A Multi-Institutional Approach to Create Fruit Fly-Low Prevalence and Fly-Free Areas in Central America

J. REYES[1], X. CARRO[2], J. HERNANDEZ[3], W. MÉNDEZ[4], C. CAMPO[5], H. ESQUIVEL[6], E. SALGADO[7] and W. ENKERLIN[8]

[1]*International Atomic Energy Agency, Department of Technical Cooperation, 16 calle 3-38, Zona 10, Ciudad de Guatemala 01010, Guatemala*

[2]*Ministerio de Agricultura y Ganadería, Aptdo.70-3006, Barreal, Heredia, Costa Rica*

[3]*Ministerio Agropecuario y Forestal, Km 3.5 Carretera a Masaya, contiguo al Gaucho, Managua, Nicaragua*

[4]*Ministerio de Agricultura, Ganadería y Alimentación, 16 calle 3-38, Zona 10, Ciudad de Guatemala, 01010, Guatemala*

[5]*Ministerio de Desarrollo Agropecuario, Aptdo. Postal 5390, Zona 5, Río Tapia, Tocumén, Panamá*

[6]*Ministerio de Agricultura y Ganadería, Cantón El Matasano, Zoyapango, San Salvador, El Salvador*

[7]*Secretaría de Agricultura y Ganadería, Av. La FAO, Boulevard Miraflores, Edificio 3, piso 3, Tegucigalpa, Honduras*

[8]*Insect Pest Control Sub-Programme, Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, IAEA, Wagramerstrasse 5, A-1400, Vienna, Austria*

ABSTRACT New approaches to facilitate fruit and vegetable exports, through the establishment of fruit fly-low prevalence and fly-free areas, were used in Central America and Panama, by implementing an area-wide integrated pest management approach (AW-IPM), including in some cases a sterile insect technique (SIT) component. These included: (1) the establishment of multi-institutional strategic alliances; instead of the historical isolated efforts scattered throughout the region; involving four international organizations, two donor government institutions and the Ministries of Agriculture of El Salvador, Costa Rica, Guatemala, Honduras, Nicaragua and Panama joining efforts under the umbrella of a regional technical cooperation project coordinated by the International Atomic Energy Agency, (2) the selection of naturally isolated medium-sized pilot areas for intervention where application of fruit fly AW-IPM with a SIT component could be technically and economically feasible. Thereafter, several isolated fruit fly-low prevalence or fly-free areas could be merged to increase the area under fruit fly control, instead of the traditional approach of fruit fly suppression or eradication on a country or region-wide basis, and (3) a focus on exports, with application in the pilot areas of a package of procedures which included the key elements required for exporting fruits and vegetables from fruit fly-low prevalence and fly-free areas, instead of focusing only on applying the technology per se in the field. In this approach, the industry played an important role. Outcomes included: (1) the establishment of a number of fruit fly-low prevalence and fly-free areas in each of the participating countries, (2) involvement of the fruit and vegetable industry which has invested around USD 150 million to export fresh pepper and red tomato from the areas of low fruit fly-prevalence in Guatemala, El Salvador, Nicaragua and Costa Rica that were established through a systems approach, and (3) exports of papaya from the Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) fly-

M.J.B. Vreysen, A.S. Robinson and J. Hendrichs (eds.), Area-Wide Control of Insect Pests, 627–640.

free area in the Department of Peten, Guatemala, without undergoing quarantine treatment. Major constraints to be overcome for future sustainability include: (1) strengthening alliances among the international organizations and donors since these are still fairly weak, (2) improving coordination between governments and stakeholders, (3) reducing the drastic turnover of civil servants in the national plant protection organizations, which affects continuity, and (4) overcoming insufficient funding from public and private sectors to be able to extend actions to larger or new areas.

KEY WORDS Mediterranean fruit fly, West Indian fruit fly, Mexican fruit fly, area-wide integrated pest management, sterile insect technique, strategic alliances, pilot areas, areas of low pest prevalence, pest free areas, industry

1. Introduction

For the past decade, countries in Central America have been affected by low international prices for coffee, banana and sugarcane and there is no indication that this situation will improve. The governments of these countries and Panama have therefore been seeking new alternatives for international trade through production and export of non-traditional fruits and vegetables. To assist them in this task, support was provided by the International Atomic Energy Agency (IAEA), through a regional project RLA/5/045, to establish fruit fly-low prevalence and fruit fly-free areas using an area-wide integrated pest management (AW-IPM) approach that included in some cases the sterile insect technique (SIT), and by strengthening the countries' phytosanitary frameworks.

After the Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) was found in Costa Rica in 1955, many efforts were made to eradicate it from Central America and Panama. The first of these was by the United States Department of Agriculture (USDA) at the request of the Government of Costa Rica, and focused on the transfer of methodologies for monitoring and control using ground protein bait sprays (Salas 1958). In the 1960s, the Mediterranean fruit fly had spread into Nicaragua, and the IAEA and the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA) launched a pilot project to eradicate it through the integrated use of the SIT (Rhode 1970). However, this failed due to lack of support and understanding of the area-wide application of SIT by the United Nations Development Programme (UNDP) (UNDP 1970), and the fly invaded the three neighbouring countries of Honduras, El Salvador, and Guatemala, reaching southern Mexico in 1977.

Since then, over 20 projects have been implemented focusing on the Mediterranean fruit fly including: its taxonomy, temporal and spatial distribution, determination of its hosts, use of biological control and implementation of pilot scale mass-rearing. Moreover, over 18 initiatives were funded or presented for funding by national and international institutions for regional eradication of this pest, and in recent years these have been extended to cover native *Anastrepha* fruit flies. These institutions include: the Instituto Interamericano de Cooperación para la Agricultura (IICA), IAEA, the Food and Agriculture Organization of the United Nations (FAO), the Secretaría de Agricultura Ganadería, Desarrollo Rural, Pesca y Alimentación of México (SAGARPA), OIRSA, the UNDP, the United States Agency for International Development (USAID) and USDA (Vo et al. 2003).

In spite of these efforts, the entities involved did not succeed in achieving a single fruit fly-low prevalence or fly-free area in Central America except for the Mediterranean fruit fly-free area of Peten in Guatemala and preventing the establishment of the Mediterranean fruit fly in Belize. This was achieved through a containment programme managed since the late 1970s by the Governments of Guatemala, Mexico and the

USA to prevent the spread of this pest into Mexico and the USA. The main obstacles that prevented success with these efforts included: (1) unaligned phytosanitary policies among the countries, (2) lack of clear regional agricultural goals, (3) isolated and duplicated projects in the region, and (4) lack of a holistic approach to solving the problem.

Consequently, a new approach was proposed to overcome earlier constraints and increase the likelihood of establishing fruit fly-low prevalence or fly-free areas. This involved the integration of three main elements: (1) a project based on developing multi-institutional strategic alliances, (2) the use of pilot areas as a territorial strategy for suppression/eradication of fruit flies, and (3) a focus on promoting export of fruits and vegetables.

2. Multi-Institutional Strategic Alliances

In order to coordinate efforts and overcome constraints arising from working in isolation, the following strategy was implemented. The Ministries of Agriculture of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama joined resources and efforts with IICA, FAO, OIRSA, USDA and SAGARPA. This initiative was coordinated by an IAEA-employed full-time regional manager, and the establishment of a Regional Coordination Group (RCG) with representatives of the National Plant Protection Organization (NPPO) of each country. In addition to the resources provided by the ministries of agriculture and private sector stakeholders, the RCG effectively coordinated the financial and in-kind contributions provided by (1) the IAEA through a Regional Technical Cooperation Project (RLA/5/045) for establishing fruit fly-low prevalence and fly-free areas in Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, (2) the USAID through the "Mitch funds" for establishing Mediterranean fruit fly-free areas in El Salvador, Honduras and Nicaragua, (3) the FAO contributions through a Technical Cooperation Project (TCP/072) for establishing Mediterranean fruit fly-free areas in Belize, Costa Rica and Panama, (4) the USDA, the MAGA and the SAGARPA through the "Programa Moscamed" to maintain the Department of Peten, in northern Guatemala, and the border between Guatemala and Mexico free of Mediterranean fruit fly.

3. Strategic Approach for a Succesful and Sustainable Project

The strategy focused on demonstrating the technical and operational feasibility of establishing fruit fly-low pest prevalence areas (FF-ALPP) and fruit fly-pest free areas (FF-PFA) to promote fruit and vegetable exports and the viability of sustaining them through the resulting economic and social benefits to ministries of agriculture, national plant protection organizations and the fruit and vegetable industries.

According to FAO's Glossary of Phytosanitary Terms (FAO 2001) an ALPP is:

> *An area, whether all of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures.*

A PFA is:

> *An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained.*

Implementation was based on an AW-IPM approach. In some cases the SIT was a major component to achieve the desired levels of pest control (Tween 1993). In others, where populations occurred naturally at low levels, only marginally attacked the relevant host, or did not exist, the approach taken was through certification of the phytosanitary status by means of an effective surveillance system. Exports from FF-ALPP would then be done under a systems approach (USDA 1997) to assure negligible level of risk of moving live pests.

This strategic approach is quite different from a country or region-wide fruit fly suppression, containment or eradication effort, which requires a different level of financial commitment, infrastructure and phytosanitary framework. By using pilot areas, the human and financial resources and infrastructure to develop and sustain FF-ALPP and FF-PFA was minimized compared to taking a country or region-wide approach. Additionally, project objectives were aligned with the sanitary and phytosanitary regulations of the US-Central American Free Trade Agreement (CAFTA); with the US-Panama free trade negotiations, and with the goals of the Regional Council for Agricultural Cooperation in Central America and Panama (CORECA) and of the Regional International Committee for Health in Agriculture and Livestock for Central America (CIRSA), which are the bodies that set up regional agricultural and phytosanitary policies.

Thus, it was expected that once it became fully aware of the potential benefits that can be derived from the project, the industry would contribute not only to sustain the project but also to gradually expand the areas from where fruits and vegetables could be exported. It was also expected that governments would act more decisively to implement policies that encouraged trade of agricultural products within and from the region.

4. Pilot Areas

4.1. Target Pests

The list of target fruit fly species considered of economic importance in the region was determined. These are: Mediterranean fruit fly, West Indian fruit fly *Anastrepha obliqua* (Macquart), Mexican fruit fly *Anastrepha ludens* (Loew), guava fruit fly *Anastrepha striata* (Schiner), sapote fruit fly *Anastrepha serpentina* (Wiedemann), and to a minor degree the South American fruit fly

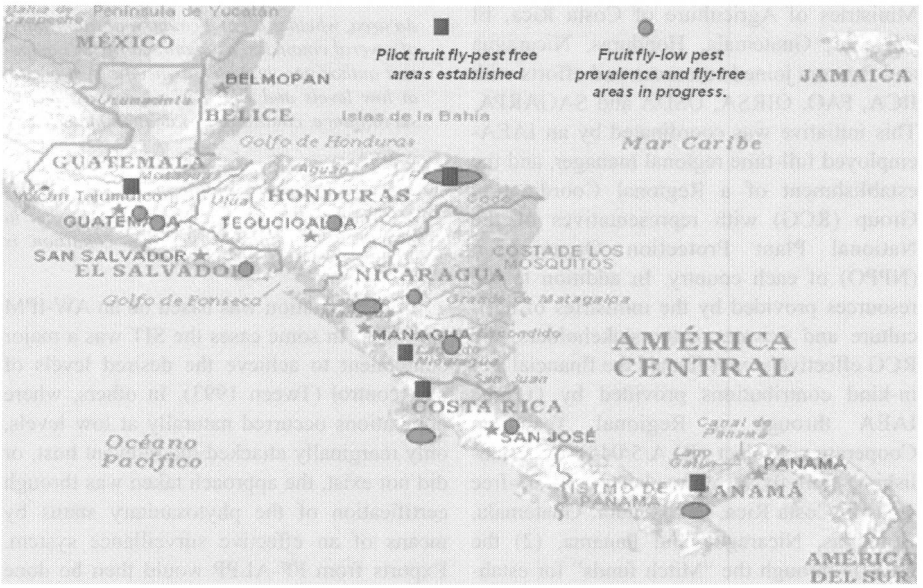

Figure 1. *Pilot Mediterranean fruit fly-pest free areas established from 2001 to 2004 and fruit fly-low pest prevalence and fly-free areas in progress.*

Anastrepha fraterculus (Wiedemann), which is not the same aggressive biotype that occurs in South America (Hernandez-Ortiz 2004).

4.2. Selection of Pilot Areas

From the outset, it was evident that the infrastructure and financial resources available were not adequate to suppress or eradicate even one species of fruit fly if it occurred at high population levels, even when present only during certain periods in the year. In addition, it was necessary to select suitable areas in which all steps required for exporting fruits and vegetables (from detection of the pest to the phytosanitary negotiations for export) could be transferred to the countries during the project lifespan (four years). Therefore, it was decided to select areas in which fruit fly populations were relatively low throughout the year, regardless of whether fruits and vegetables were produced commercially. Accordingly, one naturally isolated medium-sized area (20 000 to 40 000 hectares) was selected in each country.

Fortunately, previous studies had clearly demonstrated that the distribution of fruit flies was not uniform throughout the Central American region (OIRSA 1987), and seasonal fluctuations of each fruit fly species showed a similar year-round pattern. Moreover, although they differed among countries, the major hosts for each species of fruit fly were well known. Hence, sufficient baseline data were available in 2001 to select at least one feasible area in each country to establish either an FF-ALPP or an FF-PFA (Fig. 1).

5. Focusing on Exports

Activities carried out in the pilot areas not only addressed field aspects (e.g. surveillance and control), but also included all phytosanitary actions needed to ensure the export of commodities produced in FF-ALPP or FF-PFA. Therefore, the project focused both on the needed critical actions prior the development of the FF-ALPP or FF-PFA, and those that are essential once a FF-ALPP or FF-PFA is already established.

5.1. Preparatory Activities for the Establishment of FF-ALPP or FF-PFA

Activities were aimed at conducting baseline studies to support the establishment of the specific pilot FF-ALPP or FF-PFA. The first action was to gather and analyse existing data to determine and recommend to governments the specific areas for intervention through the project. Secondly, actions were aimed at preparing technical and economic feasibility studies for each of the pilot areas that were initially selected. Thereafter, the same studies were undertaken for the additional areas selected by the governments. Moreover, a public information programme was prepared for the entire region, which included communication strategies for the pilot areas.

5.2. Establishment of FF-ALPP or FF-PFA

Activities focused on building the technical capacity of national staff who were trained both *in situ* through *ad hoc* training courses, and through hands-on training within operational programmes using AW-IPM with an SIT component in Argentina, Chile, Guatemala, Mexico and Peru. In addition, high-level officials from ministries of agriculture and national plant protection organizations visited countries using FF-PFA and/or FF-ALPP as the core measure in a systems approach for exporting fruit fly hosts to fly-free countries or areas within countries such as Chile, Mexico and the USA. Also, the heads of national fruit fly programmes were trained in leadership and management of AW-IPM projects with an SIT component, as well as in using strategic planning and logical frameworks for planning and evaluating these projects. Special training was given for using geographic information systems (GIS) and global positioning system (GPS) technologies for developing accurate field databases on the occurrence of target fruit flies in each country. Particular attention was given to developing fruit fly identification capabilities and on

training for preparing public information programmes. In the case of Costa Rica, attention was given to transferring the know-how for establishing and managing the mass-rearing and sterilization of the West Indian fruit fly.

5.3. Maintenance of FF-ALPP or FF-PFA

Activities were directed towards preparing a phytosanitary framework for export of horticultural products. This involved provision of assistance to develop national phytosanitary standards and regulations for establishing FF-ALPP and FF-PFA and preparing official quarantine resolutions to recognize and validate them based on the standards of the International Plant Protection Convention (IPPC).

Assistance was also provided to prepare and implement the protocols for emergency actions in case of fruit fly outbreaks, pest risk analyses were prepared for mangosteen and litchi, and support was given for a pest risk analysis on tomato from Honduras, all of them prepared by the Fundación Hondureña de Investigación Agrícola (FHIA 2004a,b). Moreover, under the project, work plans were developed to export papaya without quarantine treatment from the Mediterranean fruit fly-free area in Peten, Guatemala, and to export several species of peppers and red tomatoes from Central America to the USA through a systems approach from a FF-ALPP.

5.4. Role of Industry in the Development of FF-PFA or FF-ALPP

Meetings were held and visits made by experts on trade of horticultural products considered to be fruit fly hosts. These meetings were aimed at advising the governments and industry on the procedures for negotiating exports of fruits and vegetables from FF-ALPP and Mediterranean fruit fly-free areas to fruit fly-free countries. In addition, officials from the USDA who visited the pilot areas supported the goal of exporting fruit and vegetables from FF-PFA and from FF-ALPP through the establishment of a systems approach specific for these areas. Thus, in 2003, the industry actively joined the project, being convinced about the possibility of establishing FF-PFA and FF-ALPP and the likelihood of exporting from these areas.

6. Outcomes and Perspectives

After four years of activities, and with the exception of El Salvador, one pilot Mediterranean fruit fly-free area has been established in each of the participating countries. Based on this experience the governments have selected additional areas to establish FF-ALPP and/or FF-PFA (Fig. 1).

The presence of fruit flies in the pilot and additional areas was determined through a surveillance programme conducted in a manner consistent with the definition contained in the FAO Glossary of Phytosanitary Terms (FAO 2002). The traps used for surveillance were Jackson traps (Scentry Biologicals Inc. Billings, MT 59102, USA) baited with trimedlure (two to four weeks rebaiting interval) to target Mediterranean fruit fly males. This trapping system is the standard trap recommended to demonstrate the presence or absence of this pest. In addition, Multilure® traps (i.e. McPhail type) (Better Trap Inc. Fresno, CA 93727, USA) baited with BioLure® (ammonium acetate, putrescine and trimethylamine) (Suterra LLC Bend, OR 97702, USA) were used to target female flies (four to six weeks rebaiting interval). This female-biased attractant is a powerful tool to detect low numbers of Mediterranean fruit flies (IAEA 2003). The presence of *Anastrepha* fruit fly populations was determined by Multilure® traps baited with torula yeast (one to two weeks rebaiting interval) (Scentry Biologicals Inc. Billings, MT 59102, USA) (IAEA 2003). Traps were serviced at weekly intervals. Trap density is indicated in the sections below dedicated to each country. Fruit fly populations were expressed using the fly per trap per day (FTD) index (IAEA 2003).

Although there is currently no international value for determining the level of fruit fly-low prevalence, for the purpose of this project

the level of low prevalence requested by the USA for export of fruits (mango, papaya, oranges and avocado) from Central America and Mexico through postharvest treatments and/or a systems approach was equal to or less than 1.0 FTD.

Areas were considered as fruit fly-free after one year of zero captures. Once declared as fruit fly-free, a detection was considered an outbreak if it was consistent with the definition contained in FAO's Glossary of Phytosanitary Terms (FAO 2002):

> *An isolated pest population, recently detected and expected to survive for the immediate future.*

6.1. Costa Rica

The selected pilot area of Los Inocentes in the Province of Guanacaste was declared officially free of Mediterranean fruit fly by the Ministry of Agriculture in 2003. The Government of Costa Rica notified the World Trade Organization (WTO) about the establishment of this area. The area encompasses around 40 000 hectares with more than 10 000 hectares of commercial orange and grapefruit orchards grown by a private company that produces fruit juice. The rest of the area includes a national park of forest and dry tropical forest where there are no fruit fly hosts present. In 2001, surveillance was established in fruit fly host areas using a total of 300 traps and a trap density of two traps per square kilometre of hosts for Mediterranean fruit fly detection and one trap per square kilometre of hosts for other fruit flies. Results from 17 000 trap inspections out during 2001-2003 demonstrated that the Mediterranean fruit fly was absent and that the prevalence of other fruit flies of economic importance was low (less than 0.01 FTD). In 2004, several Mediterranean fruit fly outbreaks were detected around the juice facility but the pest was eradicated each time through implementation of an emergency action plan.

In 2003, the Government selected an additional area, the Peninsula of Nicoya, consisting of 500 000 hectares. Although most of the area is used for cattle farming, 2000 hectares are used for producing mango, cantaloupe and watermelon. This area has potential for growing star fruit *Averroha carambola* L., pitahaya *Hylocereus undatus* Britton & Rose, guava, orange and other tropical fruits. In 2003, a surveillance programme was established with a total of 375 traps placed in areas where fruit fly hosts are present using a density of two traps per square kilometre of hosts for Mediterranean fruit fly and one trap per square kilometre of hosts for other fruit flies. Results from the inspections of 40 500 traps carried out during 2003-2005 demonstrated that the West Indian fruit fly was the major pest of concern, with population densities surpassing 2.0 FTD during April, May and June (end of the hot-dry season and beginning of the rainy season). The Mediterranean fruit fly and other species of *Anastrepha* fruit flies of economic importance occurred at low prevalence levels (less than 0.01 FTD) all year round, and Mediterranean fruit fly populations were usually higher in towns and villages.

At present, the Ministry of Agriculture continues trapping against all fruit flies of economic importance, and it is foreseen that the eradication programme will start once the West Indian fruit fly mass-rearing facility is fully operational. Since 2003, the project has supported the Ministry of Agriculture's efforts to upgrade and modify a laboratory for mass-rearing and sterilization of this fruit fly, the main pest of mangoes in the region. The Ministry of Agriculture is acquiring a Gamacell-220® source through a cost-sharing agreement with the IAEA. The sterile flies produced will be used to start the eradication of fruit flies from the peninsula of Nicoya. It is envisioned that this laboratory will have a catalytic effect in the region for controlling *Anastrepha* fruit flies.

In addition, since 2004, the project has supported the development of several FF-ALPP in the Central Valley to export pepper and red tomato through a systems approach. Activities are supported by the National Commission of Agricultural Production in Protected Environments, which is investing over USD 50 million in the initiative. Agreement to export these commodities to the USA requires

approval of the USDA, which is foreseen to occur in 2005-2006.

6.2. *El Salvador*

The selected area in San Juan Opico, Department of La Libertad, never reached the status of an FF-PFA due to its high Mediterranean fruit fly population densities, which usually reached levels of 3.0 FTD during several months each year. The area encompasses more than 10 000 hectares, including over 500 hectares of oranges and tangerines, which are sold on the local market. Citrus groves are scattered within a zone of 1000 hectares of coffee plantations, and in most of the area there are several species of major fruit fly hosts. Surveillance was set up in 1997 (before the project was launched) using a total of 30 traps placed in areas with fruit fly hosts and using a density of 0.3 traps per square kilometre of hosts for Mediterranean fruit fly and 0.2 traps per square kilometre of hosts for other fruit flies. Results from 8600 trap inspections carried out during 1997-2002 demonstrated that Mediterranean fruit fly populations were always high (more than 1.0 FTD). However, *Anastrepha* fruit fly populations were usually under 1.0 FTD. From the beginning, the NPPO was informed about this risk, but at the request of the local citrus industry it insisted on selecting this area as a pilot for intervention.

When the limitations of the selected area to become an FF-PFA were realized in 2003, the NPPO proposed the Island of Espiritu Santo, Department of Usulutan for developing a FF-PFA. This island has an area of about 3000 hectares, is isolated by swamps and it has coconut, banana and cashew as major crops. All of the target fruit flies are present, and in 2003, surveillance was initiated with a total of 24 traps placed in areas with presence of fruit fly hosts using a density of 0.8 traps per square kilometre of hosts for Mediterranean fruit fly and 0.4 traps per square kilometre of hosts for other fruit flies. The results of 2600 trap inspections carried out during 2003-2004 demonstrated that the West Indian fruit fly was the major pest reaching levels of 2.0 FTD. Occurrence of the other fruit flies, although variable, did not surpass 1.0 FTD. It is foreseen that in early 2006 a programme of ground bait sprays will be launched for population suppression and to prepare the area for an eventual eradication of the fruit flies.

In 2004, the sugarcane industry of San Juan Opico launched a project to produce and export bell peppers and red tomato through a systems approach. Using previous data gathered for this area, the project supported this initiative by carrying out complementary surveillance procedures in 2004 to develop a FF-ALPP. The industry has invested over USD 15 million in building the infrastructure to export these commodities. It is expected that negotiations for exporting these commodities to the USA will be completed successfully in 2005-2006.

6.3. *Guatemala*

The selected pilot area in the Municipalities of Quetzaltenango and Totonicapan, in the western highlands (over 2500 metres high), is free of Mediterranean fruit fly and *Anastrepha* fruit flies. The area encompasses more than 50 000 hectares, including over 400 hectares producing peaches and apples that are sold in the local market. In 2001, surveillance was set up with a total of 60 traps placed in areas with fruit fly hosts using a density of 0.8 traps per square kilometre of hosts for Mediterranean fruit fly and 0.4 traps per square kilometre of hosts for other fruit flies. Results from 6700 trap inspections carried out during 2001-2004 demonstrated absence of the Mediterranean fruit fly except for three outbreaks that were detected and eradicated in 2004; since then there have been no Mediterranean or *Anastrepha* fruit fly detections. Since these activities are supported by peach and apple producers and because the border with Mexico is nearby, the Ministry of Agriculture of Guatemala is negotiating with its Mexican counterpart for permission to export peaches from these areas into Mexico.

In 2004, at the request of the industry, the

Ministry of Agriculture established four FF-ALPPs in the Departments of Guatemala and Jalapa which qualify for the export of pepper and red tomato to the USA through a systems approach. The project is supporting and working closely with the industry in these areas, and negotiations for exporting these commodities to the USA are foreseen to be completed in 2005-2006.

In 2000, the Department of Peten was established by the Moscamed Programme (Guatemala-Mexico-USA) as a Mediterranean fruit fly-free area. In April 2005, based on a bilateral work plan prepared by the project, the papaya growers of the department began exporting this commodity to the USA.

6.4. Honduras

The selected pilot area in the valley of the river Aguan, Departments of Yoro and Colon, was declared officially free of Mediterranean fruit fly by the Ministry of Agriculture in 2003. The area covers around 400 000 hectares, including more than 25 000 hectares with oranges for fresh fruit domestic and regional markets, and grapefruit for concentrated juice. There are also 40 000 hectares of different commodities such as oil palm, banana, pineapple and cocoa. Also, coffee, avocado and mango are grown to a minor degree. In 2001, surveillance was implemented with a total of 700 traps placed in areas with fruit fly hosts using densities of 1.7 traps per square kilometre of hosts for Mediterranean fruit fly and 0.3 traps per square kilometre of hosts for the other fruit flies. Results of 43 000 trap inspections carried out during 2001-2003 indicated the absence of the Mediterranean fruit fly. At present (2005), results of 58 000 trap inspections carried out from 2001 to early 2005 indicated that this pest is not present. Other fruit flies of economic importance occurred at low prevalence, with total captures of the six economic fruit fly species barely reaching 0.25 FTD, and the Mexican fruit fly being responsible for 0.20 FTD of that value. In late 2004, a Mediterranean fruit fly outbreak was detected in the urban area of the small port of Trujillo (one square kilometre), near the northern edge of the free area. By early 2005, that outbreak had not been eradicated, and thus jeopardizing the Mediterranean fruit fly-free status of the valley.

Once the Mediterranean fruit fly outbreak is eliminated the next step would be to eradicate the Mexican fruit fly, the West Indian fruit fly and the guava fruit fly. The possibility of doing so is based on the low prevalence of all fruit flies of economic importance. Thus, the establishment of a fruit fly-free area is feasible in this vast fertile valley.

6.5. Nicaragua

The selected pilot area, the Island of Ometepe (on Lake Cocibolca), in the Department of Rivas, was declared officially free of Mediterranean fruit fly by the Ministry of Agriculture in 2003. The area covers more than 30 000 hectares, including over 5000 hectares of banana and 500 hectares of coffee. In 2000 (before the project was launched), surveillance was set up with a total of 425 traps placed in areas with fruit fly hosts using a density of 1.5 traps per square kilometre of hosts for Mediterranean fruit fly and 0.3 traps per square kilometre of hosts for the other fruit flies. Results of 71 400 trap inspections carried out during 2000-2003 demonstrated that the Mediterranean fruit fly was not naturally present, that the prevalence of the guava fruit fly and sapote fruit fly was low (0.01 FTD) and that the West Indian fruit fly could reach population levels of 0.5 FTD. In 2003, four outbreaks of Mediterranean fruit fly occurred in Moyogalpa, a small town that surrounds the main harbour of the island, but the pest was eliminated by implementing an emergency action plan.

The experience gained in Ometepe provided the Ministry of Agriculture (with the support of the producers who had been exporting mango to the USA since 1999 from the north of Lake Xolotlan, between the Departments of Leon and Managua, through hot water quarantine treatment) with the confidence to develop

Figure 2. *Fruit fly-low pest prevalence areas (FF-ALPP) planned for production and export of bell pepper and tomato, through a systems approach based on an FF-ALPP and pest free growing structure, Valley of Sebaco, Nicaragua. (upper, left) Location of the FF-ALPP, (upper, right) greenhouse frame, (lower, left) first plantation and (lower, right) bell pepper fruits produced.*

a FF-PFA in that area. The area covers around 40 000 hectares, of which more than 4000 hectares of rice and corn (by irrigation) and around 1000 hectares of mango, papaya, cantaloupe and watermelon. Also there are a few scattered avocado and orange groves. The area has exceptionally favourable conditions for becoming fruit fly-free since it has only two small towns (less than 2000 inhabitants), one road going across the area, a large airstrip (not in use), no more than five species of fruit fly hosts and a very low density of wild host trees (one host tree per 50 square kilometres).

Records of 25 000 trap inspections during the last ten years of trapping (1994-2003) supervised by the Ministry of Agriculture and USDA using a total of 52 traps located in 600 hectares of a mango and a density of 87 traps per square kilometres of hosts for Mediterranean fruit fly and for other fruit flies, indicated that the Mediterranean fruit fly never reached a level of 0.05 FTD, while the West Indian fruit fly, which is the main pest of mango, reaches a maximum level of 1.5 FTD only during June and July. During the rest of the year, this pest occurs at low prevalence levels (between 0.05 and 0.7 FTD). During these ten years, the annual occurrence of the guava fruit fly was negligible (less than 0.0001 FTD).

Based on these data, and under the framework of the regional project, the Ministry of Agriculture and the industry launched an eradication programme in 2004 based on ground insecticide-bait sprays. After 12 weekly bait spray treatments, and an intensive surveillance programme in areas with fruit fly hosts using 14 traps per square kilometre of hosts for the Mediterranean fruit fly and seven traps per square kilometre of hosts for other fruit flies, and with traps inspected weekly for seven months (around 5200 trap inspections), fruit fly populations were eradicated from this area. Based on these results and considering

that the area has enough water resources to irrigate over 10 000 hectares throughout the year, the Ministry of Agriculture, the industry, USAID and USDA developed a three-year plan starting in late 2005 to strengthen current public outreach, quarantine activities and emergency plans to keep the area free of fruit flies in order to further develop agriculture through expansion of the area planted with mango and papaya.

The resulting successes in Ometepe Island (2000-2003) and in the northern Lake Xolotlan area (2004-2005), culminated in early 2005 in another industry/Ministry of Agriculture initiative for establishing a FF-ALPPs in the Sebaco Valley, Department of Matagalpa, and on the south-eastern area of Lake Cocibolca, Department of Rio San Juan. Data gathered by the Ministry of Agriculture during the period 2003-2005 through a surveillance programme using a total of 50 traps placed in areas with fruit fly hosts, using a density of 0.2 traps per square kilometre of hosts for the Mediterranean fruit fly and the same for other fruit flies, indicated that it is feasible to develop a fruit fly-free area in both places.

In Sebaco Valley, the industry has invested USD 50 million to produce bell pepper and red tomato for export through a systems approach including pest-free growing structures (Fig. 2). Negotiations for exporting these commodities to the USA are foreseen to be successfully concluded in 2005-2006.

6.6. Panama

The selected pilot area of Las Churuquitas in the Province of Coclé is in the process of being declared officially free of Mediterranean fruit fly by the Ministry of Agriculture. The area covers about 30 000 hectares, of which more than 2000 hectares are oranges for fresh local consumption. Also, there are 3000 hectares of coffee. In 2001, surveillance was established with a total of 25 traps placed in areas with fruit fly hosts using a density of 0.1 traps per square kilometre of hosts for Mediterranean fruit fly. In 2003, the number of traps was increased to 180 using a density of 2.7 traps per square kilometre of host area. Results from 22 140 trap inspections carried out during 2001-2004 demonstrated the absence of the Mediterranean fruit fly but the presence of the West Indian fruit fly and the guava fruit fly. However, unlike with Mediterranean fruit fly, trapping is not reliable for these species, and so their levels are still unknown. The absence of Mediterranean fruit fly in this area is not surprising, since except for the small (25 square kilometres) Valley of Anton situated 25 kilometres east of Churuquitas, extensive trapping (0.01 traps per square kilometre) by the Ministry of Agriculture in different periods since 1985 had shown that most of the region, from the central part to the eastern border of Panama with Colombia, had failed to result in captures.

In 2003, at the request of the mango industry of the Pensinsula of Azuero, which demanded a fruit fly-free area to boost mango exports, the Ministry of Agriculture decided to select the peninsula for establishing an area free of several species of fruit flies. Azuero is an area of 650 000 hectares mostly dedicated to livestock. However, in the north-eastern part of the peninsula, in a zone called Arco Seco, there is a government irrigation project of 10 000 hectares aimed at producing different fruits and vegetables such as mango, papaya, star fruit, pitahaya and bell pepper.

Since 1995, the Ministry of Agriculture had been operating a trapping network of 200 Jackson and McPhail traps on a bi-weekly basis in the peninsula of Azuero. This activity stopped in 2001 after six years of collecting data that the Ministry of Agriculture had used to determine the absence of the Mediterranean fruit fly. However, these activities were not conclusive for the project since they were neither permanent nor of the required technical quality. Therefore, with the support of the project, the Ministry of Agriculture started fruit fly surveillance in 2003 with a total of 300 traps placed in areas with fruit fly hosts using a density of one trap per square kilometre of hosts for Mediterranean fruit fly and 0.5

traps per square kilometre of hosts for other fruit flies. After a year of consistently improved trapping (i.e. over 95% of traps were serviced using high quality lures), the absence of the Mediterranean fruit fly was confirmed, while the prevalence of the West Indian fruit fly was established at 1.5 FTD.

Since Azuero is characterized by extensive cattle farms with only a few clustered fruit orchards, if the government and industry decide to eradicate the West Indian fruit fly from this area, the establishment of a fruit fly-free area is highly feasible.

6.7. Belize

Under the multi-institutional project alliance, Belize was supported through FAO's Technical Cooperation Project TCP/072. The exotic fruit fly detection network was strengthened as well as the emergency response capabilities. This was done through training of plant protection staff in deployment and operations of trapping networks, population suppression methods, fruit fly identification and the supply of trapping materials and equipment. In 2004, this capacity building allowed Belize to maintain its status of a Mediterranean fruit fly-free country by eradicating an outbreak that occurred in the southern part of the country, in an area near the border with Guatemala.

6.8. Additional Outcomes

As a result of the public relations activities, the ministry of agriculture set up a regional public information group aimed at developing and implementing a uniform framework for public information activities to improve the management of national fruit fly programmes and eventually, a regional fruit fly programme.

The high level of integration and experience gained by members of the RCG on different approaches for dealing with fruit flies in Central America has resulted in OIRSA setting up a fruit fly technical advisory group coordinated by the same members of the RCG. This technical advisory group is presently preparing OIRSA's regional vision for management of fruit flies of economic importance in Central America.

When the regional project was initiated, representatives of the NPPOs of Honduras and Belize participated in the RCG as associated participants because these countries were not Member States of the IAEA. However, once the project generated results, the Governments of Honduras and Belize decided to become a Member State.

7. Constraints

A major external limitation for the sustainability of the project is that with the exception of the IAEA and USDA-APHIS in Guatemala, which have strongly supported the project, the alliances among international organizations have, despite the project, been fairly weak. Various factors are negatively influencing the possibility of a more solid future partnership. One is competition among international organizations for the relatively limited international funds available, which affects the potential commitment that these organizations may have towards the project. Another factor is that even though project partners share common goals, they envision different ways of achieving the goals, thereby opening the prospect that funds and efforts could be duplicated and wasted.

Analysis of the constraints within the national plant protection organizations running the project in the different countries was made possible through the development of a model by IICA with support of the IAEA (IICA 2003). The model evaluates the level of institutional capability that the national plant protection organizations have to implement and effectively sustain pest suppression and eradication projects without active support from international organizations. It enables precise diagnosis of the national plant protection organizations' weaknesses and strengths, thereby making it possible to predict potential setbacks that would affect future project actions. This in turn enables major institution-

al constraints to be addressed before embarking on these projects.

Application of the model in 2004 revealed that coordination between the ministries of agriculture and the industry for operating suppression and eradication activities is still not well developed. Also it was realized that the rapid turnover of civil servants in the national plant protection organizations could lead to loss of the technical capacity that was built up through the project. Finally it was found that in most of the countries there is insufficient funding for operating the national plant protection organizations, much less for implementing emergency action plans or for extending ongoing actions to larger areas.

When taking into account all these constraints, the outcomes of this project are very significant: with a very low budget, each participating country learned how to establish, negotiate and maintain FF-PFAs and FF-ALPPs. In the future the industry will have to play an increasing role in co-financing the expansion of these area-wide phytosanitary projects.

8. Conclusions

Enhancing exports of non-traditional fruits and vegetables as a viable alternative to traditional tropical crops can be achieved by establishing FF-PFA and FF-ALPP as the core phytosanitary measure integrated within a systems approach.

As described for the different pilot areas in the various Central American countries, any attempt to establish these areas through an AW-IPM approach with an SIT component can be successful if: (1) the ministries of agriculture are the driving forces of any initiative, (2) the industry is convinced of the potential benefits that these areas can bring and is an active partner in the activities, and (3) there are alliances between technical and financing organizations present in the region and they commit to work together sharing a common vision.

Pilot projects establishing FF-ALPP and FF-PFA, in which a comprehensive package of procedures is effectively applied (from suppressing or eradicating the pest to negotiating a work plan for exporting fruit and vegetables from the area concerned), are both low-cost and appropriate to demonstrate the benefits of fruit fly AW-IPM with an SIT component. They are also preferable to venturing *a priori* into extensive, costly and unfeasible fruit fly eradication projects.

9. References

(IICA) Inter-American Institute for Cooperation on Agriculture. 2003. Estudio de la capacidad institucional de los ONPF de los países de Centroamérica para enfocar el proyecto RLA/5/045 de una manera sostenible e integrada. Informe Final. IAEA, Vienna, Austria.

(FAO) Food and Agriculture Organization of the United Nations. 2001. International standards for phytosanitary measures. Glossary of phytosanitary terms, Publication no. 5. Secretariat of the International Plant Protection Convention, FAO, Rome, Italy.

(OIRSA) Central America Regional Organization for Animal and Plant Sanitary Protection. 1987. Distribución geográfica y monitoreo de poblaciones de mosca del Mediterráneo en Centro América y Panamá. Informe diciembre 1987, San Salvador, El Salvador.

(FHIA) Fundación Hondureña de Investigación Agrícola. 2004a. Importation of litchi, *Litchi chinensis* from Central America into the United States. Qualitative, pathway-initiated pest risk assessment. Final Report. IAEA, Vienna, Austria.

(FHIA) Fundación Hondureña de Investigación Agrícola. 2004b. Importation of mangosteen, *Garcinia mangostana* from Central America into the United States. Qualitative, pathway-initiated pest risk assessment. Final Report. IAEA, Vienna, Austria.

Hernandez-Ortiz V., J. A. Gomez-Anaya, A. Sanchez, B. A. McPheron, and M. Aluja. 2004. Morphometric analysis of Mexican and South American populations of the *Anastrepha fraterculus* complex (Diptera: Tephritidae) and recognition of a distinct Mexican morphotype. Bulletin of

Entomological Research 94: 487-499.

(IAEA) International Atomic Energy Agency. 2003. Trapping guidelines for area-wide fruit fly programmes. IAEA/FAO-TG/FFP, IAEA, Vienna, Austria.

Rhode, R. H. 1970. Application of the sterile-male technique in Mediterranean fruit fly suppression. A follow-up experiment in Nicaragua, pp. 43-50. *In* Proceedings, Panel: Sterile-Male Technique for Control of Fruit Flies. Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture, Panel of experts, 1-5 September 1969, Vienna, Austria. STI/PUB/276, IAEA, Vienna, Austria.

Salas, F. L. A. 1958. Informe sobre el estudio de la mosca del Mediterráneo en Costa Rica. *In* Publicaciones de la Universidad de Costa Rica. Serie Agronomía No. 1. Editorial Universitaria, San Jose, Costa Rica.

Tween, G. 1993. Fruit fly control and eradication program management: factors influencing action criteria and program design, pp. 307-310. *In* Aluja, M., and P. Liedo (eds.), Fruit flies: biology and management. Springer-Verlag, New York, NY., USA.

(UNDP) United Nations Development Programme. 1970. Report of a scientific panel on the eradication in Central America of the Mediterranean fruit fly. DP/SF/310 REG 62, San Jose, Costa Rica. UNDP, New York, USA.

(USDA) United States Department of Agriculture. 1997. Quarantine security for commodities: current approaches and potential strategies. Proceedings of Joint Workshops of the Agricultural Research Service and the Animal and Plant Health Inspection Service. Agricultural Research Service, Beltsville, MD., USA.

Vo, T., W. Enkerlin, C. E. Miller, G. Ortiz, and J. Perez. 2003. Economic analysis of the suppression/eradication of the Mediterranean fruit fly and other fruit flies in Central America and Panama. USDA-APHIS, Riverdale, Maryland, USA.