantine treatment to obtain certification prior to shipment of fruit to importing countries. Since ethylene dibromide was banned, a major post-harvest chemical fumigant and the impending phase-out of the only other effective fumigant methyl bromide, alternative post harvest treatments are presently being used or explored. Methyl Bromide phase-out is scheduled for the year 2000 according to the US Clean Air Act, and a more gradual phase-out elsewhere according to the Montreal Protocol, because of the ozone-depleting characteristics of this chemical.

To rid some fruits from fruit fly eggs and larvae for example, a double hot-water dip, steam or hot air can be applied to such fruits as papayas and mangos. In general, these treatments are effective in meeting quarantine requirements, although there have been instances of failure to eliminate all the eggs and/or larvae of the flies. However, application of these techniques requires that fruit be collected at an early stage of maturity to avoid penetration of fly larvae beyond the effective range of hot water, steam or hot air. As a result, and aside from frequent damage to fruit caused by these treatments, subsequent fruit maturation is impaired and the fruit often does not develop to its optimal organoleptic quality. The loss of market share by Hawaiian papayas in the mainland United States in recent years is a clear example of the detrimental results of such treatments. On the other hand, fumigation with chemicals is still required for shipments found to contain flies upon arrival in the importing country, something that will no longer be possible once methyl bromide is phased out.

In view of the above considerations, irradiation, an effective and safe technological alternative for quarantine treatment of fruits, is being considered worldwide. Among some advantages over other treatments, irradiation does not leave residues in fruit, as do chemical fumigants. In terms of cost, irradiation is estimated at around US$ 0.02/kg and compares very favorably with hot vapor treatment (HVT, US 0.20-0.25/kg). Furthermore, it delays but does not prevent full maturation of fruit, thereby allowing development of optimal fruit flavor and aroma and more time for distribution. In addition, it prevents emergence of fruit flies and other insects that might hatch from eggs. All this is made possible by a single, low-dose irradiation treatment.

Besides the worldwide restriction/ban of chemical fumigants, and particularly in the context of the Central American sub-region, a major development that opens new opportunities for irradiation treatment of fruits for quarantine purposes is the upcoming generic approval by the United States Department of Agriculture (USDA), of fruit irradiation. Through its Animal and Plant health Inspection Service (APHIS), irradiation will be approved for quarantine treatment of all fruits against all fruit flies. Such approval, the first of its kind in the world, makes irradiation the technology of choice for post-harvest dis-infestation of fruits in the sub-region. It must be pointed out that irradiation of fruit for consumption, at doses up to I kGy (for insect dis-infestation or delay of maturation), is already permitted by a Food and Drug Administration (FDA) regulation, and that the new USDA authorization would be specific for quarantine treatments.

Nevertheless, good manufacturing practices and commercial success require that only high-quality fruit be irradiated, so that the full benefits of this technology can be achieved. Therefore, an integrated approach to fruit fly control covering a pre-harvest fly control program to minimize damage to fruit and level of infestation, and post-harvest irradiation for quarantine treatment should be considered.

The countries of the Central American sub-region, which together with l) Dominican Republic, Mexico and Panama conform to the sub-region covered by IICA), and the Regional Plant Protection Support Program (PARSA), have made two requests for technical support from the IAEA to address the problem described earlier and help develop the fruit industry in the sub-region. The first is related to development of integrated area-wide fruit fly control programs, including the Sterile Insect Technique (SIT), and the second concerns the establishment of an irradiation facility for quarantine treatment of fruits.

The IAEA, through its Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has expertise in management of irradiation preservation, quarantine treatment of fruit, and fly control programs. It can, therefore, provide effective technical backstopping in the post-harvest (Food Preservation Section) and pre-harvest (insect and Pest Control Section) areas of interest. A sub-regional Technical Cooperation Project, in collaboration with the above sub-regional organizations as well as the USDA/APHIS office in Central America, could help coordinate and integrate all these post- and pre-harvest efforts. A systematic approach would have a direct impact on the agricultural sector of some of the poorer countries in Latin America.

Never has the window of opportunity been wider to initiate the proposed program. The governments of Mexico and the US are undertaking an aggressive approach to the control of medfly in Mexico and Guatemala and are also committed to assist in the control of other economic fruit species in the sub-region. With the infusion of increased program monies and new leadership, the Moscamed Program has indicated they are in a unique position to facilitate the development and implementation of collaborative sub-regional programs.

A cooperative initiative could be implemented with the current Moscamed Program who have requested the establishment of an IAEA position in Central America to promote the mutual interests of IAEA, Moscamed, and member states. The Moscamed program have even offered to co-fund and support the position as well as provide cost free expertise to aid in the IAEA sub-regional program development. The use of a regional irradiation facility could be instrumental in the development of new quarantine treatment strategies as well as many post harvest uses. Moscamed has also indicated that their new Gamma Cell 667 irradiator is available to assist in the development of other post harvest and food irradiation treatments.

This enhanced association with international governments and organizations can speed the development of the FFLPA concept since export protocols must be the product of formal agreements between the Plant Protection services. An IAEA-Moscamed-USDA cooperative activity would facilitate the development of Pest Risk Analysis, and establishment of the appropriate system's approach for managing the existing fruit fly problem and other quarantine pests of concern. This synergistic approach to fruit fly problems of the sub-region would promote the assistance of international experts.

Current Moscamed-USDA activities include the validation of alternatives to the chemical malathion for aerial bait sprays as malathion could receive a carcinogen classification further restricting its use in some USDA pest control programs. Also there is an ongoing effort in foreign exploration and mass rearing of fruit fly parasites for classical and inundative releases. The mass rearing sterile medfly facility in El Pino is being expanded. The mass rearing of Anastrepha species at the Moscafruit facility are also available to support regional programs. In addition, a new initiative focused on defining the ecological conditions that will best favour fruit fly control is being planned.

AN INTEGRATED PRE-HARVEST and POST-HARVEST APPROACH

Considering that the problems already described, namely the damage to fruit production in the sub-region caused by fruit flies and the consequential activities to control these insects, as well as the parallel need to provide viable post-harvest quarantine treatments prior to shipping of fruit export cargoes, are two components of the same overall problem, an integrated approach for solving it is suggested.

Both requests from QLRSA could be addressed through a sub-regional project involving pro-harvest program for the development of a Fruit Fly Low Prevalence Areas in cooperation with local authorities and industries, and post-harvest irradiation for quarantine treatment of fruit in a centralized, strategically located irradiation facility.

Although fruit fly control programs have been conducted in several of the OIRSA countries over the years, such programs have been uncoordinated. On the other hand, and although the geographic and climatic characteristics of the sub-region make it very difficult to foresee full eradication of all types of fruit flies, localized control measures -i.e., development of Fruit Fly Low Prevalence Areas - are possible and constitute effective means to reduce fruit losses. More important from the point of view of a comprehensive pro- and post-harvest program, fruit fly control measures are essential to protect the quality of products prior to radiation post-harvest quarantine treatment, since irradiation of fly-damaged fruit would not only be wasteful but also contrary to good manufacturing practices.

Through the OIRSA, the countries that will be involved in the sub-regional project have expressed their interest in establishing pre- and post-harvest fruit fly control and quarantine systems to increase productivity and exports of their fresh fruit products. An indispensable action to achieve these goals is the creation of Fruit Fly Low Prevalence Areas (FFLPA), since it is essential that only undamaged fruit or fruit with little or no infestation be considered for irradiation and eventual export to markets requiring high-quality fruit. In addition, irradiation capabilities must be developed to allow application of this quarantine treatment to fruits prior to shipment.

FFLPA is an officially and internationally recognized phytosanitary instrument approved by the International Plant Protection Convention (IPPC). Regional plant protection organizations, including NAPPO, EPPO, OIRSA, etc., which operate within the framework of the IPPC, have endorsed irradiation as a quarantine treatment of fresh agricultural products since 1992. In addition, food irradiation in general has been endorsed by FAO, WTO, IAEA and many other international and national organizations and by the legislation of 10 countries as a safe treatment for producing wholesome fresh and processed foods. Moreover, the Codex Alimentarius, which constitutes the basic set of food standards and practices for the hygienic processing and handling of foods recognized by the OATT agreements, includes a Codex General Standard for irradiated Food.

PRESENTATIONS

Copies of the presentations and/or overheads from each of the speakers is available upon request.

Also available upon request is a generic Medfly Cost-Benefit Analysis Programme, developed by Dr. John Mumford and his group at Imperial College, UK.