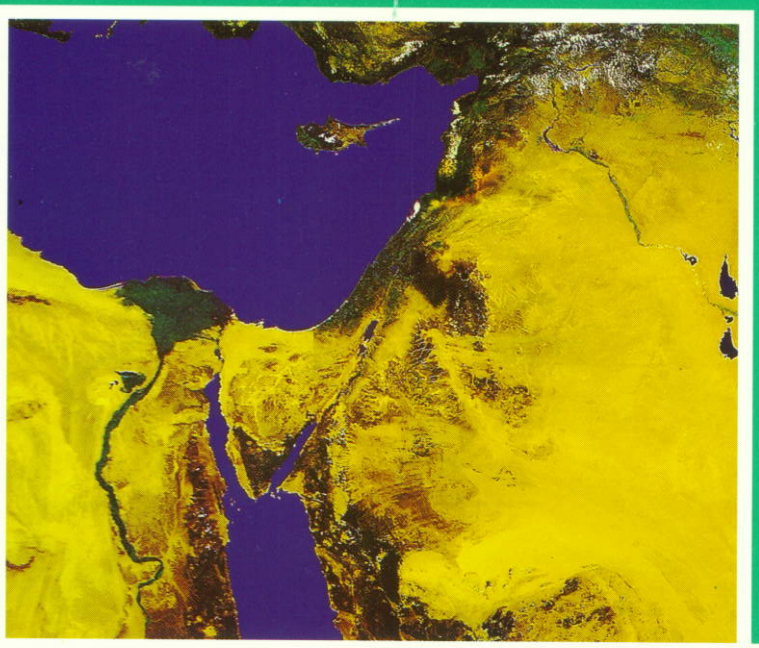
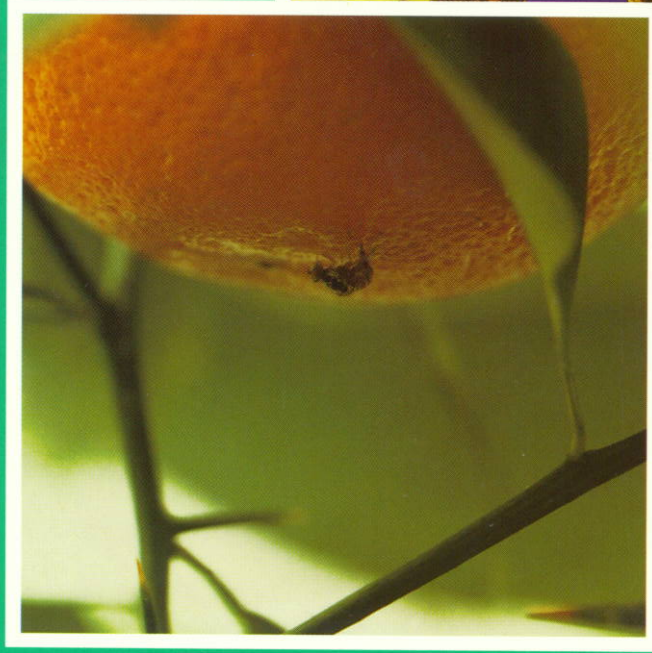
CONTROL OF THE MEDITERRANEAN FRUIT FLY IN THE NEAR EAST REGION USING THE STERILE INSECT TECHNIQUE





SUBREGIONAL PROPOSALS TO ERADICATE THE MEDFLY AND ESTABLISH FRUIT FLY FREE AREAS IN CYPRUS, EGYPT, ISRAEL, JORDAN, LEBANON, THE SYRIAN ARAB REPUBLIC AND THE TERRITORIES UNDER THE JURISDICTION OF THE PALESTINIAN AUTHORITY

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INTERNATIONAL ATOMIC ENERGY AGENCY
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

VIENNA, 1997

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EXECUTIVE SUMMARY

A series of negotiated agreements among various Near East countries may soon lead to a long term peace settlement and greater stability within that region. A more secure peace process may be further enhanced through joint projects of mutual interest, especially those that will benefit the social, political and economic well-being of all persons within the Near East region. These projects represent an opportunity to bring people in the region closer together towards a common purpose by providing better agricultural and economic opportunities for each of the countries involved.

The Mediterranean fruit fly or medfly, *Ceratitis capitata* Wiedemann, is the single most important pest species affecting fresh fruits and vegetables within the Mediterranean region, but especially the Near East [1]. For a wide range of commercial crops, including most citrus varieties, mangoes, grapes, apples, peaches, apricots, pears, plums, figs, dates, persimmons, papayas, peppers and tomatoes, it is the only economically important fruit fly in the region.

Without the repeated use of pesticides, medfly infestations of 90–100% commonly occur. Backyard and garden production of fruits also is very difficult if not impossible. The presence of this pest in the Near East region severely limits the degree to which agricultural and economic development can occur. Each year, these countries incur high economic losses, reduced availability of foodstuffs, and elevated pest control costs. Altogether these losses are estimated to amount to US $60 million annually [2, 3].

The sterile insect technique (SIT) has been successfully applied in North America, Japan, Central America, Australia, North Africa and South America. Recent breakthroughs in medfly SIT technologies, such as development of males only strains of sterile flies and more refined methods of detection, have increased the effectiveness of SIT as the final eradication tool within the context of an integrated areawide pest management approach. Eradication can be accomplished within a relatively short time-frame and is sustainable with proper follow-up and cost effective over the medium term. To achieve this goal, fruit fly rearing facilities, preferably of modular design and managed by private companies, must be constructed to produce and sterilize medflies for purposes of supplying the required quantities of sterile insects for the eradication phases of the various projects in the region.

This document, prepared at the request of Member States in the Near East region and developed by a group of international experts in fruit fly control, outlines plans to eradicate the medfly from three subregions of the Near East. The objective is the eradication of the medfly and establishment of fruit fly free areas within participating countries in order to reduce pesticide applications and to enable fresh fruit exports without post-harvest treatments. Three independent project proposals have been designated: (1) CYPRUSMED, (2) EASTMED, and (3) EGYPTMED. They contain specific recommendations for project organization and management, eradication strategies, work plans and projected costs for each project.

Implementation of any of the proposed projects will require a substantial show of interest and support, as well as initiative in seeking funding on the part of the agricultural producers and the governments of countries within the respective Near East subregions. Funding must not only come from interested donors, but commitment should be demonstrated by investments from local producers, together with significant contributions from the participating Near East governments.

Technical support for any of the the proposed projects would be provided by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, the FAO Near East Regional Office, and medfly specialists from research and action agencies in various countries. These plans also include methods development and mission oriented research so that the proposed operations may be continuously improved. At the specific request of the participating countries and interested donors, IAEA and FAO could also serve as the lead agencies in providing managerial oversight to the proposed projects.

Attitudes toward extensive pesticide usage are becoming progressively more critical. Environmental pollution and protection are becoming dominant concerns of society. In recognition of this concern, it is very timely to initiate crop protection practices that will reduce or eliminate repeated pesticide usage. Furthermore, in the increasingly sophisticated international trade of agricultural commodities, tolerance of fruit shipments with pesticide residues or some pest presence is decreasing and rejections of shipments are becoming common occurrences. Reduced usage of insecticides would be very beneficial to the environment, and allow the implementation of integrated pest management programmes against other fruit pests whose natural enemies are normally disrupted by insecticide applications against the medfly.

Medfly eradication will provide producers and consumers within this region with many benefits including significantly reduced production and control costs, along with an important decrease in pesticide usage. Costly commodity treatments could be avoided. Crop yields would increase, as would the potential to produce a greater variety of high quality host commodities.

Human population growth rates within the region range from 1.6 to 4.1% annually. Expanded fruit and vegetable production would help to address the burden placed on these countries by their increasing population, while lessening the need to import foodstuffs to meet their basic needs. At the same time, with an increase in the quality of production, they also can target the profitable international market for fresh fruit. Producers will need to develop different marketing strategies and activities to take full advantage of new opportunities as the eradication effort advances and fruit fly free areas are established.

Inherent in each of the proposed projects is the development or reinforcement of national plant health infrastructures to protect fruit and vegetable industries. Even after eradication of medfly from an area, surveillance networks will have to be maintained to allow emergency operations against incipient outbreaks of reintroduced medfly. Strengthening phytosanitary infrastructures within the region greatly benefits both plant and animal health programmes and will reduce the number of exotic pest introductions into the region. Training and experience gained by project professionals and technicians will prepare them to assume roles of future leadership in their respective countries, to more effectively manage plant and animal pests and diseases, and to use the most advanced plant protection technologies available. Improvements in local and regional areawide pest management programmes can be expected.

to medfly development, allowing many generations per year. Under warm (summer) conditions, the life cycle is completed in 18 to 33 days. Flies having newly emerged must feed on proteinaceous materials in order to become sexually mature and mate. The female deposits one to ten eggs per puncture and lays an average of 300 eggs in a life span of one to two months. Eggs hatch in about three days. The larvae feed throughout the fruit for ten days and leave it during the third instar to pupate in the soil. The pupal stage lasts about ten days at which time the adult emerges (see Annex 1).

CROPS ATTACKED

The scientific literature cites more than 300 different hosts for the medfly [5]. However, the list of preferred hosts is restricted to about 35 species. Preferred hosts include: apples, apricot, fig, guava, loquat, mango, nectarine, peach, pear, plum and some varieties of citrus such as grapefruit, mandarin, sour orange, and sweet orange. All hosts, whether primary or secondary, must be regulated to prevent the artificial spread of the pest. A list of regulated hosts appears in Annex 3.

EXTENT OF DAMAGE CAUSED BY THE PEST

The medfly is so destructive that intensive pest controls must be applied in order to grow its preferred host crops commercially. Estimates show that if the medfly became established in the major fruit and vegetable production areas of the continental USA, losses would average US $1.3 billion annually [6]. For that reason, millions of dollars are expended to eradicate new introductions. In the Near East region, a conservative estimate of the financial loss is US $60 million per year [4]. These figures do not adequately take into consideration the losses that are associated with trade restrictions on crops other than citrus, stone and pome fruits, nor those direct and indirect losses associated with production, harvesting, marketing 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 (GDP) in the Syrian Arab Republic and for 20% in Egypt. More than one third of the labour forces of the Syrian Arab Republic and Egypt are employed in agriculture. Although agriculture constitutes a lower percentage of the GDP in other countries within the region, it is extremely important to their overall economy and stability. Efforts are made to increase the exports of fruits in various countries of the region. For instance, Israel continues each year to increase its export of fruits to the USA, Japan, and other new markets. Even so, Israel must spend US $1.5 million on cold treatments to address quarantine concerns regarding the medfly.

DISTRIBUTION AND POPULATION DYNAMICS OF MEDFLY IN THE NEAR EAST

The medfly is widely distributed over approximately 92 800 km^2 of rainfed or irrigated lands within the three project areas mentioned above. Pockets of infestation also occur in low rainfall areas whenever alternate sources of water are available, i.e. wells, reservoirs, fresh-water springs. Primary hosts include many commercial fruit species which grow in an area of approximately 7218 km^2. They include most varieties of citrus, stone fruits (apricot, peach, plum, nectarine), pome fruits (apples, pears, quince), subtropicals (mango, guava) and other traditionally cultivated fruits and fleshy vegetables such as figs, dates, cactus fruits, peppers and tomatoes. Uncultivated or wild hosts, such as prickly pear, buckthorn, jujube, box thorn, figs or dates, also may be of significance from location to location.

The estimated levels of infestation in cultivated fruits may reach up to 30% with multiple pesticide treatments, but are much higher in the absence of treatments. Stone fruit and citrus are more heavily infested than pome fruits. Infestation levels in other hosts are usually very light, with the exception of certain preferred non-commercial hosts.

The medfly 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. These follow a somewhat similar pattern in all Near East countries. Medfly populations start building up slowly from early April to the beginning of June, then fly densities increase rapidly, reaching high levels in July. These high levels persist until September and October, to decrease gradually thereafter. The population density drops drastically and remains low from January through March.

III. OBJECTIVES

The primary, long term objective of the three projects is the eradication of the medfly from the three distinct ecological subregions of the Near East, thus achieving self-sufficiency and a better quality of life in the Near East by increasing the quality and quantity of fresh fruit and vegetables available to local consumers at lower prices. This is both technically and operationally feasible, as the medfly is mostly found in the relatively narrow bands of arable land that are isolated from other parts of the Mediterranean basin by sea or large expanses of arid desert. The eradication of this pest from some of the subregions will probably stimulate other countries in the Mediterranean basin to consider a similar course of action.

Another long term objective is to support the small fruit producers who cannot afford to invest in insecticides to protect their crops. In the absence of the medfly they will be able to compete more effectively with growers applying insecticides regularly. Reduction or elimination of multiple applications of pesticides by commercial producers of host fruits and host vegetables is another related objective. This is an important consideration in the global effort to protect the environment and to enhance sustainable agricultural development. With reduced pesticide usage, biological pest control approaches will become viable.

A further long term objective is a significantly strengthened plant health infrastructure within the region, thereby improving efforts to exclude the medfly and other exotic pests. The training and development of professionals and technicians will allow national plant protection organizations in the Near East region to better protect their respective countries from the introduction of other injurious plant and animal pests/diseases. If other pests are accidentally introduced, these countries also will have the added expertise and improved infrastructure in place to respond quickly to new pest outbreaks in order to contain or possibly eliminate new pests.

The immediate objectives are, therefore, to identify the financial and physical resources, as well as the expertise that will be needed to eradicate the medfly within any one of the three separate ecological subregions. Foremost, this will involve initially securing the funds required to build a sterile fly mass rearing facility or to contract with private companies for the required amount of flies for a minimum number of years, so that they can profitably invest in such a facility.

The first zones could be declared medfly free within three years of project initiation with others to follow after the verification phase has been completed. Work plans for each project outline the estimated time frame to accomplish each phase based on zones of operation. This effort also will involve training personnel in each country to develop and maintain a quarantine programme that will control pest movement, establish a surveillance system to detect the pest and the use of integrated control/eradication methods that include SIT and occasionally limited bait treatments.

IV. PROJECT BENEFITS

A. PLANT PROTECTION INFRASTRUCTURE DEVELOPMENT

(1) Survey

Surveys must be conducted to control or eradicate/manage the medfly. Surveys must be conducted to provide for early detection of new outbreaks of the medfly, to delineate infestation limits, and to monitor the effectiveness of eradication procedures. Very effective detection procedures are available for many other economically important fruit flies that do not exist in the Near East, but could be introduced accidentally (Annex 6). Although the degree of effectiveness varies between species, sufficiently effective tools are available to develop baseline data and guide management/eradication technologies for many species. Although different survey procedures are required for other plant and animal pests, the principles involved are similar. Therefore, an effective survey programme for the medfly serves as a useful model for designing programmes for other pest species.

(2) Plant quarantine

Adequate quarantine controls must be in place and enforced to prevent new medfly invasions. Regulations within the country also are essential to control movement of the medfly in support of the eradication programme. Quarantine procedures used for the medfly can be used as a basis for amending/developing regulations for preventing the introduction and spread of other plant and animal pests. The employment of effective quarantine procedures in developing and developed countries is to the mutual benefit of all countries concerned with pests of agriculture. The extent to which strong quarantines are put into effect and enforced will directly reduce the number of new pest introductions that are likely to occur. Also, when assessing quarantine regulations of a country that wishes to export, officials of importing countries normally give consideration to all plant protection activities and official controls present in the exporting country.

(3) Pest management/eradication

The general approach employed to eradicate or manage the medfly can be used for other economically important insect pests. Central to an effective application of integrated pest management is the concept of an area-wide approach, in which the total population of the pest in an area or region is managed in an integrated way. Present pesticide use, on the other hand, can best be described as an uncoordinated attack by individual farmers on a small segment of the pest population. Insects often move over considerable distances. Such uncoordinated field by field action is therefore, at best, only a temporary control measure. As long as the farmer's neighbours do not join in the efforts, regular insecticide applications will be required to protect his crops. On the other hand, when growers of a given area or region organize themselves into farmer associations to take co-ordinated action against the total population of the pest, including in marginal and urban areas, fewer resources will be required and the degree of control achieved will be much more effective.

The specific technologies for different pests vary; however, the concepts of area-wide management, as well as the co-operation of growers, areas and countries, will be of great value in designing, and applying more effectively, pest management programmes for other key plant/animal pests in the Near East region.

B. EDUCATION, TRAINING AND RESEARCH

The technical expertise needed for fruit fly management programmes (including medfly) may or may not be available in each specific country. Regardless of the extent to which it is available, management/eradication programmes offer both training and employment opportunities. Training received in such programmes will be of value to other agricultural pest management programmes. Additionally, many employees on fruit fly programmes have been inspired to attend schools and obtain more technical training. This is beneficial not only to the employees, but to their countries as well.

This document is not intended to deal with the basic need for effective research to guide fruit fly eradication or pest management programmes. It goes without saying that research findings make it possible to develop and further improve management/eradication programmes. Also, research organizations benefit from such programmes as action programme managers identify specific needs for new knowledge or technology and demand research support to improve programme effectiveness. The resultant interrelationships are mutually beneficial to the two groups and they benefit agriculture and the general public.

C. ECONOMIC AND SOCIAL BENEFITS

As has been briefly discussed, successful management/eradication of the medfly should:

(1) Improve the economic stability and profitability of agriculture and related industries;
(2) Improve and stabilize governmental programmes for plant and animal pest management;
(3) Result in increased local consumption of fruit, leading to more varied diets and better nutrition within the country;
(4) Expand export markets for agricultural produce;
(5) Provide opportunities for crop diversification;
(6) Provide for increased employment to produce and market high quality crops for local consumption and export;
(7) Create staff positions due to the development of fly free areas that will employ persons who traditionally have worked in applying pesticides for medfly control.

D. MARKET POTENTIAL AND DEVELOPMENT

The presence of the medfly in the Near East region significantly limits the export of fresh fruits and vegetables to lucrative markets. Elimination or management programmes for the medfly would permit producers to export host crops currently in production, as well as provide an opportunity to produce and export other temperate and subtropical hosts that can be grown in the Near East region. This would provide an incentive for national crop diversification projects leading to increased variety of production and better quality fruits and vegetables.

The marketing of potential export crops requires the development of techniques for proper grading and packing, adequate transportation facilities and equipment, and other procedures involved in product export. Many countries have little or limited experience in the international marketing of many fruit fly host materials. The development of such procedures opens new job possibilities in addition to those related strictly to crop production. Thus, with the development of export markets, there would be an increase in the availability of 'hard currency', jobs with good pay and general economic well-being in the area.

In addition, each participating country should develop a list of potential new host crops that they intend to export in the future. This list, along with a comprehensive list of all plant

pests associated with each of the new proposed commodities, should be sent to the national plant protection organization of the importing country for purposes of conducting a pest risk analysis (PRA) to determine the entrance status of these new products. Requests for new imports are processed on a first come/first served basis so that the time required to complete a PRA can vary. To avoid possible delay, countries are encouraged to submit their lists to the proposed importing country as soon as they become available. If quarantine pests other than medfly exist in a particular area, additional phytosanitary measures may be required.

Because of the extremely effective eradication technologies available and the limited time required to achieve eradication, it is essential that market development activities be initiated at the same time as eradication. Since market development takes much longer than eradication, it would be desirable to initiate such work as soon as a decision is made to initiate an action programme, or at least before the beginning of the eradication/management programme.

E. ENVIRONMENTAL PROTECTION

In the presence of the medfly, a marketable crop cannot be produced unless the growers apply pesticides on a regular basis. The consequences of repeated pesticide applications against the medfly are not only residue problems, the potential pollution of waterways and other possible environmental contamination, but also the disruption of the fruit tree parasitoid/predator complex. These ecological disruptions often result in the emergence of secondary pests in orchards, which in turn are the cause for more pesticide applications. Integrated pest management (IPM) approaches with emphasis on cultural practices and natural enemies have been shown to effectively control other citrus pests in the absence of pesticide use against medfly.

In most cases, fruit fly control programmes conducted by individual growers involve the use of small droplet cover sprays with or without baits. Often formulations and insecticides selected by growers are more toxic to non-target organisms than the malathion bait sprays employed in public programmes. Area-wide supervised management programmes result in less damage to the environment than programmes conducted independently by growers because they usually require a smaller quantity of insecticide per hectare. However, even malathion bait sprays can be toxic to honeybees, fish and some pollinators if proper mitigative measures are not taken. Area-wide eradication programmes using SIT as the primary tool are therefore the most benign to natural enemy complexes and the environment.

As an adjunct measure, area-wide SIT eradication sometimes requires various malathion bait applications to reduce feral medfly populations to a low level so that they can be eradicated with sterile males. This is generally the case under subtropical conditions. Under the climatic conditions of the Near East, however, medfly populations decline drastically during the winter months. Population suppression using bait sprays may not be necessary as long as sterile fly releases are initiated in winter or early spring when the natural medfly populations are low. Usually, eradication is achieved after programme operations have covered three to nine life-cycles of the pest — usually lasting three to nine months. After eradication, no treatments are needed to protect the fruit or to permit export. Accordingly, in less than one year, an areawide programme has a very beneficial effect on the environment.

Programmes designed to prevent re-entry of a pest after its eradication can provide additional important environmental benefits. Considering the potential ecological disruptions of new species on existing biota, a strengthened quarantine infrastructure will result in significant reductions of pest introductions.

V. PROJECT PREREQUISITES

PARTICIPATING COUNTRIES WILL AGREE TO:

(1) Put in place national legislation that would allow project personnel to conduct all activities necessary to detect, delimit, control and eradicate the medfly within the entire project subregion or area. This would include access to properties for purposes of pest surveillance and control actions. This also would include authority for the project to employ direct and discharge personnel, enter into contracts for services, and make purchases for supplies, materials and equipment.
(2) Establish an organizational structure with some degree of autonomy to effectively administer and execute eradication activities within the proposed project areas.
(3) Develop an overall action plan in conformance with the eradication strategies outlined in this document and adopt standardized operational procedures for the proposed projects.
(4) Establish a project co-ordination committee (PCC) with representatives from local agricultural producer organizations, national plant protection organizations, the various donors, and project management.
(5) Establish a permanent technical advisory group (TAG) with representatives from national plant protection organizations, IAEA/FAO, and donors (if required by them).
(6) Provide qualified candidates to serve as co-project directors for purposes of co-ordinating project actions with co-project directors from other participating Near East countries.
(7) One year before the initiation of the eradication activities in a given project area: (a) have a fully operational survey programme for the medfly and other exotic fruit flies in accordance with the local work plan, and (b) adopt and enforce internal and external quarantine regulations to support the eradication activities and prevent the introduction of fruit flies from adjacent infested areas or other infested countries (see Annex 2).
(8) Provide all necessary offices, field operation centres, packing/distribution facilities, and associated storage areas for project equipment, material and supplies.
(9) Permit and expedite the tariff free importation of supplies, materials, equipment and other associated items needed to conduct the project.
(10) Approve the use of airport facilities (landing rights), foreign civilian aircraft, and low altitude flight operations (overflight permits) to accomplish project objectives.
(11) Provide assurance that project operations can proceed without undue interference from activities associated with national/religious holidays, military manoeuvres, etc.
(12) Permit the use of electronic communication and navigational devices used by the project, i.e. cellular telephones/facsimiles/computer modems, radios/radio navigational equipment, computerized flight recorders and analysers, geopositional equipment and computer mapping capabilities.
(13) Maintain, after eradication of the medfly from an area, surveillance networks to allow emergency operations against any incipient outbreaks of reintroduced medfly.

MANAGEMENT OF EACH PROJECT WILL AGREE TO:

(1) Execute the eradication campaign according to the operational plan, associated protocols and manuals in order to accomplish all project objectives within the specific time frames. Also, make those changes that are required to implement all field operations successfully.
(2) Report at monthly intervals to the TAG and execute the technical recommendations made by this group.

(3) Organize, twice yearly, project review meetings by the PCC and implement project activities within the policy framework, budget and general decisions taken by this committee.
(4) Effectively communicate with growers, home-owners and other interested parties in government and society to inform, update and disseminate pertinent information concerning the objective and status of execution of the project.

INVESTORS, CONTRIBUTORS AND DONORS WILL AGREE TO:

(1) Secure the required funds and provide them in a timely fashion to allow the appropriate execution and administration of the project.
(2) Establish an autonomous organization to manage eradication activities at project and national levels.
(3) Appoint representatives to serve on the PCC and the TAG.

VI. RISKS

There are a number of factors that could adversely affect the progress of the proposed eradication projects or result in failure to achieve eradication in the specified project areas of the Near East region. The proposed projects would be a complex and involved undertaking. They could fall short of reaching the objectives if not conducted in accordance with the work plans. The following constraints that could prevent the attainment of complete eradication of the pest from any given project were identified:

POLITICAL CONSTRAINTS

(1) Breakdown or disruption of political co-operation within the region.
(2) Lack of full co-operation and support of agricultural authorities within the region for programme objectives and actions.
(3) Acts of political opposition that cannot be controlled by personnel conducting the eradication campaign.

FINANCIAL CONSTRAINTS

(1) Insufficient funding or delays in allocation of funds so that work cannot be accomplished according to plan.

OPERATIONAL CONSTRAINTS

(1) Lack of operational flexibility or an effective organizational structure to allow for timely decisions and proper implementation of prescribed actions.
(2) Natural catastrophes or other disasters that cannot be controlled by the management of the eradication campaign.
(3) Failure to conduct recommended surveillance measures at the prescribed density and frequency.

(4) Failure to effectively conduct the prescribed actions recommended during the pre-eradication, eradication, post-eradication and confirmation phases of the programme.
(5) Inadequate enforcement of quarantine measures by the national plant protection services.
(6) Lack of availability of high quality sterile flies, or interruptions in their delivery and distribution in accordance with operational plans.
(7) Failure to promptly contain, delimit, control or eradicate any medfly outbreaks within the fly free areas.

SOCIAL CONSTRAINTS

(1) Failure to gain the co-operation of fruit growers and their associations.
(2) Failure to gain the co-operation and compliance of the general public and travellers to the region in support of any programme measure.

VII. OPERATIONAL DETAILS OF THE THREE PROJECTS

The three independent projects were viewed separately from one another because of: (1) existing common or contiguous host conditions; (2) the degree of geographical and biological isolation that exists between areas; (3) certain operational limitations, including the size of the proposed project zones and the availability of sterile insects.

No specific order is implied in the manner in which each proposed project appears. Since each project is totally independent of the other projects, they could proceed on an independent basis or in conjunction with the other projects, depending, first and foremost, upon local producer interest and support, active participation on the part of the national plant protection organizations of the respective project countries, financial support gained from private investors, public contributions, or donations from other sources and supply of sterile male flies.

Although it would be desirable to initiate eradication activities in all three projects simultaneously, the limited availability of sterile insects would prevent this. As additional sterile fly resources become available, concurrent actions may be possible depending on the level of interest and support by local producers and the national plant protection organization, and financial support available from private investment, public contributions or outside donations.

The projects are designated as follows:

CYPRUSMED — This involves the entire island of Cyprus as one eradication zone, and will require four years to achieve eradication and verify its status as medfly free at an estimated cost of US $23 million.

EASTMED — The project area extends from southern Israel, the El Arish area of Egypt, Gaza, northward to the border between the Syrian Arab Republic and Turkey. The area has been divided into seven zones of approximately the same size, taking particular advantage of national boundaries for quarantine purposes, geographical/topographical features, and continuity of host areas. The process from initiation of pre-eradication activities until the verification of a fly free area for each zone will require four years. Complete eradication within this project area will require a total of nine years at an estimated cost of US $273 million.

EGYPTMED — The project area is comprised of three separate eradication zones beginning at Aswan in the south, extending up to Sohag (including the outlying oases in New Valley), then from Asyut to Beni Suef (including the oasis in Al Fayyum), and ending in the Nile river delta. All other outlying oases within Egypt would be included in the final phase as sterile flies become available. Complete eradication and verification of fruit fly free areas of the project will require six years at an estimated cost of US $134 million.

Each project will begin by distinguishing host and non-host areas within each designated zone of operation. Urban areas (generally containing a variety of host plants), commercial host production areas, other host areas (i.e. vegetable or cereal crops with relatively few hosts or areas with dispersed native or wild hosts), and non-host areas (barren desert, rocky areas, estuaries) also should be identified to verify estimates made by the expert group. The various activities, such as suppression methods, trapping and sampling protocols, and intensity of sterile fly releases must be confirmed and adapted specifically to the requirements of each independent project.

PROJECT PHASES

The eradication process for all three projects is the same. Within each designated zone of operation, the project will progress through four sequential phases as follows: (1) pre-eradication, (2) eradication, (3) post-eradication and (4) confirmation or verification as a fruit fly free area. The time frame from initiation of phase 1 until completion of phase 4 will be four years. In order to successfully carry out these broad phases, several basic activities must be accomplished. These activities include training, public information, trapping, regulatory controls, insecticidal bait treatments or other means of population suppression, procurement of sterile pupae, packing and distribution of sterile flies, and quality control.

Some of these activities must be initiated early during the pre-eradication phase and will have to be accomplished before other activities can be started. Other activities will be conducted concurrently and serve to complement the achievement of the overall strategy (these phases and activities are described in Annexes 2, 4 and 5).

VIII. COMPONENTS COMMON TO THE THREE PROJECTS

A. PUBLIC INFORMATION

Public information activities are indispensable to obtain support for project activities and will greatly influence the success or failure of the proposed projects. In order to inform, educate and engender support for a given project, public information activities will be started during the pre-eradication phase and well ahead of the field activities. A public relations unit (PRU) will have to be established by the project management. Once started, public information will continue throughout the project. While the PRU will have an established campaign to address anticipated needs, it will have to be prepared at all times to adjust its focus to address many unforeseen issues.

The PRU will be responsible for managing the inquiries of the media, for responding to requests for information by the authorities and the public, and for providing support to project personnel by preparing oral or written presentations. Also, this PRU will co-ordinate the development and production of project posters, publications, radio, TV and other educational materials that will be used to strengthen ongoing activities. Some informational activities and relations with the press will be managed in co-operation with local government officials to ensure that the intended message is appealing and meets the needs of the public while building support for project actions.

B. TRAINING

Training is one of the most important elements of the project. A formalized training activity will facilitate the development of a permanent plant protection and quarantine infrastructure at the national level. It will also promote regional interaction since training will be accomplished on a national and project wide basis. The plant health infrastructure that is a consequence of the eradication project will ensure that the countries in the region remain free of injurious pests. A higher standard of quarantine protection will promote more beneficial involvement with other countries and a more productive, sustainable and profitable agricultural industry in each of the host countries.

The basic methods and procedures that will be needed to initiate and execute the project will have to be introduced to a nucleus of the work force before starting actual field activities. This group can then train others in the technologies as the field project becomes operational. Any 'on the job' (OJT) training will be augmented by the curriculum of a regional training centre. Structured training courses will be designed to provide more formal training in plant protection and quarantine concepts, principles, procedures and activities. Advanced training will include all phases of field operations, as well as management and supervisory concepts.

A training centre for conducting these activities should be located in the Near East region to reduce costs and better accommodate travel. At a later date, this centre could also serve an expanded region such as much of the Mediterranean basin.

C. METHODS DEVELOPMENT

Some mission oriented methods development must be conducted to continuously improve operational procedures and technologies. This type of work can and should be conducted by or within the project. It should be initiated during the pre-eradication phase and continue during the whole project.

Of course, not all lines of potentially beneficial studies can be conducted within the project. Thus, to assure effective international co-ordination and conduct of well targeted applied research and development, the co-operation of various national and international organizations should be enlisted, including the global fruit fly working group of the International Organization of Biological Control (IOBC).

Specific topics that will be addressed by the methods development unit include fly quality assessment, population dynamics, evaluation of trapping systems and attractant dispensers, assessment of release systems, geographic information systems, improvement of survey methods and public information.

D. ENVIRONMENTAL PRECAUTIONS AND MONITORING

This section deals in general terms with environmental precautions that need to be considered in planning and conducting a project aimed at medfly eradication from portions of the Near East.

The projects will primarily involve the release of sterile insects in combination with occasional bait sprays when needed to reduce wild fly populations to the level that permits eradication. On the basis of emerging technological developments, it may be possible to reduce native fly populations through the use of techniques other than insecticide application, such as the release of parasitoids or use of 'lure and kill' devices that can be placed in the field and collected at a later date.

The medfly eradication project may involve pesticide treatments in areas inhabited or transited by threatened or endangered species. On the basis of environmental assessments of the control technologies and identical eradication strategies applied by other countries, no significant impacts to the environment or human health are expected to occur, provided that operational procedures and other prescribed mitigations are strictly followed. This should not present a problem since SIT is the primary technology and will be supported by only limited use of bait sprays. Considering that commercial host production areas in many countries already apply tons of pesticides of different types each year for medfly control and these treatments are conducted in an independent rather than regionally co-ordinated fashion, endangered and threatened species are at much greater risk if the proposed projects are not implemented.

In programmes to eradicate medfly that have been conducted in other parts of the world, fish kills in naturally occurring water systems resulting from bait sprays have not presented a problem. Nevertheless, it is highly desirable to avoid contamination of water with insecticides to the extent possible.

The primary problems which may be encountered in connection with the use of malathion bait sprays relate to potential impacts on honey bees, other pollinating insects, and on beneficial parasites or predators. Various mitigations exist, however, to avoid such negative impacts. These should be considered for adoption by the various projects [7, 8]. No cumulative or long term significant impacts have been noted involving parasites and predators of agricultural pests. Additional studies would be desirable to determine how best to proceed if medfly infestations involve crops on which pest control is attained primarily through the use of biological control organisms. Eradication has been accomplished by utilizing bait sprays applied in alternate swaths or strips. This approach is effective because of the attractiveness and residual activity of large droplet bait sprays while minimizing impact to non-target organisms and promoting early recovery when temporary upsets occur. In selecting options, consideration must be given to the insecticide applications made by growers to control or manage pest species other than the medfly.

Strategies employed to protect honey bees include covering hives during application of bait sprays, timing applications to avoid periods when bees are actively foraging in treatment areas, and temporarily moving bee colonies from treatment areas. The options selected will depend on many factors including the size of area under treatment, as well as the number of bait sprays that must be used.

Regardless of the extent of previous field observations and research studies dealing with non-target organisms, it is suggested that efforts be made to co-operatively conduct monitoring studies, particularly for projects involving new geographic areas. Monitoring studies on non-target organisms, including biocontrol agents in infested areas previously involved in bait sprays, may not need to be as extensive as those in areas where poison baits are being used for the first time. In any case, emphasis should be given to involving various groups such as ornithologists, entomologists, and environmental organizations in studies on project impacts on non-target species. Through such co-operative studies, as well as through increased emphasis on developing modified or new pest suppression strategies, it should be possible to develop information and approaches needed to eradicate the medfly without causing serious long term impacts on non-target species in areas where this is of special concern.

E. PROCUREMENT OF STERILIZED PUPAE

It is assumed that implementation of any of the proposed projects will involve the purchase of sterile medfly pupae from a mass rearing facility (or facilities) located in the Mediterranean region. The technical requirements for a mass rearing factory are specified in

the EASTMED proposal (IAEA 1995). Such medfly factory(ies) can be either public sector or commercial undertakings operating on a profit basis. Therefore, the cost of establishing and operating such mass rearing factory(ies) is not included in the total budget estimate for each project. However, provision is made in each project budget estimate for the purchase of the required numbers of sterile pupae for the eradication campaigns. Movable trailers for handling the purchased pupae, including holding, quality control and packaging for release of emerged medflies, will have to be established successively in the project zones where releases are in progress.

F. QUALITY CONTROL

Monitoring the quality of the products and services performed, or quality control (QC), should be accomplished at every level of management and supervision. Quality control is a practice that each employee should adopt to better execute daily activities. Indeed, quality is every employee's business and responsibility.

The supervision and review of operational activities will be done according to predetermined standards of measurement and performance that will be outlined in operational manuals and protocols (see Annex 5). The documents will be used by the management and supervisory personnel to execute each activity and review the quality of the results. Deviations from accepted standards, procedures, methods (process control) or expected results will necessitate review and occasional correction. Changes in operational activities may be made only with prior approval of the supervisor, especially when there is an action or situation that obviously would result in a negative consequence if not dealt with immediately.

While each operational unit will have to conduct quality control activities to ensure that the product or activity is proceeding as planned, a separate QC unit will be responsible for overall quality control of the project. This operational unit will review survey, chemical control, quarantine, and SIT activities. This review responsibility will make it necessary for the QC personnel to be familiar with all phases of the operations and the technologies involved. They will interact with employees in the operations sections and with the supervisors of these field units to inform them of their findings. The QC group will be directly responsible to the Executive Director, as are the other unit supervisors.

Quality control checks will also be applied to the sterile flies as they are produced in the mass rearing factory(ies), as well as at the receiving end in the projects.

The flies will be produced according to specific standards which they will have to meet before purchase and use in the project. A representative of the project's QC unit will be present at the mass rearing facility(ies) to monitor quality.

CYPRUSMED

DESCRIPTION OF PROJECT AREA

It is projected that medfly eradication on the island of Cyprus can be completed within four years at a total cost of US $23 million. The total area of Cyprus is 9240 km^2, of which 2320 km^2 have to be treated for medfly eradication purposes because of the presence of hosts (Fig. 1). The island contains 730 km^2 of urban areas possessing a large variety of medfly hosts located in backyards, as well as 85.1 km^2 of commercial fruit orchards, 90% of which are citrus hosts. The group estimates the existence of 1500 km^2 of other areas with mostly non-host vegetable and cereal crops mixed with relatively few and widely dispersed medfly hosts. All activities must be conducted on an island wide basis with representation and participation from each political entity.

Years	Project Phases	Goals
1	Pre-eradication	Surveillance and population suppression
2	Eradication	Medfly eradication
3	Post-eradication	Verification of medfly eradication
4	Medfly free zone	

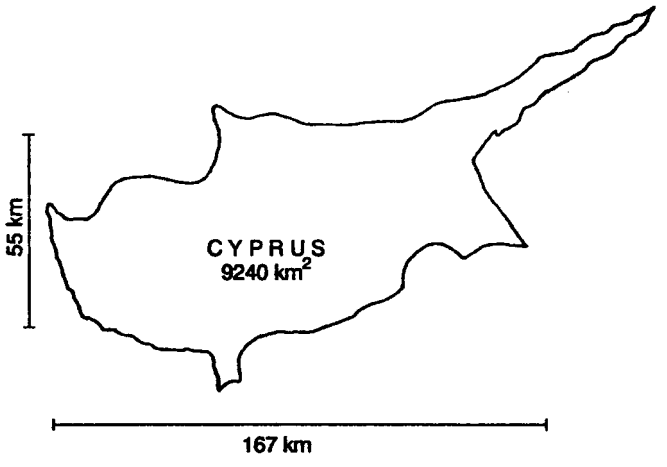

FIG. 1. Eradication phases in CYPRUSMED project.

ERADICATION STRATEGY

Specific activities are planned for each project phase. Pre-eradication, eradication, post-eradication and fly free area phases should be completed successfully within four years (Fig. 1). Eradication will be achieved through an integrated control programme. The pre-eradication phase will include activities for suppression of natural medfly populations. After rigorous pest suppression activities using cultural control and bait sprays are carried out during year 1, the release of sterile insects will start in the eradication phase, year 2. A minimum of 160 million sterile medflies per week should be released over all cultivated lands for 18 consecutive months. In year 3, eradication is completed and verified. In year 4, confirmation or verification will be completed, and freedom from medfly declared.

TABLE I. WORK PLAN TIME FRAME FOR CYPRUSMED PROJECT

Activities	Years 1	2	3	4
A. Analysis and funding				
(1) Cost-benefit	*			
(2) Technical feasibility	*			
(3) Environmental study	*	*	*	*
(4) Funding sources	*	*	*	*
(5) Define support of Cyprus	*			
B. Staffing				
(1) Recruitment of personnel	*	*		
(2) Selection of key staff	*			
(3) Selection of local technicians	*			
(4) Administrative personnel	*			
C. Training				
(1) Key staff training	*	*		
(2) In-service training for local personnel	*	*	*	
D. Public information				
(1) Local public information campaign	*	*	*	*
E. Data management systems				
(1) Purchases of computer equipment	*	*		
(2) Development of custom designed computer program for field operations, quarantine and administrative evaluation	*	*	*	*
F. Methods development				
(1) Key factors of medfly population dynamics in the island (spatial and temporal distribution)	*	*		
(2) Refinement of operational procedures	*	*		
(3) Refinement of eradication processes		*	*	
G. Establishing the organization and infrastructure to conduct the eradication programme				
(1) Programme headquarters and infrastructure	*			
(2) Development of operational manuals including quarantines	*			
(3) Reinforcement of national programme HQs		*	*	*
(4) Preparation of administrative protocols	*			

TABLE I. (cont.)

Activities	Years 1	2	3	4
H. Surveillance system				
(1) Complete medfly surveys on the island	*	*		
(2) Intensive survey/monitoring in zones under suppression/eradication			*	*
(3) Adult surveys for medfly and other exotic fruit flies	*	*	*	*
I. Regulatory actions				
(1) Declaration and enforcement of international quarantines		*		
(2) Establishment/strengthening of domestic and international checkpoints		*	*	*
J. Eradication activities				
(1) Aerial and ground bait sprays	*	*		
(2) Aerial and ground sterile fly releases		*	*	
K. Post-eradication activities				
(1) Evaluations				
— technical		*	*	*
— administrative		*	*	*
(2) Successful eradication declaration				*
(3) Review contingency plan			*	*

TABLE II. CYPRUSMED PROJECT ZONE (SURFACE IN km^2)

Zone	Urban areas	Commercial orchards	Other areas[a]	Total Cyprus
I	730	85.1	1504.9	9240

[a] The entry 'other areas' represents cultivated land with scattered medfly hosts.

Work plan time frames for the CYPRUSMED project are presented in Table I. Detailed information on trap densities, intensity of fruit sampling and sterile fly requirements have been determined on the basis of ecological–geographical conditions dividing the working areas into urban, commercial orchard, and other cultivated areas with scattered medfly hosts as shown in Table II.

TABLE III. TRAP DENSITIES RECOMMENDED FOR CYPRUSMED PROJECT PHASES

Project phase	Type of trap	Urban areas (traps/km^2)	Commercial orchards (traps/km^2)	Other areas with medfly hosts (traps/20 km^2)
Pre-eradication	Modified Steiner with trimedlure	5	10	1
Eradication	Ladd or frutect trap	1	1	1
Post-eradication	Ladd or frutect trap	1	1	1
Fly free zone	Modified Steiner with trimedlure	10	10	4
Fly free zone	McPhail	2	2	2
Fly free zone	Jackson with methyl eugenol	0.4	0.1	0.4
Fly free zone	Jackson with cuelure	0.4	0.1	0.4

Trap densities criteria:
100% of urban areas
100% of commercial orchards
Traps will be strategically placed over 5% 'other areas'.

Trapping service intervals will be:

Pre-eradication phases:	Every three weeks
Eradication phases:	Weekly
Post-eradication phases:	Weekly
Fly free zone:	Weekly (during fruiting season)
	Fortnightly (out of season).

TABLE IV. WEEKLY FIGURES FOR THE FRUIT SAMPLING ACTIVITY FOR THE CYPRUSMED PROJECT

	Number of fruit samples		
Phase	Urban areas (samples/km^2)	Commercial orchards (samples/km^2)	Other areas (samples/20 km^2)
Pre-eradication	2	1	1
Eradication	6	3	3
Post-eradication	6	3	3
Fly free zone	2	1	1

SURVEILLANCE AND DETECTION ACTIVITIES

The eradication effort will rely on a well planned and efficient surveillance system. This system must be operational for at least twelve consecutive months before any eradication activities are carried out. Project surveillance activities will be used to determine fly locations and densities and will serve to guide control actions. Fruit collection will complement adult trapping to detect whether immature stages of the medfly are present. Detection activities consist of installing and servicing a large number of traps within a grid that provides coverage of host areas and some non-host areas.

The trapping methodology will vary according to the phase of the project and the intended purpose of the trapping activities. For example, the preliminary surveys conducted during the pre-eradication phase will determine the exact distribution of medfly and assess its seasonal fluctuations. For this, traps baited with an attractant for males (trimedlure) should be used, such as the modified Steiner or Magrebmed trap, currently used in various Mediterranean countries.

During the phase of sterile fly releases, the objectives of trapping activities will be to assess the quality of sterile males, their distribution within the release zone and changes in the sex ratio. Since sterile males will be released, recapture of males should be minimized. To accomplish this, a trap will be used that captures more female medflies and reduces male captures by using a combination of visual stimuli and food attractants. The modified Ladd trap could be used for this purpose, as well as other traps that are being developed by researchers in a co-ordinated research programme of the Joint FAO/IAEA Division.

After the last wild fly detection, sterile fly releases will continue for up to three generations. During these sterile fly releases (post-eradication phase), the same trapping and fruit sampling densities will be maintained.

Following the post-eradication phase, during the fly free zone confirmation phase, traps for males baited with trimedlure will again be used at a high density. For periods of intensive trapping, higher densities have been planned for urban areas where infested fruit is likely to be introduced. A lower trapping density will be used in commercial host production areas. To verify the absence of fertile medfly females, McPhail traps for females baited with a liquid food attractant will be used. The trap densities recommended for the various phases are detailed in Table III.

Another objective of the surveyance activities before, during and after eradication is to ascertain whether the island is completely free of significant quarantine species of fruit flies (Annex 6). A low density of traps baited with other sexual attractants (cuelure, methyl eugenol) and food lures will be used for this purpose.

Fruit sampling will be conducted during all phases of the project (four years) in order to detect and quantify the incidence of larval infestation in all known hosts. In contrast to trapping activities, the intensity of fruit sampling activities will be low during pre-eradication and fly free zone phases, and intensified during eradication and post-eradication phases (Table IV).

SUPPRESSION ACTIVITIES

Currently, in Cyprus, Medfly control is being carried out independently by growers. With reduced host diversity present, the geographic isolation afforded by the island, and the low medfly populations in winter and early spring, the number of bait spray applications to suppress them is likely to be small. At least one bait spray application is recommended to eliminate in late fall all gravid females that oviposit into late season fruit and from where the overwintering populations result in spring. The bait spray is made of a mixture of an insecti-

cide (usually malathion) and a hydrolysed protein. The bait is applied at low volumes and in the form of droplets that lower the potential for adverse environmental impacts against non-target organisms. In some cases, no bait spray treatment may be necessary, particularly if the sterile releases are initiated when the population is at its lowest level (winter and early spring).

It is estimated that the cost of aerial applications of bait sprays will be approximately US $30 per hectare and year. When aerial bait sprays cannot be applied or are considered by project management to be impractical, suppression activities should rely on ground bait sprays. For urban areas, owners of backyard hosts will be encouraged to practice fruit stripping during periods (winter and spring) when medfly populations are very low. The use of bait stations (such as Ladd or frutect traps that attract both sexes) for control purposes also will be implemented in these areas. Cost estimations for this activity have been based on the assumption that an average of 1000 households exist within a square kilometer of urban and suburban area, and a single bait station will be installed on each household property. Costs of ground bait sprays and bait stations have been estimated to be US $7 per household per season.

STERILE INSECT RELEASE ACTIVITIES

Following the suppression phase, the eradication phase will consist of weekly releases of sexually sterile male medflies to eliminate reproduction of any remaining adults in the population. The strain that will be used within the Near East region will be one of the genetic sexing strains developed by the Joint FAO/IAEA Division.

Compared to classical SIT programmes, where both sterile males and females are released, the use of male-only strains will result in much higher effective ratios of sterile males versus feral females. The near absence of sterile females will reduce both time and sperm expended by sterile males each time that they mate with sterile females. Furthermore, the near absence of sterile females will avoid the problem of 'sterile punctures' to host fruits.

Implementation of the eradication actions must be timed to take full advantage of the biotic and abiotic factors that tend to lower the fly population. Maximum efficiency of the SIT is achieved when initial releases are timed so as to coincide with these naturally occurring low fly population densities. However, to provide programme personnel experience in packing and distributing sterile flies, it is recommended to initiate these activities before the critical release period in spring.

TABLE V. STERILE MEDFLY REQUIREMENTS FOR CYPRUSMED PROJECT

Areas	Surfaces in hectares	Year 2 (million males released/week)	Year 3 (million males released/week)
Urban	73 000	109.5	109.5
Commercial orchards	8 510	12.7	12.7
Others	150 490	37.6	37.6
Totals	232 000	159.8	159.8

Release densities: 1500 males/ha per week for urban areas and commercial orchards;
500 males/ha per week for other areas (50% coverage).

The number of sterile flies to be released will be higher for urban areas (1500 males per hectare) because of the variety of hosts available. Commercial host production areas will require 1500 males per hectare, and areas of low host density will require 500 males per hectare. A minimum of 160 million sterile males per week will be needed during the more intensive periods of eradication (Table V).

Cyprus could be considered as a possible site for the construction of a large medfly mass rearing facility within the Near East region, because of its favourable location and good communications. This facility could supply sterile males for CYPRUSMED. In addition, independently of the execution of CYPRUSMED, it could sell sterile flies to other medfly control or eradication projects in the eastern and southern parts of the Mediterranean basin. A site close to the international airport facilities, but preferably away from host areas, could be examined for this possibility.

REGULATORY CONTROLS

Internal and external regulatory controls will be the specific responsibility of each national plant protection service in accordance with national law and international convention. These activities will be the key to successful eradication and continually maintaining areas medfly free. High priority must be given to the regulatory controls and related activities that are undertaken to support the proposed eradication projects. It must be stressed that the regulation of potentially infested commodities constitutes the primary method of preventing artificial spread and reinfestation by the medfly. There must be appropriate control of the movement of potentially infested host material from infested areas into post-eradication and fly free areas, as well as external quarantines that prevent the importation of infested plant material into each country. Long term protection from reinvasion will come from strong institutional commitment to regulatory quarantines and the consistent and effective use of the eradication technologies. As Cyprus is an island, the task of exclusion should be easier than in areas of contiguous land mass.

DATA MANAGEMENT

A complex project requires an efficient management system to handle the large volume and wide variety of data and information. Through the use of computers and data management systems (software), it is possible to use current data/information to accomplish timely and effective management. This technology can be expanded to facilitate the production of technical reports, inter- and intra-project correspondence, and mapping (with satellite imagery and the use of the Geographical Information System (GIS)).

Public information, training, and methods development activities will be conducted in support of the overall eradication. These activities have been described in further detail within other sections of this plan.

ORGANIZATION AND MANAGEMENT

A CYPRUSMED Project Co-ordination Committee (PCC) will be appointed by the ministers of agriculture. Active representation must come from the highest levels within the national governments for the project to succeed. Representatives of agricultural producers, donors and participating international organizations will also be members of the PCC. The PCC will be chaired alternatingly by the two representatives of the two national plant protec-

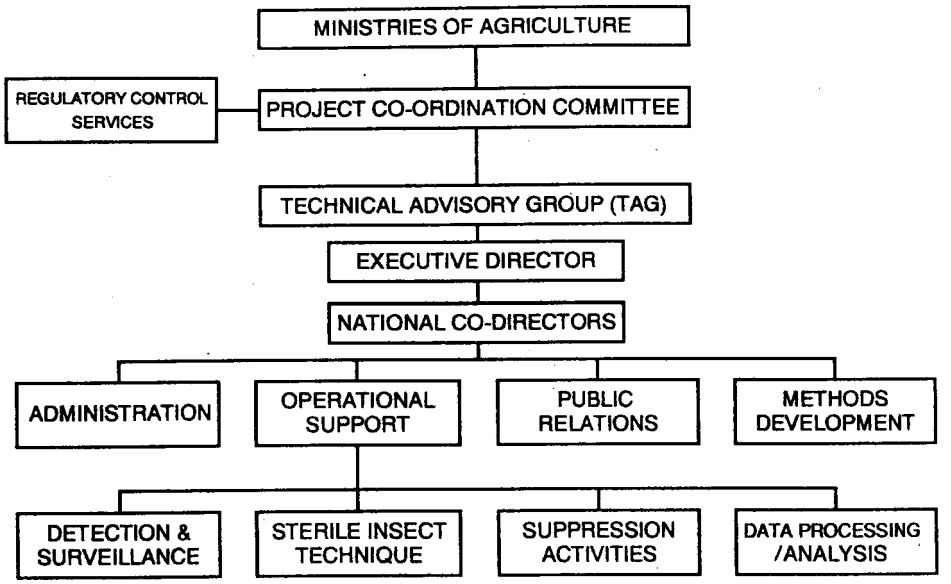

FIG. 2. CYPRUSMED project organizational chart.

tion services (Fig. 2). Members will serve without compensation apart from travel expenses to attend meetings.

The PCC will deal with matters of policy, budgeting and resource acquisition, but not with management issues. This will be the responsibility of the executive director under the technical guidance of the Technical Advisory Group (TAG). The PCC will secure international and national support for accomplishing project activities. It can assist in resolving complex political/administrative problems that may jeopardize the accomplishment of project goals. The PCC will review the project every six months during the first four years of the programme, then at the discretion of the PPC. However, it will function as needed to avert or solve problems.

The Technical Advisory Group (TAG) will be composed of three selected full time technical experts appointed by the donors/multilateral organizations and the national plant protection services. It will provide technical oversight of all activities and operations that have a bearing on the effectiveness and efficiency of the overall effort to eradicate the medfly from the designated project area.

On the basis of the recommendation of the TAG, the PCC will be responsible for selecting a full time executive director, who will have primary responsibility for the management and the administration of all activities pertaining to the CYPRUSMED project. The executive director will recruit and direct a small staff of full time technical and administrative professionals responsible for the following areas: operational support; methods development; public information and administration. This project staff will direct overall day to day project activities and provide management co-ordination.

The organizational structure of the CYPRUSMED project will resemble that of an emergency action project. It will require separate and distinct institutional arrangements and operational procedures. Therefore, a separate, well defined and functional project organization must be established. Although temporary in nature, project staff must have sufficient autonomy and authority to conduct the project as dictated by operational plans, protocols and field conditions. Although the executive director and his staff will be solely responsible for conducting the eradication activities, they must receive required support from all involved parties to accomplish the goals of the project.

TABLE VI. ESTIMATED BUDGET FOR CYPRUSMED PROJECT (US $ × 1000)

Activity	Totals	Years 1	2	3	4
Training	201	76	43	43	39
Public information	1 009	378	217	217	197
Data management	172	66	40	33	33
Methods development	400	150	86	86	78
Trapping	893	143	162	162	426
Fruit sampling	1 712	224	632	632	224
Control in urban areas	5 110	5 110			
Bait sprays	766	766			
Sterile fly purchase and release	8 310		4 155	4 155	
Quarantine	2 294	859	494	494	447
Management	1 700	637	366	366	331
Emergency plans	283	106	61	61	55
Totals	22 850	8 515	6 256	6 249	1 830

The project will have the right to receive and disburse funds, authority to employ and discharge personnel, ability to purchase supplies and equipment, enter into contractual arrangements, and conduct the field activities under the delegated authorities granted to it by each host government. Personnel can be seconded to the eradication effort from the host government on a temporary basis to augment the administration and implementation of project activities; however, they will have to follow project regulations and will respond exclusively to the instructions of the executive director and his project staff.

The executive director is a vital and key participant in the project because he will be responsible for all activities conducted on the whole island of Cyprus. The national co-directors will serve as the local interface with policy making officials and government personnel. Some activities, such as regulatory controls, will be accomplished by the national plant protection service. Post-eradication activities, i.e. verification of the area as medfly free, will also be the responsibility of this service.

A CYPRUSMED project headquarters will be established at a centrally located site. Both headquarters and field project personnel must adequately support the diverse activities with administrative and technical expertise to ensure that the CYPRUSMED project receives the required management support and guidance, technical oversight and review.

At the same time, a conscious effort must be made to accomplish technology transfer. To this purpose, a methods development unit will work directly under the executive director. This will enable equal access by all project personnel to acquire the most advanced plant protection and quarantine concepts, principles, procedures and methodologies. These advances can then be incorporated into the existing national eradication and medfly free zone activities as soon as they become available. This will promote long term protection of the pest free status achieved through project efforts.

The estimated budget of the CYPRUSMED project is presented in Table VI.

DESCRIPTION OF PROJECT AREA

It is projected that medfly eradication from the project area will require a total of nine years at an estimated cost of US $273 million. The project would extend from the El Arish area of Egypt, Gaza, and southern Israel and Jordan, northward to the border between the Syrian Arab Republic and Turkey. This project entails a higher degree of complexity than the other two projects in the subregion because activities would be spread over many international boundaries.

The area has been divided into seven zones of approximately the same size, taking particular advantage of national boundaries for quarantine purposes, geographical/topographical features that favour establishment of a temporary biological barrier using sterile flies, and continuity of host areas (see Fig. 3). For each zone, the process from initiation of pre-eradication activities until the verification of a fly free area will require four years.

Goals	Project phases	Year	Zones
Declare Zone VII medfly free by year 9	Fly free zone FFZ	9	VII
	Post-eradication POST	8	
	Eradication ERA	7	
	Pre-eradication PRE	6	
Declare Zone VI medfly free by year 8	FFZ	8	VI
	POST	7	
	ERA	6	
	PRE	5	
Declare Zone V medfly free by year 7	FFZ	7	V
	POST	6	
	ERA	5	
	PRE	4	
Declare Zone IV medfly free by year 6	FFZ	6	IV
	POST	5	
	ERA	4	
	PRE	3	
Declare Zone III medfly free by year 5	FFZ	5	III
	POST	4	
	ERA	3	
	PRE	2	
Declare Zone II medfly free by year 4	FFZ	4	II
	POST	3	
	ERA	2	
	PRE	1	
Declare Zone I medfly free by year 3	FFZ	3	I
	POST	2	
	PRE-ERA	1	

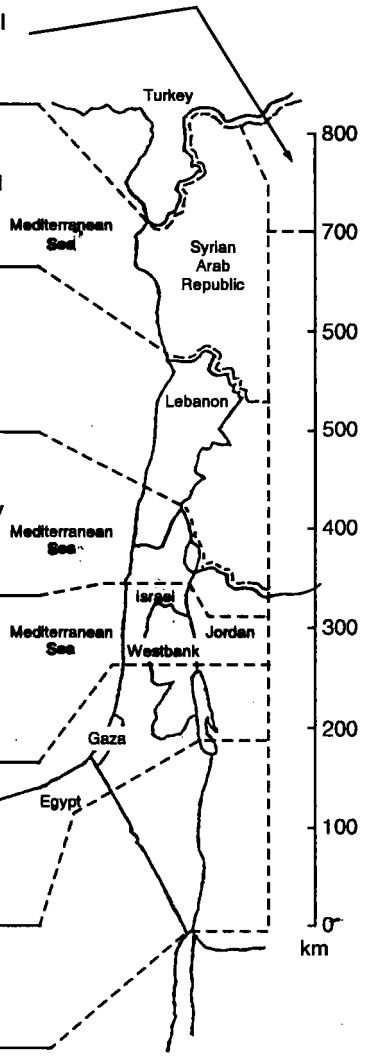

FIG. 3. Eradication phases for EASTMED project.

TABLE VII. WORK PLAN TIME FRAME FOR THE EASTMED PROJECT

Activities	Years								
	1	2	3	4	5	6	7	8	9
A. Analysis and funding									
(1) Cost-benefit	*	*							
(2) Technical feasibility	*	*							
(3) Environmental study	*								
(4) Funding sources	*		*		*		*		
(5) Define support of participating countries	*	*	*	*	*				
B. Staffing									
(1) Recruitment of personnel	*	*	*	*	*	*	*	*	*
(2) Selection of key staff	*	*	*	*					
(3) Selection of local technicians	*	*	*	*					
(4) Administrative personnel	*	*	*	*					
C. Training									
(1) Key staff training	*	*	*	*	*	*	*		
(2) In-service training for local personnel		*	*	*	*	*	*	*	
D. Public information									
(1) Region wide information campaign	*	*	*	*	*	*	*	*	*
(2) Local public information campaign									
— Zone I	*	*	*						
— Zone II		*	*	*					
— Zone III			*	*	*				
— Zone IV				*	*	*			
— Zone V					*	*	*		
— Zone VI						*	*	*	
— Zone VII							*	*	*
E. Data management systems									
(1) Purchases of computer equipment	*	*	*	*	*	*			
(2) Development of custom designed computer programme for field operations, quarantine and administrative evaluation	*	*	*	*	*	*			

TABLE VII. (cont.)

Activities	Years								
	1	2	3	4	5	6	7	8	9
F. Methods development									
(1) Key factors of medfly population dynamics in the region (spatial and temporal distribution	*	*	*	*	*				
(2) Refinement of operational procedures		*	*	*	*	*	*		
(3) Refinement of eradication processes		*	*	*	*	*	*		
G. Establishing the organization and infrastructure to conduct the eradication programme									
(1) Programme headquarters and regional infrastructure	*	*	*	*	*				
(2) Development of operational manuals including quarantine	*	*	*	*	*				
(3) National programme HQs	*	*	*	*	*				
(4) Reinforcement of national programme HQs									
— Israel		*	*						
— Jordan		*	*						
— El Arish (Egypt)		*	*						
— Territories under the Jurisdiction of the Palestinian Authority		*	*						
— Lebanon			*	*					
— Syrian Arab Republic				*	*				
(5) Preparation of administrative protocols	*								
H. Surveillance system									
(1) Complete medfly surveys in all countries	*	*	*	*	*				

TABLE VII. (cont.)

Activities	Years								
	1	2	3	4	5	6	7	8	9
(2) Intensive survey/ monitoring in countries under suppression/eradication									
— Zone I	*	*							
— Zone II		*	*	*	*				
— Zone III			*	*	*	*			
— Zone IV				*	*	*	*		
— Zone V					*	*	*	*	
— Zone VI						*	*	*	*
— Zone VII							*	*	*
(3) Adult surveys for medfly and other exotic fruit flies									
— Zone I		*	*	*	*	*	*	*	*
— Zone II		*	*	*	*	*	*	*	*
— Zone III		*	*	*	*	*	*	*	*
— Zone IV		*	*	*	*	*	*	*	*
— Zone V			*	*	*	*	*	*	*
— Zone VI			*	*	*	*	*	*	*
— Zone VII			*	*	*	*	*	*	*
I. Regulatory actions									
(1) Declaration and enforcement of international quarantines									
— El Arish (Egypt)		*	*						
— Territories under the Jurisdiction of the Palestinian Authority		*	*	*					
— Israel			*	*	*				
— Jordan				*	*	*			
— Lebanon					*	*	*		
— Syrian Arab Republic						*	*	*	
(2) Establishment/ strengthening of domestic and international checkpoints									
— El Arish (Egypt)		*	*	*	*	*	*	*	*
— Territories under the Jurisdiction of the Palestinian Authority			*	*		*	*	*	*
— Israel				*	*	*	*	*	*
— Jordan					*	*	*	*	*
— Lebanon						*	*	*	*
— Syrian Arab Republic							*	*	*

TABLE VII. (cont.)

Activities	Years								
	1	2	3	4	5	6	7	8	9
J. Eradication activities									
(1) Aerial and ground bait sprays									
— Zone I		*							
— Zone II		*	*						
— Zone III			*	*					
— Zone IV				*	*				
— Zone V					*	*			
— Zone VI						*	*		
— Zone VII							*	*	
(2) Aerial and ground sterile fly releases									
— Zone I		*	*						
— Zone II			*	*					
— Zone III				*	*				
— Zone IV					*	*			
— Zone V						*	*		
— Zone VI							*	*	
— Zone VII								*	*
K. Post-eradication activities									
(1) Evaluations									
— technical		*	*	*	*	*	*	*	*
— administrative		*	*	*	*	*	*	*	*
(2) Successful eradication declaration									
— Zone I			*						
— Zone II				*					
— Zone III					*				
— Zone IV						*			
— Zone V							*		
— Zone VI								*	
— Zone VII									*
(3) Review contengency plan			*	*	*	*	*	*	*

TABLE VIII. ESTIMATED PROJECT WORKING ZONES (SURFACES IN km^2)

Zones	Urban areas	Commercial orchards	Other areas[a]	Total
I	10	6	60	76
II	1 280	317	2 155	3 752
III	1 575	314	1 260	3 149
IV	1 120	695	2 875	4 690
V	900	1 300	7 950	10 150
VI	250	1 500	12 000	13 750
VII	50	140	3 960	4 150
Total	5 185	4 272	30 260	39 717

[a] The entry of 'other areas' represents cultivated land with scattered medfly hosts.

Israel and Gaza currently use bait sprays on a regular areawide basis against the medfly. The existing infrastructures for such suppression and surveillance activities in these areas will greatly enhance initial efforts to use sterile fly releases. This programme could be developed as a model around which to organize and train growers and national plant protection services of the subregion for areawide pest management activities.

ERADICATION STRATEGY

The EASTMED project would begin in Zone I consisting of the Arava valley (between the Dead Sea in the north and the Red Sea in the south) and the Negev oases. In the agricultural settlements of this zone, the main crops are vegetables and the surface area occupied by medfly hosts is quite limited. It corresponds mostly to backyard trees in urban areas. These urban sites comprise 19 settlements and the cities of Eilat and Aqaba (Israel and Jordan). The whole area is surrounded by an extremely arid desert, so that it can be easily isolated and maintained as a fruit fly free area after eradication. It is deemed useful to implement a pilot test in a limited area of Zone I, which will serve to demonstrate the effectiveness of SIT and the use of medfly genetic sexing strains, also referred to as the males-only strains. This will allow project management to refine field activities, so that they function efficiently under diverse conditions elsewhere in the EASTMED subregion.

Eradication activities should then be initiated in the rest of Zone I and in Zone II corresponding to Gaza, the West Bank (WB) and southern Israel (including the Egyptian area of El Arish, adjacent to Gaza), then proceed progressively northward in predetermined operations until the medfly has been eradicated from the Syrian Arab Republic (Fig. 3). Each incremental zone represents up to approximately 14 000 km^2. As eradication is achieved in any one zone, the adjacent zone will be subjected immediately to the same eradication operations. Work plan time frames for the EASTMED project are presented in Table VII. Estimation of the working areas for Zones I through VII is presented in Table VIII. Detailed information of the subzones for Zones I through VII is presented in Table IX.

TABLE IX. EASTMED PROJECT SUBZONES (SURFACES IN km^2)

Zones	Subzones	Urban areas	Commercial areas	Other areas	Total host area	Total non-host area	Total area
I	Aqabah–Eilath–Arava	10	5	60	75	2 925	3 000
	Negev and Judean desert	0.2	0.7	0.01	1	9 999	10 000
II	El-Arish	40	5	165	210	-	-
	Gaza	150	70	140	360	0	360
	Israel — Southern coastal plain	450	130	1 020	1 600	500	2 100
	Southern portions of West Bank/Dead Sea	500	100	250	850	150	1 000
	Mountain II — Central West Bank/Dead Sea	110	10	580	700	200	900
	Beersheba	30	2	0	32	568	600
III	Medcoast II — Israel northern coastal plain	800	113	40	953	547	1 500
	Mountain III — Northern portions of West Bank	350	100	100	550	2 850	3 400
	Rift Valley Jordan Valley	25	1	20	46	554	600
	Central Jordan	400	100	1 100	1 500	-	-
IV	Medcoast III — Israel/ Lebanon coastal plain	70	10	30	110	390	500
	Northern Jordan Valley III	250	125	1 125	1 500	400	1 900
	Southern Lebanon	300	200	450	950	?	-
	Galilee–Golan Heights	300	60	100	460	1 940	2 400
	Northern Jordan	200	300	1 170	1 770	-	-
V	Northern Lebanon	700	400	950	2 050	-	-
	Southern portions of Syrian Arab Republic	200	900	7 000	8 100	-	-
VI	North-western portions of Syrian Arab Republic	250	1 500	12 000	13 750	-	-
VII	North-eastern portions of Syrian Arab Republic	50	140	3 960	4 150	-	-
Totals		5 185	4 271	30 260	39 717	-	-

One argument for initiating eradication activities in the south is that Israeli and Palestinian growers have many years of experience controlling medfly by using aerial bait sprays dating back to the 1960s. A semi-private/public plant health infrastructure with strong financial and political support from the local producers conducts areawide medfly control over an area that is isolated on all sides by desert. This will greatly enhance suppression activities conducted during the pre-eradication phase. Growers should be easier to convince to switch to alternative control methods that would be more effective and economical. Host availability in this area is comparatively small, again enhancing the probability of a successful eradication during the first phases of the project.

While the primary eradication activities begin in southern Israel, Jordan, Gaza and the West Bank, other field activities that must be accomplished in advance of eradication efforts will be started in Zone II, i.e. public relations, training, survey by trapping and fruit sampling, medfly population suppression, etc. Internal quarantine activities also will be implemented between Zones I and II. The project will then successively advance to the next zones until complete eradication is achieved. This planning does not preclude any participating country from establishing certified fruit fly free areas on an earlier or accelerated time frame if sufficient resources are available. If this approach is supported by additional actions taken by local growers, eradication could advance at a more rapid pace and bring the project ahead of schedule.

SURVEILLANCE AND DETECTION ACTIVITIES

The eradication effort will rely on a well planned and efficient surveillance system. This system must be operational before any eradication activities are carried out. Project surveillance activities will be used to determine fly locations and densities and will serve to guide control actions. Fruit sampling will complement adult trapping to detect whether immature stages of medfly are present. Detection activities consist of installing and servicing a large number of traps within a grid that provides complete coverage of host areas and some non-host areas.

The trapping methodology will vary according to the phase of the project and the intended purpose of the trapping activities. For example, the preliminary surveys conducted during the pre-eradication phase will determine the exact distribution of medfly and assess its seasonal fluctuations. For this, traps baited with a powerful sexual attractant for males (trimedlure) should be used. The type of trap to be used could be a modified Steiner trap, an effective trap currently used in Israel that is baited with trimedlure and DDVP.

During the phase of sterile fly releases, the objectives of trapping activities will be to assess the quality of sterile males, their distribution within the release zone and changes in the sex ratio. Since sterile males will be released, recapture of males should be minimized. To accomplish this, a trap will be used that captures mainly female medflies rather than males by using a combination of visual stimuli and food attractants. The modified Ladd trap ('frutect') currently used in Israel could be used for this purpose, as well as other traps that are being developed by researchers in a co-ordinated research programme of the Joint FAO/IAEA Division.

After the last wild fly detection, sterile fly releases will continue for up to three generations. During these sterile fly releases (post-eradication phase), the same trapping and fruit sampling densities will be maintained.

Following eradication, during the second part of the post-eradication phase and during the free zone confirmation phase, traps for males baited with trimedlure will again be used at a high density. For periods of intensive trapping, higher densities have been planned for urban areas where infested fruit is likely to be introduced. A lower trapping density will be used in commercial host production areas. To verify the complete absence of fertile medfly females, standard McPhail traps for females, baited with a liquid food attractant, will be used. The trap densities recommended for the various phases are detailed in Table X.

Another objective of the surveyance activities before, during and after eradication is to ascertain whether the area is completely free of significant quarantine species of fruit flies (Annex 6). A low density of traps baited with other sexual attractants (cuelure, methyl eugenol) and food lures will be used for this purpose.

TABLE X. TRAP DENSITIES RECOMMENDED FOR THE EASTMED PROJECT PHASES

Project phase	Type of trap	Urban areas (traps/km^2)	Commercial orchards (traps/km^2	Other areas (traps/20 km^2)
Pre-eradication	Modified Steiner with trimedlure	5	10	1
Eradication	Ladd or frutect trap	1	1	1
Post-eradication	Ladd or frutect trap	1	1	1
— sterile fly releases				
— no sterile fly releases	Modified Steiner with trimedlure	10	10	4
Fly free zone	Modified Steiner with trimedlure	10	10	4
Fly free zone	McPhail	2	2	2
Fly free zone	Jackson with methyl eugenol	0.4	0.1	0.4
Fly free zone	Jackson with cuelure	0.4	0.1	0.4

Trap density criteria: 100% of urban areas
100% of commercial orchards
Traps will be strategically placed in 5% of 'other areas'.

Trapping service intervals will be:

Pre-eradication phases:	every three weeks
Eradication phases:	weekly
Post-eradication phases:	weekly
Fly free zone:	weekly (during fruiting season) fortnightly (out of season).

TABLE XI. WEEKLY FIGURES FOR THE FRUIT SAMPLING ACTIVITY FOR EASTMED PROJECT

Phase	Number of fruit samples		
	Urban areas (samples/km^2)	Commercial orchards (samples/km^2)	Other areas (samples/20 km^2)
Pre-eradication	2	1	1
Eradication	6	3	3
Post-eradication	6	3	3
Fly free zone	2	1	1

Fruit sampling will be conducted during all phases of the project (four years) in order to detect and quantify the incidence of larval infestation in all known hosts. In contrast to trapping activities, the intensity of sampling activities will be low during pre-eradication and fly free zone phases, and intensified during eradication and post-eradication phases (Table XI).

SUPPRESSION ACTIVITIES

Eradication will be achieved through an integrated control programme. The pre-eradication phase will include activities for suppression of natural medfly populations. Israel and Gaza currently have the infrastructure to carry out an organized, centralized control campaign, including monitoring and chemical control in commercial host production areas. In these orchards, bait sprays are currently an essential component of fruit fly management. Within this project, bait sprays will be used in some areas to suppress populations so that a more favourable ratio of sterile male medflies to fertile feral flies may be achieved. At least one bait spray application is recommended to eliminate in late fall all gravid females that potentially could oviposit in late season fruit and from where the overwintering populations result in spring. The bait spray is made of a mixture of an insecticide, malathion, and a hydrolysed protein. It is applied at low volumes and in the form of droplets that lower the potential for adverse environmental impacts to non-target organisms. In some cases, no bait spray treatment may be necessary, particularly if the sterile releases are initiated when the population is at its lowest level (winter).

It is estimated that the cost of aerial applications of bait sprays will be approximately US $45 per hectare (ha) per year, on the basis of the present per hectare cost in Israel. When aerial bait sprays cannot be applied or are considered impractical by the project management, suppression activities should rely on ground bait sprays. For urban areas, owners of backyard hosts will be encouraged to practice fruit stripping during periods (winter and spring) when medfly populations are very low. The use of bait stations (such as Ladd or frutect traps that attract both sexes) for control purposes will also be implemented in these areas. Cost estimations for this activity have been based on the assumption that an average of 1000 households exist within a square kilometre of suburban and urban areas, and a single bait station will be installed on each household property. Costs of ground bait sprays and bait stations have been estimated to be US $7 per household per season.

STERILE INSECT RELEASE ACTIVITIES

Following this, the eradication phase will consist of weekly releases of sexually sterile male medflies to eliminate reproduction of any remaining adults in the population. This procedure has been used successfully in many countries during the last twenty years. The strain that will be used within the Near East region will be one of the genetic sexing strains developed by the Joint FAO/IAEA Division.

Compared to classical SIT programmes, where both sterile males and females are released, the use of male only strains will result in much higher effective ratios of sterile males versus feral females. The near absence of sterile females will reduce both time and sperm expended by sterile males each time that they mate with sterile females. Furthermore, the near absence of sterile females will avoid the problem of 'sterile punctures' to host fruits.

Implementation of the eradication actions must be timed to take full advantage of the biotic and abiotic factors that tend to lower the fly population. Maximum efficiency from the SIT is achieved when initial releases are timed to coincide with these naturally occurring low fly population densities. It is recommended that, in a given project zone, sterile releases begin

TABLE XII. STERILE MEDFLY REQUIREMENTS FOR THE EASTMED PROJECT
(million males per week)

Year	Eradication phase[a]				Post-eradication phase[b]				Total
	Urban	Commercial	Other	Total	Urban	Commercial	Other	Total	
1	1.5	0.6	3	5.1	-	-	-	-	5.1
2	192	32	108	332	-	-	-	-	332
3	236	31	63	331	192	32	108	332	663
4	168	70	144	382	236	31	63	331	713
5	135	130	397	662	168	70	144	382	1044
6	38	150	600	788	135	130	397	662	1450
7	8	14	198	220	38	150	600	788	1007
8	-	-	-	-	8	14	198	220	220

[a] The sterile insect release period is 52 weeks.
[b] The sterile insect release period is 26 weeks.

after suppression during the months of October or November. This will serve to drive the declining medfly populations down even faster while preventing population increases in the spring. An operational advantage is also gained by providing programme personnel experience in the packing and distributing sterile flies before the critical release period in the spring.

The number of sterile flies to be released will be higher for urban areas (1500 males per hectare), because of the variety of hosts available. Commercial host production areas will require 1000 males per hectare, and areas of low host density will require 500 males per hectare. A minimum of 1.5 billion sterile males per week will be needed during the more intensive periods of eradication. For this reason, all three projects cannot proceed simultaneously unless additional mass rearing facilities are constructed to overcome this constraint. The yearly requirement for sterile medflies is presented in Table XII.

REGULATORY CONTROLS

Internal and external regulatory controls will be the specific responsibility of each national plant protection service in accordance with national law and international convention. These activities will be the key to successful eradication and continually maintaining areas medfly free. High priority must be given to the regulatory controls and related activities that are undertaken to support the proposed eradication projects. It must be stressed that the regulation of potentially infested commodities constitutes the primary method of preventing artificial spread and reinfestation by the medfly. There must be appropriate control of the movement of potentially infested host material from infested areas into post-erdication and fly free areas, as well as external quarantines that prevent the importation of infested plant material into each country.

Long term protection from reinvasion will come from strong institutional commitment to regulatory/quarantines and the consistent and effective use of the eradication technologies. After medfly eradication has been completed in all seven zones, a sterile fly barrier must be maintained in northern Syria along the border with southern Turkey to prevent the natural spread of fertile medflies.

DATA MANAGEMENT

A complex project requires an efficient management system to handle the large volume and wide variety of data and information. Through the use of computers and data management systems (software), it is possible to use current data/information to accomplish timely and effective management. This technology can be expanded to facilitate the production of technical reports, inter- and intra-project correspondence, and mapping (with satellite imagery and the use of the Geographical Information System or GIS).

Public information, training, and methods development activities will be conducted in support of the overall eradication. These activities are described in further detail within other sections of this plan.

ORGANIZATION AND MANAGEMENT

An EASTMED Regional Project Co-ordination Committee (RPCC) will be appointed by the ministers of agriculture or their designees to oversee the project. Active representation in the RPCC must come from the highest levels within the national governments for the project to succeed. The RPCC will be chaired by a director of a national plant protection service, and chairpersonship responsibilities will rotate from country to country each year. Representatives of agricultural producers, donors and participating international organizations also will be members of the RPCC (see Fig. 4). Members will serve without compensation, apart from travel expenses for meetings.

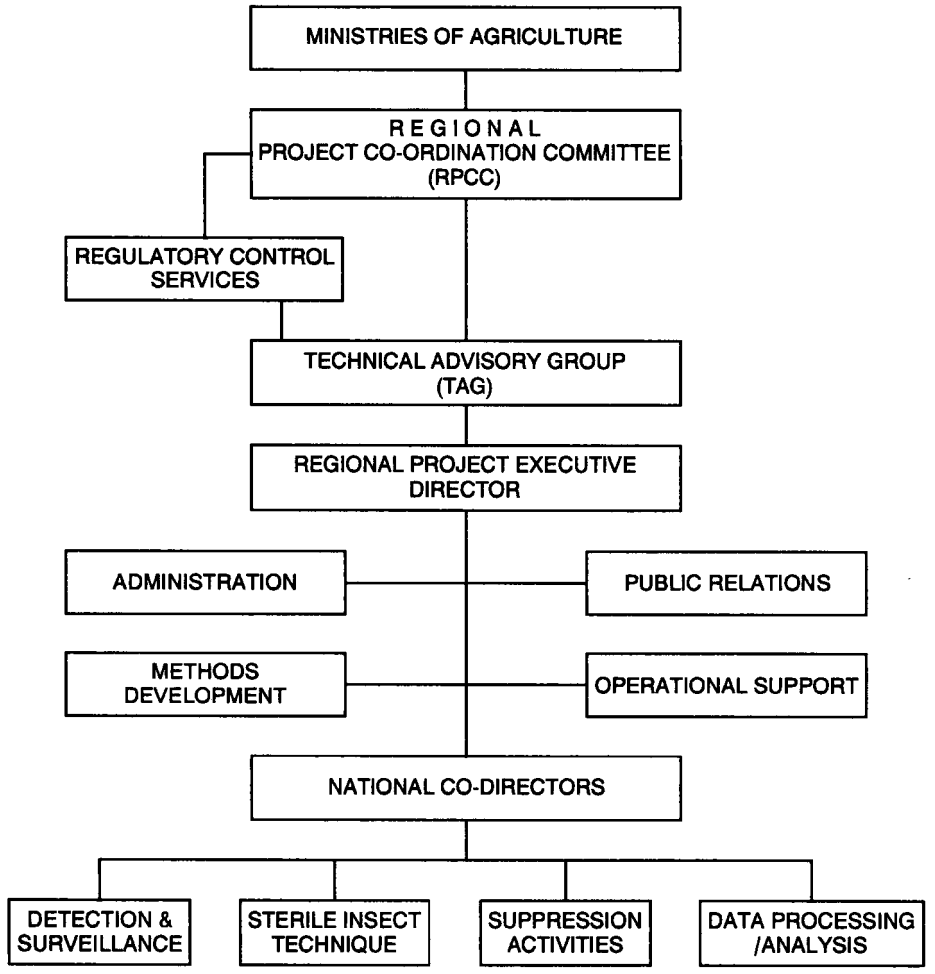

FIG. 4. EASTMED project organizational chart.

The RPCC will deal with matters of policy, budgeting and resource acquisition, but not with management issues. This will be the responsibility of the regional executive director and the national co-directors, under the technical guidance of the Technical Advisory Group (TAG). The RPCC will secure international and national support for accomplishing project activities. It can assist in resolving complex political/administrative problems that may jeopardize accomplishment of project goals. The RPCC will review the project every six months during the first four years of the programme, then at the discretion of the RPPC. It will, however, function as needed to avert or solve problems.

The Technical Advisory Group (TAG) will be composed of selected full time technical experts appointed by the donors/multilateral organizations and the national plant protection services. It will provide technical oversight of all activities and operations that have a bearing on the effectiveness and efficiency of the overall effort to eradicate the medfly from the designated project area.

On the basis of the recommendation of the TAG, the RPCC will be responsible for selecting a full time regional executive director, who will have primary responsibility for the management and the administration of all activities pertaining to the EASTMED project. Preferably, this regional executive director will not be from any of the countries involved in the project. The regional executive director will recruit a small staff of full time technical and administrative professionals responsible for the following areas: operations; methods development; public information and administration. This project staff will direct overall day to day project activities and provide management co-ordination for the operations being conducted in each country.

National co-directors will be appointed by the regional executive director, on the basis of the recommendation of the TAG, and the approval of the RPCC. They will be responsible, following the instructions of the executive director, for the day to day implementation of programme activities within their respective countries. They will also provide the regional executive director, TAG and RPCC with general project information, progress reports and other information concerning conditions or situations that may affect the project.

Each participating country will have a national project organizational structure that, once it has been decided to proceed with eradication, will be responsible and subordinate only to the regional executive director of the project. Some activities, such as regulatory controls, will be accomplished by the national plant protection service of each country. Each co-director (one per country) is a vital and key participant in the project because he will be responsible for field activities conducted within their respective countries. He will serve as the local interface with government and policy making officials, the impacted industry and others.

The organizational structure of the project will resemble that of an emergency action project. It will require separate and distinct institutional arrangements and operational procedures. Therefore, a separate, well defined and functional project organization must be established. Although temporary in nature, it must have sufficient autonomy and authority to conduct the project as dictated by operational plans, protocols and field conditions. Although the regional executive director, co-directors and their staff will be solely responsible for conducting the eradication activities, they must receive all required support from the different parties involved to accomplish the goals of the project.

The project will have the right to receive and disburse funds, authority to employ and discharge personnel, ability to purchase supplies and equipment, enter into contractual arrangements, and conduct the field activities under the delegated authorities granted to it by each host government. Personnel can be seconded to the eradication effort from the host government on a temporary basis to augment the administration and implementation of project activities; however, they will have to follow project regulations and will respond exclusively to the instructions of the regional executive director and respective co-director and his project staff.

TABLE XIII. ESTIMATED BUDGET FOR EASTMED PROJECT (US $ × 1000)

Activity	Total	Years								
		1	2	3	4	5	6	7	8	9
Training	975	184	143	173	100	125	125	125	0	0
Public information	5 167	982	1 257	1 112	989	512	236	79	0	0
Data management	8 676	1 225	1 415	1 523	1 587	1 418	1 173	179	116	40
Methods development	2 000	250	250	250	250	250	250	250	250	0
Trapping	31 380	1 367	1 914	2 648	5 787	5 477	5 231	4 322	3 851	783
Fruit sampling	30 028	510	1 795	3 113	4 282	6 187	7 241	5 068	1 690	142
Control urban areas	36 225	8 960	11 025	7 840	6 300	1 750	350	0	0	0
Bait sprays	25 596	1 902	1 884	4 170	7 800	9 000	840	0	0	0
Sterile fly purchase and release	105 873	8 693	4 320	8 580	14 220	22 170	29 090	15 950	2 850	0
Quarantine	28 639	2 781	2 774	3 374	4 752	5 371	5 110	3 047	1 134	296
Management	8 631	959	959	959	959	959	959	959	959	959
Emergency plans	2 958	0	0	0	493	493	493	493	493	493
Totals	286 148	27 813	27 736	33 742	47 519	43 712	51 098	30 472	11 343	2 713

Because of the large infested areas and the finite supply of sterile flies, eradication operations will be undertaken one zone at a time. While eradication activities are underway in a zone, preparatory activities must be undertaken in the adjacent zone in accordance with the different project phases. When one phase has been accomplished in a given zone, the next phase will begin immediately. Post-eradication activities will be the responsibility of the national plant protection service of that country. This will require commensurate adjustments in the responsibilities of each co-director.

The field operations positions (suppression, SIT, data processing/data analysis, quality control of operations, etc.) will be supervised by the respective co-director and his staff. The project headquarters may be relocated as required in concert with the primary eradication activities. Both headquarters and field personnel must adequately support the diverse activities with administrative and technical expertise to ensure that the national projects receive the required management support and guidance, technical oversight and review.

At the same time, a conscious effort must be made to accomplish technology transfer. To this purpose, a methods development unit will work directly under the regional executive director. This will enable equal access by all project personnel to acquire the most advanced plant protection and quarantine concepts, principles, procedures and methodologies. These advances can then be incorporated into the existing national eradication and medfly free zone activities, as soon as they become available. This will promote long term protection of the pest free status achieved through project efforts.

The estimated budget for the EASTMED project is presented in Table XIII. The preliminary pilot test to be carried out in advance of the project in a limited area of Zone I is estimated to cost US $1.83 million, which would have to be provided in advance to the estimated budget of US $272.51 million of the whole EASTMED project.

It is projected that medfly eradication from the project area will require a total of six years at an estimated cost of US $134 million. The implementation of the EGYPTMED project should be much facilitated by the experience that Egypt already possesses in preparing for SIT activities. Egypt is the only country in the region to have already received considerable FAO/IAEA support by way of training, expert services and equipment to implement an SIT programme against the medfly. Updated techniques in controlling the medfly, current usage of aerial or ground bait sprays, of different kinds of traps and lures for monitoring the fly are also well established in this country.

DESCRIPTION OF PROJECT AREA

From a geographical point of view, Egypt is considered an optimal country for application of a SIT programme, because of its natural isolation from other countries by the Mediterranean Sea in the North and by vast areas of desert to the south, the east and the west; additional isolation is provided by the Red Sea in the East (Fig. 5). As a result, the risk of reinfestation after the eradication should be much lower. On the other hand, because of the warmer climate of its latitude, medflies have more generations a year, and populations do not decrease as much during the winter months.

Goals	Project phases	Years
Declare Zone III medfly free by year 6	Medfly free zone	6
	Post-eradication	5
	Eradication	4
	Pre-eradication	3
Declare Zone II medfly free by year 5	Medfly free zone	5
	Post-eradication	4
	Eradication	3
	Pre-eradication	2
Declare Zone I medfly free by year 4	Medfly free zone	4
	Post-eradication	3
	Eradication	2
	Pre-eradication	1

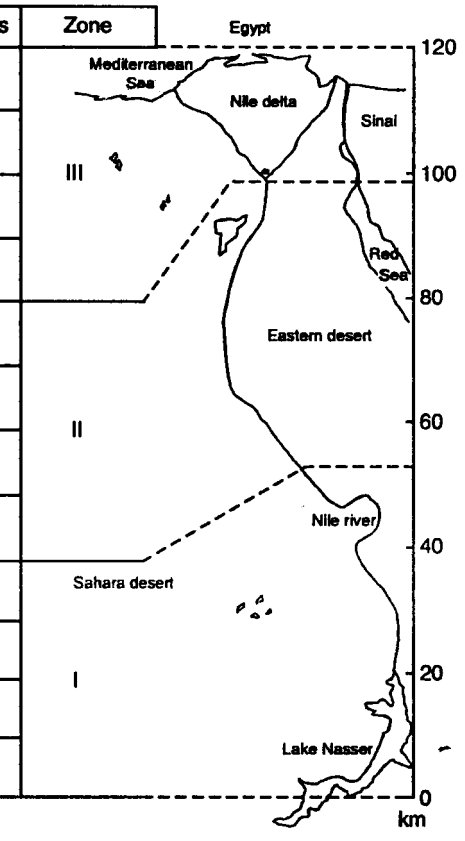

FIG. 5. Eradication plans for the EGYPTMED project.

TABLE XIV. WORK PLAN TIME FRAME FOR THE EGYPTMED PROJECT

Activities	Years					
	1	2	3	4	5	6
A. Analysis						
(1) Cost-benefit	*					
(2) Technical feasibility	*					
(3) Environmental study	*	*	*	*	*	*
(4) Funding sources	*	*	*	*	*	*
(5) Define support of host countries	*					
B. Staffing						
(1) Recruitment of personnel	*	*	*	*	*	
(2) Selection of key staff	*	*				
(3) Selection of local technicians	*	*	*			
(4) Administrative personnel	*	*	*			
C. Training						
(1) Key staff training	*	*	*	*	*	
(2) In-service training for local personnel		*	*	*	*	
D. Public information						
(1) Region wide information campaign	*	*	*	*	*	*
(2) Local public information campaign						
— Zone I	*	*	*	*		
— Zone II		*	*	*	*	
— Zone III			*	*	*	*
E. Data management systems						
(1) Purchases of computer equipment	*	*	*			
(2) Development of custom designed computer program for field operations, quarantine and administrative evaluation	*	*				
F. Research and development						
(1) Key factors of medfly population dynamics in the country (spatial and temporal distribution)	*	*	*			
(2) Refinement of operational procedures		*	*	*		
(3) Refinement of eradication processes		*	*	*	*	
G. Establishing the organization and infrastructure to conduct the eradication programme						
(1) Programme headquarters and infrastructure	*	*	*			
(2) Development of operational manuals including quarantines	*	*	*			
(3) Reinforcement of national programme HQs				*	*	*
(4) Preparation of administrative protocols	*	*	*	*	*	*

TABLE XIV (cont.)

Activities	Years					
	1	2	3	4	5	6
H. Surveillance system						
(1) Complete medfly surveys in the country	*	*	*			
(2) Intensive survey/monitoring in zones under suppression/eradication						
— Zone I		*	*			
— Zone II			*	*		
— Zone III				*	*	
(3) Adult surveys for medfly and other exotic fruit flies		*	*	*	*	
I. Regulatory actions						
(1) Declaration and enforcement of international quarantines		*	*	*	*	*
(2) Establishment and strenghtening of domestic and international checkpoints		*	*	*	*	*
J. Eradication activities						
(1) Aerial and ground bait sprays						
— Zone I	*	*				
— Zone II		*	*			
— Zone III			*	*		
(2) Aerial and ground sterile fly releases						
— Zone I		*	*			
— Zone II			*	*		
— Zone III				*	*	
K. Post-eradication activities						
(1) Evaluations						
— technical		*	*	*	*	
— administrative		*	*	*	*	
(2) Successful eradication declaration						
— Zone I				*		
— Zone II					*	
— Zone III						*
(3) Review contingency plan			*	*	*	*

EGYPTMED will be implemented successively in three zones, starting in southern Egypt in areas adjacent to the Aswan dam or Zone I, then progress northward to Zones II and III. Zones I and II consist of narrow strips of irrigated land along the banks of the Nile river. They are surrounded in the east by the eastern desert and the Red Sea, and in the west by the Saharan desert. Zones I and II also include four main groups of oases in the Egyptian Saharan desert. The programme should then progress to cover the whole delta area in which medfly hosts are cultivated over vast surfaces, including isolated host areas along the Mediterranean Sea.

TABLE XV. EGYPTMED PROJECT ZONES (SURFACES IN km^2)

Zones	Governorates	Commercial orchards	Urban areas	Other areas[a]	Total with hosts
I	Aswan Qena Sohag New Valley	237	297	13 500	14 034
II	Asyut El Minya El Fayum Giza Beni Suef	436	322	9 450	10 208
III	Kalubeya Menufeya Gharbya Beheira Sharkeya Kafr el Sheikh Dakahleya Dumiat Matruh Alexandria Ismailya Suez Port Said Western Nubareya Southern Sinai	2 189	1 442	22 899	26 530
Totals		2 862	2 061	45 849	50 772

[a] 'Other areas' represent cultivated land with scattered medfly hosts.

ERADICATION STRATEGY

Because of the large infested areas and the finite supply of sterile flies, eradication operations will be undertaken one zone at a time. While eradication activities are underway in a zone, preparatory activities must be undertaken in the adjacent zone in accordance with the different project phases. When one phase has been accomplished in a given zone, the next phase will begin immediately. The eradication campaign will proceed from the smallest afea (Zone I) to the largest and most complex area in the delta of the Nile (Zone III). One reason for initiating eradication activities in the south is that in Zone I it is easier to eradicate the pest because of few hosts; this zone will therefore be useful to train the key national programme staff, to demonstrate the eradication technology and show to growers and general public the effectiveness of the SIT.

EGYPTMED will therefore begin in the south, consisting of the four governorates of Aswan, Qena, Sohag and the oases of the New Valley. Vegetables, sugar cane and fruits are the main agricultural crops on both sides of the Nile river, but medfly hosts are scatterred along the cultivated areas and in backyards of urban areas. The whole area is surrounded by an extremely arid desert, so that it can easily be isolated and maintained as a fruit fly free area after eradication. The eradication activities planned for this first zone will serve to demonstrate the effectiveness of SIT and the use of genetic sexing strains, also referred to as the males only strain. This will allow project management to refine field activities so that they function efficiently under diverse conditions elsewhere in the country.

After their completion in Zone I, eradication activities will proceed progressively northward into Zones II and III, with predetermined operations until the medfly has been eradicated from Egypt (see eradication phases in Fig. 5). A work plan time frame for the EGYPTMED project is presented in Table XIV. As eradication is achieved in Zone I, adjacent Zone II will be subjected immediately to the same eradication operations. Detailed information on the working areas in Zones I to III, on the basis of urban, commercial orchard and other cultivated areas with scattered medfly hosts, is presented in Table XV.

While the primary eradication activities begin in southern Egypt, other field activities that must be accomplished in advance of eradication efforts will be started in Zone 2, i.e. public relations, training, survey by trapping and fruit sampling, medfly population suppression, etc. Internal quarantine activities also will be implemented between Zones 1 and 2. The project will then progressively advance to Zone III, the most complex and difficult for eradication purposes, until complete eradication is achieved.

SURVEILLANCE AND DETECTION ACTIVITIES

The eradication effort will rely on a well planned and efficient surveillance system. This system must be operational before any eradication activities are carried out. Project surveillance activities will be used to determine fly locations and densities and will serve to guide control actions. Fruit collection will complement adult trapping to determine if immature stages of the medfly are present. Detection activities consist of installing and servicing a large number of traps within a grid that provides complete coverage of host areas and some non-host areas.

The trapping methodology will vary according to the phase of the project and the intended purpose of the trapping activities. For example, the preliminary surveys conducted during the pre-eradication phase will determine the exact distribution of medfly and assess its seasonal fluctuations. For this, traps baited with a sexual attractant for males (trimedlure) should be used. The type of trap to be used could be a modified Steiner or Magrebmed trap, currently used in various Mediterranean countries.

During the phase of sterile fly releases, the objectives of trapping activities will be to assess the quality of sterile males, their distribution within the release zone and changes in the sex ratio. Since sterile males will be released, recapture of males should be minimized. To accomplish this, a trap will be used that captures more female medflies and reduces male captures by using a combination of visual stimuli and food attractants. The modified Ladd trap could be used for this purpose, as well as other traps that are being developed by researchers in a co-ordinated research programme of the Joint FAO/IAEA Division.

After the last wild fly detection, sterile fly releases will continue for up to three generations. During these sterile fly releases (post-eradication phase), the same trapping and fruit sampling densities will be maintained.

TABLE XVI. TRAP DENSITIES RECOMMENDED FOR THE EGYPTMED PROJECT PHASES

Project phase	Type of trap	Urban areas (traps/km^2)	Commercial orchards (traps/km^2)	Other areas (traps/20 km^2)
Pre-eradication	Modified Steiner with trimedlure	5	10	1
Eradication	Jackson trap	1	1	1
Post-eradication	Jackson trap	1	1	1
		10	10	4
Fly free zone	Modified Steiner with trimedlure	10	10	4
Fly free zone	McPhail	2	2	2
Fly free zone	Jackson with methyl eugenol	0.4	0.1	0.4
Fly free zone	Jackson with cuelure	0.4	0.1	0.4

Trap densities criteria: 100% of urban areas
100% of commercial orchards
Traps will be strategically placed in 5% of 'other areas'.

Trapping services intervals will be:

Pre-eradication phases:	every three weeks
Eradication phases:	weekly
Post-eradication phases:	weekly
Fly free zone:	weekly (during fruiting season)
	fortnightly (out of season).

TABLE XVII. WEEKLY FIGURES FOR THE FRUIT SAMPLING ACTIVITY FOR THE EGYPTMED PROJECT

	Number of fruit samples		
Phase	Urban areas (samples/km^2)	Commercial orchards (samples/km^2)	Other areas (samples/20 km^2)
Pre-eradication	2	1	1
Eradication	6	3	3
Post-eradication	6	3	3
Fly free zone	2	1	1

Following eradication, during the second part of the post-eradication phase and during the free zone confirmation phase, traps for males baited with trimedlure will again be used as a high density. For periods of intensive trapping, higher densities have been planned for urban areas where infested fruit is likely to be introduced. A lower trapping density will be used in commercial host production areas. To verify the complete absence of fertile medfly females, standard glass traps for females (McPhail type traps) baited with a liquid food attractant, will be used. Suggested trap densities for project phases are shown in Table XVI.

Another of the surveyance activities before, during and after eradication is to ascertain whether a zone is completely free of significant quarantine species of fruit flies (Annex 6), a low density of traps baited with other sexual attractants (cuelure, methyl eugenol) and food lures will be used during the verification phase of the project.

Fruit sampling will be conducted during all phases of the project (four years) in order to detect and quantify the incidence of larval infestation in all known hosts. In contrast to trapping activities, the intensity of sampling activities will be low during pre-eradication and fly-free zone phases, and intensified during eradication and post-eradication phases. Suggested fruit sampling intensities for all project phases are shown in Table XVII.

SUPPRESSION ACTIVITIES

Eradication will be achieved through an integrated control programme. The pre-eradication phase will include activities for suppression of natural medfly populations. In Egypt, citrus growers have wide experience of chemical control programmes against medfly, so the project could take advantage of it. Within this project, bait sprays will be used in host production areas to suppress populations so that a more favourable ratio of sterile male medflies to fertile feral flies may be achieved. It is estimated that up to 12 aerial applications will be necessary in some high population areas during the pre-eradication phase. At least one bait spray application will be made to eliminate, in late autumn, all gravid females that could oviposit into late season fruit and from where the overwintering populations usually result in spring. The bait spray is made of a mixture of an insecticide (usually malathion), and a hydrolysed protein. The bait is applied at low volumes and in the form of droplets that lower the potential for adverse environmental impacts against non-target organisms. These treatments are very effective in reducing medfly populations to manageable levels.

It is estimated that the cost of aerial applications of bait sprays will be approximately US $42 per hectare and year, on the basis of present control costs in Egypt. When aerial bait sprays cannot be applied or are considered by project management to be impractical, suppression activities should rely on ground bait sprays. For urban areas, owners of backyard hosts will be encouraged to practice bait sprays and fruit stripping during periods (winter) when medfly populations are low. The use of bait stations for control purposes also will be implemented in these areas. Cost estimations for this activity have been based on the assumption that an average of 1000 households exist within a square kilometer of urban and suburban areas, and a single bait station will be installed on each household property. Costs of ground bait sprays and bait stations have been estimated to be US $7 per household per season.

STERILE INSECT RELEASE ACTIVITIES

Following this, the eradication phase will consist of weekly releases of sexually sterile male medflies to eliminate reproduction of any remaining adults in the population. This procedure has been used successfully in many countries during the last 20 years. The strain that will be used in Egypt will be one of the genetic sexing strains developed by the Joint FAO/IAEA Division.

Compared to classical SIT programmes, where both sterile males and females are released, the use of male only strains will result in much higher effective ratios of sterile males to feral females. The near absence of sterile females will reduce both time and sperm expended by sterile males each time they mate with sterile females. Furthermore, the near absence of sterile females will avoid the problem of 'sterile punctures' to host fruits.

TABLE XVIII. STERILE MEDFLY REQUIREMENTS FOR THE EGYPTMED PROJECT
(million males per week)

Zone	Release areas in hectares		Years				
			1	2	3	4	5
I	Commercial:	23 700	—	35.5	35.5		
	Urban:	29 700		44.5	44.5		
	Other:	1 350 000		168.7	168.7		
II	Commercial:	43 600			65.4	65.4	
	Urban:	32 200			48.3	48.3	
	Other:	945 000			118.1	118.1	
III	Commercial:	2 189 000				328.3	328.3
	Urban:	144 200				216.3	216.3
	Other:	2 289 900				286.2	286.2
Total sterile flies/week				248.7	480.5	1062.6	830.8

Release densities: 1500 males/ha for urban
1500 males/ha for commercial orchards
500 males/ha for other areas (25% coverage).

Implementation of the eradication actions must be timed to take full advantage of the biotic and abiotic factors that tend to lower the fly population. Maximum efficiency from the SIT is achieved when initial releases are timed to coincide with these naturally occurring low fly population densities. It is recommended that, in a given project zone, sterile releases begin during the months of October or November. This will serve to drive the declining medfly populations down even faster and prevent population buildup in the spring. An operational advantage also is gained by providing programme personnel experience in packing and distributing sterile flies before the critical release period in the spring.

The number of sterile flies to be released will be higher for urban and commercial host areas (1500 males per hectare) because of the variety of hosts available, and areas of low host density will require 500 males per hectare. Table XVIII shows the annual requirements of sterile flies for the project.

REGULATORY CONTROLS

Internal and external regulatory controls will be the specific responsibility of the national plant protection services, in accordance with national law and international convention. These activities will be the key to successful eradication and continually maintaining areas medfly free. High priority must be given to the regulatory controls and related activities that are undertaken to support the proposed eradication project. It must be stressed that the regulation of potentially infested commodities constitutes the primary method of preventing artificial spread and reinfestation by the medfly. There must be appropriate control of the movement

of potentially infested host material from infested areas into post-eradication and fly free areas, as well as external quarantines that prevent the importation of infested plant material into each country.

Long term protection from reinvasion will come from strong institutional commitment to regulatory/quarantines and the consistent and effective use of the eradication technologies.

DATA MANAGEMENT

A complex project requires an efficient management system to handle the large volume and wide variety of data and information. Through the use of computers and data management systems (software), it is possible to use current data/information to accomplish timely and effective management. This technology can be expanded to facilitate the production of technical reports, inter- and intraproject correspondence, and mapping (with satellite imagery and the use of the Geographical Information System or GIS).

Public information, training and methods development activities will be conducted in support of the overall eradication. These activities are described in further detail within other sections of this plan.

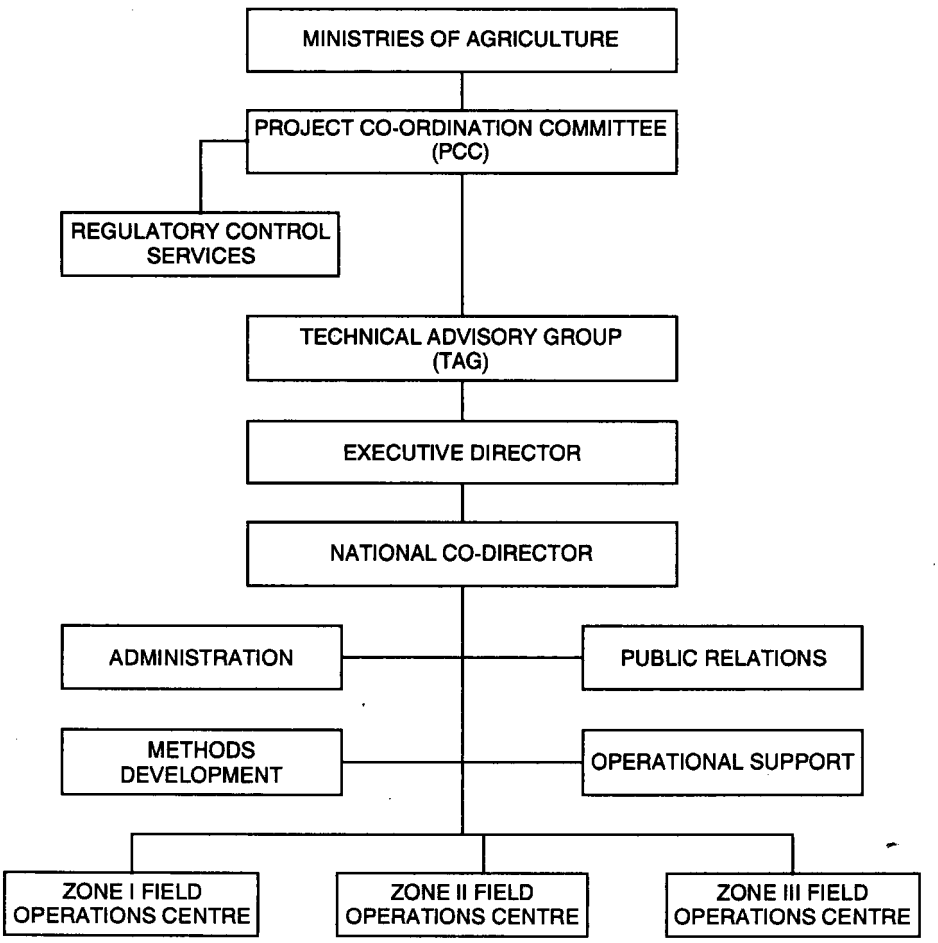

FIG. 6. EGYPTMED project organizational chart.

ORGANIZATION AND MANAGEMENT

An EGYPTMED Project Co-ordination Committee (PCC) will be appointed by the minister of agriculture. Active representation must come from the highest levels within the government for the project to succeed. Representatives of agricultural producers, donors and participating international organizations will also be members of the PCC. The PCC will be chaired by a representative of the Egyptian plant protection service (Fig. 6).

The PCC will deal with matters of policy, budgeting and resource acquisition, but not with management issues. This will be the responsibility of the executive director under the technical guidance of the Technical Advisory Group (TAG). The PCC will secure international and national support for accomplishing project activities. It can assist in resolving complex political/administrative problems that may jeopardize accomplishment of project goals. The PCC will review the project and report to the minister of agriculture every six months during the first four years of the programme, then at the discretion of the PCC. It will, however, function as needed to avert or solve problems.

The TAG will be composed of three selected full time technical experts appointed by the donors/multilateral organizations. It will provide technical oversight of all activities and operations that have a bearing on the effectiveness and efficiency of the overall effort to eradicate the medfly from the designated project area.

On the basis of the recommendation of the TAG, the PCC will be responsible for hiring a full time executive director, who will have primary responsibility for the management and the administration of all activities pertaining to the EGYPTMED project. The executive director will recruit a small staff of full time technical and administrative professionals responsible for the following areas: operational support; methods development; public information and administration. This project staff will direct overall day to day project activities and provide management co-ordination.

The executive director will appoint, on the basis of the recommendation of the TAG and the approval of the PCC, three field centre co-ordinators. Following the instructions of the executive director, they will be responsible for the day to day implementation of programme activities within their respective zones. They will also provide the executive director and TAG with information on operations activities, progress reports and other information concerning conditions or situations that may affect the project.

The organizational structure of the EGYPTMED project will resemble that of an emergency action project. It will require separate and distinct institutional arrangements and operational procedures. Therefore, a separate, well defined and functional organization must be established. Although temporary in nature, project staff must have sufficient autonomy and authority to conduct the project as dictated by operational plans, protocols and field conditions. Although the executive director and his staff will be solely responsible for conducting the eradication activities, they must receive required support from all involved parties to accomplish the goals of the project.

The project will have the right to receive and disburse funds, authority to employ and discharge personnel, ability to purchase supplies and equipment to enter into contractual arrangements, and to conduct the field activities under the delegated authorities granted to it by the government. Personnel can be seconded to the eradication effort from the government on a temporary basis to augment the administration and implementation of project activities; they will, however, have to follow the project regulations and will respond exclusively to the instructions of the executive director and his project staff.

The executive director is a vital and key participant in the project because he will be responsible for all activities conducted within Egypt. The national co-director will serve as the local interface with policy making officials and government personnel. Some activities, such as regulatory controls, will be accomplished by the national plant protection service.

TABLE XIX. TOTAL BUDGET FOR THE EGYPTMED PROJECT (US $ × 1000)

Activity	Years						
	Total	1	2	3	4	5	6
Training	1 070	247	198	277	125	200	23
Public information	5 350	1 235	990	1 385	625	1 000	115
Data management	861	182	173	175	155	92	84
R&D	2 140	494	396	554	250	400	46
Trapping	12 777	141	358	1 362	1 998	4 128	4 790
Fruit sampling	8 991	270	977	2 048	2 864	2 168	664
Control urban areas	14 427	2 079	2 254	10 094	—	—	—
Bait sprays	12 020	995	1 831	9 194	—	—	—
Mass rearing operations	50 140	—	5 466	9 260	24 614	10 800	—
Quarantine	13 607	3 090	1 463	3 439	3 194	1 933	488
Management	10 886	2 472	1 171	2 751	2 555	1 547	390
Emergency plans	1 360	309	146	344	319	193	49
Total	133 629	11 514	15 423	40 883	36 699	22 461	6 649

Post-eradication activities, i.e. verification of the area as medfly free, will also be the responsibility of this service.

An EGYPTMED project headquarters will be established in a centrally located site. Both headquarters and field centre personnel must adequately support the diverse activities with administrative and technical expertise to ensure that the EGYPTMED project receives the required management support and guidance, technical oversight and review. The operations positions (suppression, SIT, data processing/data analysis, and quality control of operations) will be supervised by the field centre co-ordinators. Public information and administration unit positions will be directly supervised by the executive director.

At the same time, a conscious effort must be made to accomplish technology transfer. To this purpose, a methods development unit will work directly under the executive director. This will enable equal access by all project personnel to acquire the most advanced plant protection and quarantine concepts, principles, procedures and methodologies. These advances can then be incorporated into the existing national eradication and medfly free zone activities as soon as they become available. This will promote long term protection of the pest free status achieved through project efforts.

The estimated budget for the EGYPTMED project is presented in Table XIX.

Annex 1

LIFE-CYCLE

The life-cycle is temperature dependent. Egg and larval development, and adult activity are influenced by air temperatures, whereas pupal development depends on soil temperatures. Minimum temperatures at which no measurable development takes place are 11.0°C in soil and 9.7°C in air (fruit). An empirical model has been developed that uses air temperature data to predict the duration of all life stages. Experience with this model has shown that the use of 12.0°C measured in the air can be used as a developmental threshold for all stages. The number of degrees accumulated for a given period of days above the developmental threshold for a life stage are called day-degrees and 346°C day-degrees must be accumulated to complete a life-cycle.

The procedure for calculating the number of day-degrees in a given period and the number of generations of the medfly that developed during that period is as follows:

(1) For each day add the minimum air temperature to the maximum air temperature and divide by two to obtain the average daily air temperature.
(2) Subtract the developmental threshold temperature (i.e. 12.0°C) from the average daily temperature. The result is the number of degrees for that particular day.
(3) For all of the days in the period find the sum of day-degrees.
(4) Now divide the total number of day-degrees by the number of day-degrees required to complete one life-cycle. The result is the number of generations of the insect that have developed during the period.

Technical project plans require a minimum of three life-cycles of trapping with negative results following the last application of bait spray or sterile fly release before eradication can be considered accomplished. Therefore, it is essential that the temperature threshold model is used during the winter or cooler part of the year.

Averages and variations in the life-cycle are as follows:

(1) *Adults*. The normal life expectancy is up to two months but may be up to ten months under cool conditions; the female deposits one to ten eggs in an oviposition puncture in the peel of the fruit, but other females may oviposit in the same puncture; only one mating is required but adults may mate more than once; females lay an average of 300 eggs in a lifetime but individuals may lay up to 800; females may wait to lay until favourable maturing hosts are available and they do not lay when temperatures drop below 17°C; newly emerged adults are not sexually mature and must feed on a proteinaceous substance to reach sexual maturity; the pre-oviposition period varies depending upon environmental conditions but the minimum period is two days.

(2) *Larvae*. They feed throughout the fruit and go through three larval stadia requiring an average of six to eleven days before leaving the fruit. By jumping the larvae find a suitable location to bury about 1 to 2.5 cm deep into the soil to pupate. Occasionally, larvae pupate in debris.

(3) *Pupae*. This stage lasts six to fifteen days. This stage allows the insect to survive in unfavourable conditions. Survival is substantial in the soil between 9.0°C and 34.0°C, but in very wet soil or below 30% relative humidity, the mortality rate is high.

Annex 2

QUARANTINE REGULATIONS

Quarantine regulations must be established by each participating state or country. The regulations must be enforced (not through the use of the voluntary 'red door/green door' procedures) to prevent spread within the country in support of fly free areas and the eradication projects. Also, such regulations must apply to, and be enforced to, cover commercial importations of host products, and, just as importantly, other avenues or means of entry such as mail, express packages, and people who often carry hosts in hand luggage or in checked luggage.

The quarantine regulations and enforcement procedures must be similar throughout the Near East region, and, in fact, internationally. Also, sufficient follow-up monitoring must be accomplished to assure compliance.

The quarantine must:

(1) provide definitions as needed;
(2) list those host products that are subject to regulation;
(3) list the particular areas of the country known to be infested with the medfly;
(4) list certification procedures, including treatments, that may be or are available to allow movement of host products from infested areas, or states/countries to non-infested areas;
(5) provide for the issuance and attachment of certificates or limited permits when necessary to prevent spread;
(6) provide for agreements, and cancellation thereof, which outline procedures to be followed by individuals or concerns which handle or transport host products; and
(7) provide for the prompt imposition and collection of fines for wilful, intentional or repeated violations of quarantine regulations.

The objectives of the proposed projects are: (1) medfly eradication, and (2) establishment of medfly free areas. This is scheduled to be completed in each proposed zone within four years. It is recognized that the primary authority and responsibility for taking regulatory actions rests with the national plant protection services of each respective country. It should be clearly understood that maintaining areas medfly free will become the responsibility of the national plant protection services within each respective country, and not the responsibility of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Close co-ordination will be necessary between the proposed projects and the national plant protection services of the various countries to accomplish this task. Project efforts will complement but not replace these actions. The national plant protection services will be called upon to strictly enforce external quarantines in order to prevent the introduction of new exotic pests.

It may be necessary for national plant protection services to amend their legal authorities to take regulatory actions against the medfly, both internally and externally. This will be particularly important before the initiation of eradication activities. Authorities also may be required to take certain abatement actions, particularly where high medfly populations are encountered. This would include unharvested, neglected or abandoned orchards or groves. Legal authority also is required to take necessary emergency actions. This includes the right of entry onto premises for the purpose of inspection, host removal, treatment, pest surveillance, detention and destruction of host commodities.

The expert group recognizes the many complexities and difficulties of imposing and enforcing internal quarantine actions to limit the movement of infested host products. The group believes that commercial movements can be effectively controlled through inspections

conducted at wholesale and retail markets, issuance of compliance agreements with commercial entities and vendors, and certification/inspection of commercial shipments at the origin, intermediate road stations, and final destination.

All major wholesale markets within medfly free areas will be inspected on a regular basis. Inspections will need to be conducted at retail markets selected at random. Nurseries also will require inspection, and host nursery stock must be stripped and treated with soil insecticide before certification and movement from infested areas towards medfly free areas. It is not known at this time how many nurseries exist within each region. Owing to the frequent applications of malathion bait sprays that are expected to take place in pre-eradication, eradication and post-eradication phases, the group believes that the movement of medfly in commercial hosts will be relatively low compared with fruit originating from backyards and home gardens.

For the purpose of supplying certain host commodities to high risk locations, such as resort hotels and historical sites, it may be possible to implement a system of certification of host fruits grown under a protocol designed to reduce pest presence before and including harvest. This would require intensive trapping, application of bait sprays at prescribed intervals, elimination of alternate host fruits near commercial groves and other mitigation measures. Various examples of fruit fly management programmes or systems approaches could be examined that would allow internal host movement until eradication is completed.

Establishment of quarantine zones by the national plant protection organizations will take into consideration the location of fruit processing plants, major produce markets, packing houses, and commercial transportation centres.

The greatest risk will come from the movement of fresh fruits and vegetables that are taken from backyards and gardens and carried to free areas by homeowners and travellers. The group believes that several mobile road stations should be placed in operation at strategic times during the season to encourage compliance by the general public. Quarantine signs will be placed along the highways or painted on the road to remind the public not to move infested host material. An intensive public information campaign will be planned and carried out in urban areas.

Annex 3

HOSTS THAT SHOULD BE REGULATED

Although the medfly has reportedly been associated in varying degrees with more than 350 species of plants, only those species that provide for reproduction of the medfly should be regulated. Effective quarantine actions must be established to protect the defined free area from re-entry of the pest. This will require the regulatory authority to stop both commercial and non-commercial movements of host materials, to hold these for inspection and/or treatment, to refuse entry or to seize items for their destruction.

Regulated hosts should include:

Common name	*Scientific name*
Aak, apple of Sodom, madar, small crown flower	*Calotropis procera* (Aiton) Aiton f.
Akee, akee apple, seso vegetal	*Blighia sapida* (Konig)
Almond with husk	*Prunus dulcis* (Miller) D. Webb
Apple	*Malus domestica* Borkh.
Apple of Sodom	*Solanum anguivi* Lam.
Apricot	*Prunus armeniaca* L.
Argan tree	*Argania spinosa* (L.) Skeels
Avocado	*Persea americana* Mill.
Barbados cherry	*Malpighia glabra* L.
Black sapote, black persimmon, sapote negro	*Diospyros digyna* Jacq.
Bourbon orange	*Ochrosia elliptica* Labill.
Box thorn, matrimony vine	*Lycium* spp.
Calamondin, Panama orange, golden lime	*Citrus madurensis* Lour.
Canistel, yellow sapote, egg fruit tree	*Pouteria campechiana* (Kunth) Baehni
Caper	*Capparis spinosa* L.
Ceylon gooseberry, ketembilla, kitambilla	*Dovyalis hebecarpa* (Gardner) Warb.
Chanar	*Geoffroea decorticans* (Hook. and Arn.) Burkart
Cherimoya, custard apple	*Annona cherimola* Miller
Cherry, sweet; sour cherry	*Prunus avium* (L.)L.; *P. cerasus* L.
Citron, cedrat	*Citrus medica* L.
Coffee	*Coffea arabica* L.
Custard apple, bullock's heart, corazon	*Annona reticulata* L.
Date	*Phoenix dactylifera* L.
Dwarf papaya	*Carica quercifolia* Solms
Eggplant	*Solanum melongena* L.
Fig	*Ficus carica* L.
Gourka, sour mangosteen	*Garcinia xanthochymus* T. Anderson
Grape	*Vitis vinifera* L.
Grapefruit	*Citrus* × *paradisi* Macfady
Guava (common, pomiform, pyriform)	*Psidium guajava* L.
Hawthorn	*Crataegus* spp.
Azarole hawthorn	*Crataegus azarolus* L.
Hog plum, jobo, yellow mombin	*Spondias mombin* L.

Ironwood, mastic	*Mastichodendron foetidissimum* (Jacq.) Cronq.
Japanese persimmon, kaki, oriental persimmon	*Diospyros kaki* Thunb.
Japanese plum	*Prunus salicinia* Lindley
Jocote, Spanish plum, redor purple mombin	*Spondias purpurea* L.
Jujube, Chinese date	*Ziziphus jujuba* Miller, *Z. lotus* (L.) Lam., *Z. spina christi* (L.) Desf.
Kei apple, umkokola	*Dovyalis* (=*Aberia*) *caffra* (Hook. f. and Harvey) Warb.
Kiwi	*Actinidia chinensis* Planchon
Kumquat, round kumquat, Marumi kumquat	*Fortunella japonica* (Thunb.) Swingle
Oval kumquat, Nagami kumquat	*F. margarita* (Lour.) Swingle
Lemon (except commercially grown Eureka, Lisbon and Villa Franca cultivars)	*Citrus limon* (L.) Burman f.
Lime	*Citrus aurantiifolia* (Christm.) Swingle
Litchi	*Litchi chinensis* Sonn.
Longan	*Dimocarpus longan* Lour.
Loquat, Japanese medlar	*Eriobotrya japonica* (Thunb.) Lindley
Mandarin orange, tangerine, clementine	*Citrus reticulata* Blanco
Mango	*Mangifera indica* L.
Mock orange, orange jasmine, China box	*Murraya paniculata* (L.) Jack
Mombin	*Spondias* spp.
Malay apple, pomerac, otaheite, rose apple	*Syzygium malaccense* (L.) Merr. and Perry
Mulberry	*Morus* spp.
Natal plum	*Carissa macrocarpa* (Ecklon) A.DC.
Myrobalan	*Terminalia chebula* Retz.
Nectarine	*Prunus persica* var. *nucipersica* (Suckow) C.
Olive	*Olea europea* L.
Prickly pear, Opuntia cactus	*Opuntia* spp.
Papaya, pawpaw	*Carica papaya* L.
Passion fruit	*Passiflora edulis* Sims
Peach	*Prunus persica* (L.) Batsch
Pear	*Pyrus communis* L.
Pepper, tabasco pepper	*Capsicum annuum* L., *C. frutescens* L.
Pineapple guava	*Feijoa sellowiana* (O. Berg) O. Berg
Plum, American; American red plum	*Prunus americana* Marshall
Plum, prune, European plum	*Prunus domestica* L.
Plum, Methley	*Prunus salicina* (Lindley) × *P. cerasifera* J.F. Ehrh.
Pomegranate	*Punica granatum* L.
Pond apple	*Annona glabra* L.
Pomelo, shaddock, pumelo	*Citrus maxima* (Burman) Merr.
Quince	*Cydonia oblonga* Mill.
Rose apple, jambos, Malabar plum	*Syzygium jambos* (L.) Alston
Rose tree	*Rosa* spp.
Sapodilla, chicle, nispero, naseberry	*Manilkara zapota* (L.) P. Royen

Sour orange, bigarade, bitterorange	*Citrus aurantium* L.
Spanish cherry, Brazil cherry, grumichama	*Eugenia dombeyi* (Sprengel) Skeels
Spanish plum	*Spondias purpurea* L.
Star apple	*Chrysophyllum* spp.
Strawberry guava, yellow strawberry guava	*Psidium cattleianum* var. *littorale* (Raddi) Fosb.
Strawberry tree, arbutus, madrono	*Arbutus unedo* L.
Sugar apple, sweetsop, custard apple, ata	*Annona squamosa* L.
Sugar palm, Areng palm, Gomuti palm, bary	*Arenga pinnata* (Wurmb.) Merr.
Surinam cherry, pitanga, grumichama	*Eugenia uniflora* L.
Sweet orange	*Citrus sinensis* (L.) Osbeck
Tomato (unripened)	*Lycopersicon lycopersicon* (L.) Karst. ex Farw.
Tree tomato, tamarillo, tomate d'arbre	*Cyphomandra betacea* (Cav.) Sendtner
Trifoliate orange	*Poncirus trifoliata* (L.) Raf.
Tropical almond, kamani, Malabar almond badam	*Terminalia catappa* L.
Walnut with husk	*Juglans* spp.
White sapote, zapote blanco, Mexican apple	*Casimiroa edulis* Llave and Lex.

Note: Scientific and common names of hosts and authors correspond to those found in TERRELL, E., et al. (1986) and LIQUIDO, N., et al. (1991). In addition, the on-line taxonomic database located on the Germplasm Resources Information Network (GRIN) of the National Germplasm Resources Laboratory, Agricultural Research Service, United States Department of Agriculture, was used to verify recent changes in nomenclature. This database can be accessed through the Internet at the following web-page site: http://www.ars-grin.gov/npgs/tax/index.html. — This is a tentative host list. It should be reviewed by the countries involved.

Annex 4

REQUIREMENTS FOR PEST FREE AREAS

Pest free areas (PFAs) are recognized by an increasing number of countries throughout the World (Argentina, Australia, Brazil, Canada, Chile, Japan, Mexico, New Zealand, and the United States of America, just to name a few). Currently, a proposed International Standard prepared by the Secretariat of the International Plant Protection Convention, UN/FAO, is under review. Presumably all countries may eventually allow the importation of agricultural host crops from areas or countries free from economically important fruit flies and other pests. Some countries may require that a representative of their country visit the exporting country before recognizing their proposed PFA(s). The PFA designation means that the importing country will not require a post harvest treatment for that specific target pest (e.g. medfly) associated with a specific host commodity from a particular origin. However, additional phytosanitary measures may be required if a pest risk analysis shows that other quarantine significant pests are present on that same commodity, from the same origin.

In order to obtain certification or recognition of a PFA, the exporting country must:

(1) Submit a written request to the national plant protection organization of the intended importing country that identifies the host commodity along with a list of the plant pests that are known to attack that crop within the exporting country;
(2) Establish and enforce quarantine regulations necessary to protect the defined free area from re-entry of the pest;
(3) Conduct an eradication project as necessary to eliminate the pest (medfly) from the defined area(s);
(4) Conduct a detection level survey as mutually agreed to with the importing country to promptly detect any pest (medfly or other quarantine significant pests) that may have breached the quarantine and immediately telephone or transmit information by facsimile about the discovery to the importing country;
(5) Agree to report any export shipment that may be en route to, or received by, the importing country that may contain infestation as a result of the discovery of infestation and mutually agree with the importing country as to the remedial measures that may be used to handle such shipments; and
(6) Apply mutually agreed upon procedures to eradicate the outbreak and implement any necessary restrictions to prevent spread until eradication is again achieved.

Refer to Ref. [9] for additional guidelines on pest free area requirements.

Annex 5

OPERATIONAL MANUALS

Manuals should be developed to cover each phase of the operational project. Some of the more important items that must be considered and incorporated are the following:

(1) STERILE INSECT TECHNIQUE (SIT)

The quality of the flies produced in the rearing facility must be checked in accordance with a quality control manual [10]. This manual outlines the types of test that must be accomplished to assure the production of high quality sterile flies. Such a manual is available and currently under review. This manual also outlines shipping procedures and quality tests to be performed on flies received for field use.

(2) SURVEY AND DETECTION

Two types of manual are required to assure that high quality surveys are conducted. One is a manual for the collection, holding and study of fruit and its objective is therefore the survey and detection of the immature stages of medfly. The other one is a trapping manual and is therefore directed at the survey and detection of adult medflies. The Moscamed programme in Mexico and Guatemala has developed an excellent manual for fruit sampling activities that should be consulted [11]. In the case of trapping, there are a number of good manuals available, including those of the USDA, that should be revised for the region.

The medfly attractant trimedlure primarily attracts the male medfly and immature females. Purchases of trimedlure should be tested for compliance with contract specifications. This includes chemical analysis and field bioassays. This will assure that the attractant meets the highest chemical standards and avoid compromising the surveillance and detection systems.

If the traps are properly utilized, they can be relied upon to trap the medfly during the first generation after introduction. However, if not used in accordance with the trapping protocol, the survey may not detect the medfly in time to provide for rapid and prompt eradication. A very essential consideration is trap location. Traps should be placed in highly preferred wild or cultivated hosts during the time that the host is fruiting. It is, therefore, essential that the manual lists preferred hosts and the period during which the fruit is attractive, usually beginning just before maturity.

The type of trap that will be most effective for detection in the Near East region will be determined at a later date. Published results of the FAO/IAEA standardized trapping studies should be consulted with regard to the best trap type for detection purposes. Data contained in this report are useful in comparing capture results for a variety of different trap types and lures. Additional studies on traps that attract female medflies are currently underway. Other improvements are under evaluation including the use of yellow sticky panels coated with trimedlure and different matrices for release of the attractant.

(3) CHEMICAL CONTROL

The principal elements that should be in this manual are:

(i) type(s) of application equipment — ground, air — and spray dispersal system;
(ii) bait spray formulation;
(iii) aircraft calibration for bait sprays;
(iv) electronic navigation and guidance systems to assure adequate spray and sterile fly coverage.

(4) QUARANTINE

The manual should refer to the host country quarantine documents and outline procedures and methods to be employed to assure compliance with regulations including inspections at ports of arrival. Also included is the use of X ray and other procedures to detect hosts in commercial shipments, express shipments, mail, host material carried by passengers or in checked luggage. Quarantine actions to support the eradication projects or free areas must include the regulation of the movement of economic hosts through commerce and by individuals. The procedures to be used in the levy of fines and their collection also should be outlined. Quarantines must be in operation 24 hours daily including national holidays.

(5) CONTINGENCY PLANS

During the eradication phase, every country should prepare a contingency plan which refers to the timely elimination/eradication of any detection of fruit fly having occurred during the post-eradication and fruit fly free zone phases. This contingency plan should be prepared as a manual and should outline the resources needed, the specific detection and eradication procedures, times and working areas, quarantine measures to be applied, etc. The manual has to be officially approved by the project technical committee and by government plant protection officials.

ANNEX 6

EXOTIC AND ENDEMIC FRUIT FLIES OF THE NEAR EAST*

Several exotic species of polyphagous tephritids are a major threat to fruit and vegetable growing in the Near East. Most of them belong to the oriental fruit fly *Bactrocera dorsalis* Hendel species complex. Others are the peach fruit fly, *B. zonata* Saunders and the melon fly, *B. cucurbitae* Coquillett. They are native to Asia where they can cause extensive damage. The following fruit grown in the Near East could be infested by species of the Oriental fruit fly complex and by the peach fruit fly:

apple	quince
apricot	olive
clementine	orange
fig	peach
grapefruit	pear
guava	persimmon
kumquat	pomegranate
lemon	prune
loquat	sapote
mandarin	sour orange
nectarine	tomato

The melon fly breeds in tomatoes, green beans and chili peppers besides infesting cucurbit crops.

Another species, the mango fly, *Ceratitis cosyra* Walker, occurs in Sudan and Africa south of the Sahara where it attacks mango, common guava, sour orange, peach, avocado and wild custard apple.

The five spotted fruit fly, *C. quinaria* Bezzi, also known as the Rhodesian or Zimbabwean fruit fly, is reported from Yemen, Sudan, South Africa, Malawi, Namibia and Zimbabwe. It infests apricot, citrus, common guava and peach, and has also been found in a wild host, *Ziziphus spina christi* L. Wild, belonging to the Near East flora. So far, the above species have not been reported from the Near East.

Four exotic fruit flies breed only in cucurbit crops. The following two are known to occur in countries around the Near East region: *Dacus ciliatus*, the Ethiopian fruit fly or cucurbit fly, is widely distributed in Africa, including Egypt, the Indian Ocean, Oriental Asia and the Middle East (Saudi Arabia, Yemen). Recently, this pest was detected in southern Israel. The Israeli Plant Protection Service, Ministry of Agriculture, initiated efforts to delimit and eliminate this infestation through intensive trapping and eradication measures. *D. frontalis* Becker is widespread in Africa, including Egypt, and also in Saudi Arabia and Yemen.

The other exotic tephritids attacking only cucurbits are: *D. punctatifrons* Karsh occurring in several African countries south of the Sahara and Yemen and the jointed pumpkin fly or melon fly, *D. vertebratus* Bezzi, widely distributed in Africa and reported from cucurbits in Saudi Arabia and Yemen.

The berfruit fly, *Carpomya vesuviana* Costa, breeding in jujuba (*Ziziphus* spp.) has been found in temperate Asia and Italy.

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* Based on Ian M. WHITE, Marlene M. ELSON-HARRIS, Fruit Flies of Economic Significance: Their Identification and Bionomics, C.A.B. International, Redwood Press, Melksham, UK (1992).

The fruit flies endemic to the Near East are besides the medfly, *C. capitata* Wiedemann, *Carpomya incompleta* Becker breeding only in jujube, *Capparimiya savastani* Martelli, only in capers, the olive fly, *Bactrocera oleae* Gmelin, only in olives and the Baluchistan or Russian melon fly, *Miyopardalis pardalina* Bigot, attacking only cucurbit crops in Cyprus, Israel, Lebanon, the Syrian Arab Republic and Turkey.

With the continuing increase in air travel, the risks of involuntary introduction of pests and pathogens noxious to plants have grown enormously. The cases of new infestations occurring in many countries, for example in the United States of America, show that the danger of introducing fruit fly species is great. There would be little justification in starting to eliminate the medfly if the door remained wide open to the introduction of other polyphagous tephritids of similar economic importance. Besides plant quarantine measures, a surveillance programme consisting essentially of trapping belts around cities and international airports and harbours to detect accidental introductions of exotic fruit flies is highly advisable. Attractants are methyl eugenol for the oriental fruit fly and the peach fruit fly, cuelure for the melon fly, *D. frontalis* and *D. punctatifrons*, terpinyl acetate for the mango fruit fly and the five spotted fruit fly, vert lure for the jointed pumpkin fly.

ANNEX 7

PROVISIONAL LIST OF MEDFLY HOST PLANTS IN THE NEAR EAST

Botanical name	Common name
ACTINIDIACEAE	
Actinidia chinensis Planchon	Kiwi fruit*
ANACARDIACEAE	
Mangifera indica	Mango
ANNONACEAE	
Annona cherimola Mill.	Cherimoya
Annona reticulata L.	Custard apple
APOCYNACEAE	
Carissa macrocarpa Ecklon A.DC. (=*C. grandiflora* (E.H. Mey.) A.DC.)	Natal plum*
Thevetia peruviana (Pers.) Schumann	Lucky nut
AVERRHOACEAE	
Averrhoa carambola L.	Carambola
CACTACEAE	
Opuntia ficus indica (L.) Mill.	Spineless cactus, tuna, Indian fig, prickly pear
Opuntia vulgaris Miller	Prickly pear, barbary fig
CAPPARACEAE	
Capparis spinosa L. (*C. rupestris* Sibth. & Smith)	Caper, caprier, alcaparro, caperbush
CARICACEAE	
Carica papaya L.	Papaya, pawpaw
EBENACEAE	
Diospyros kaki Thunb.	Oriental persimmon, kaki, Japanese persimmon

* Plants listed only, laboratory but no field infestation data reported.

Botanical name	Common name
FLACOURTIACEAE	
Dovyalis (=*Aberia*) (Hook f. & Harv.) Warb	Kei apple
JUGLANDACEAE	
Juglans regia L.	English walnut
LAURACEAE	
Persea americana Mill.	Avocado
MORACEAE	
Ficus carica L.	Fig tree
Morus alba	White mulberry
Morus nigra	Black mulberry
Morus rubra	Red mulberry
MUSACEAE	
Musa × *paradisiaca* L.	Banana
MYRTACEAE	
Eugenia uniflora L.	Surinam cherry
Feijoa sellowiana (O. Berg) O. Berg	Feijoa
Psidium guajava L.	Common guava
Psidium var. *littorale* (Raddi) Fosb.	Strawberry guava, waiawi, yellow strawberry guava
PALMAE	
Phoenix dactylifera L.	Date palm
PUNICACEAE	
Punica granatum L.	Pomegranate
RHAMACEAE	
Rhamnus lycioides spp.*oleiodes* (L.) Jah. & Maire	Buckthorn
Ziziphus jujuba Miller (=*Z. sativa* Gaertner)	Common jujube, Chinese date
Ziziphus spina christi (L.) Desf.	Jujube, Christ thorn, kurna, nabbag, sidr

Botanical name	Common name
ROSACEAE	
Crataegus azarolus L.	Azarole hawthorn
Crataegus sp.	Hawthorn
Cydonia oblonga Mill. (*C. vulgaris* Pers.)	Quince, membrillo
Eriobotrya japonica (Thunb.) Lindley	Japanese medlar, loquat, nispero
Fragaria chiloensis (L.) Duchesne	Chilean strawberry, beach strawberry
Malus domestica Borkh. (*Mespilus germanica* L.)	Apple
Prunus americana Marshall	Wild plum, American plum
Prunus armeniaca L.	Apricot
Prunus avium (L.) L.	Sweet cherry
Prunus cerasus L.	Sour cherry
Prunus domestica L.	Common plum
Prunus persica (L. Batsch)	Peach
Prunus persica var. *nucipersica* (Suckow) C.	Nectarine
Prunus salicina Lindley	Japanese plum
Prunus salicina Lindley × *P. cerasifera* J.F. Ehrh.	Methley plum
Pyrus communis L.	Pear
Rosa spp.	Rose tree
Rubus longobaccus (L. Bailey)	Boysenberry, longanberry
RUTACEAE	
Casimiroa edulis Llave & Lex.	White sapote
Citrus aurantiifolia (Christm.) Swingle	Lime, sour lime, Persian lime, key lime
Citrus aurantium L.	Sour orange, bigarade, Seville orange, bitter orange
Citrus limetta Risso	Sweet lime
Citrus limon (L.) Burm.f.	Lemon, sour lemon
Citrus × *limonia* Osbeck	Lemandarin, Rangpur lime, mandarine lime, otaheite orange
Citrus maxima (Burm.) Merrill (*C. grandis*)	Pomelo, shaddock, pummelo
Citrus medica L.	Citron, cedrat
Citrus × *nobilis* Lour.	Tangor, king orange, temple orange
Citrus × *paradisi* Macfady	Grapefruit
Citrus reticulata Blanco	Satsuma orange, mandarin orange, clementine, tangerine
Citrus sinensis (L.) Osbeck	Sweet orange
Citrus × *tangelo* J. Ingram & H. Moore	Tangelo
Fortunella japonica (Thunb.) Swingle	Round kumquat
Fortunella margarita (Lour.) Swingle	Oval kumquat
Poncirus trifoliata (L.) Raf.	Trifoliate orange

Botanical name	Common name
SAPINDACEAE	
Dimocarpus longan Lour.	
Euphoria longan (Lour.) Stendel	Longan
Litchi chinensis Sonn.	Lychee, litchi
SAPOTACEAE	
Chrysophyllum cainito L.	Star apple, caimito
SOLANACEAE	
Capsicum annuum L.	Red pepper, chili pepper, green pepper,paprika pepper, bell pepper, pimento
Capsicum frutescens L.	Tabasco pepper, Cayenne pepper
Lycium europaeum L.	Box thorn, European matrimony vine
Lycium shawi (=*L. arabicum* Bioss.)	Box thorn, matrimony vine
Lycopersicon lycopersicum (L.) Farw. (=*L. esculentum* Mill.)	Common tomato
Solanum incanum L.	—
Solanum melongena L.	Eggplant, aubergine, berenjena
Solanum anguivi Lam.	Apple of Sodom
Solanum nigrum L.	Black nightshade
VITACEAE	
Vitis vinifera L.	Wine grape, European grape

ANNEX 8

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ANNEX 9

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