REPORT ON

SEMINAR ON QUARANTINE TREATMENTS FOR FRESH TROPICAL FRUITS ENTERING THE UNITED STATES OF AMERICA

Conducted by

Private Sector Relations
Office of International Cooperation and Development
U.S. Department of Agriculture

Sponsored by

Regional Office of Central American Programs (ROCAP)
U.S. Agency for International Development

July 10-14, 1989
Mazatlán, Mexico

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PREFACE

As more and more countries are finalizing the research on alternative quarantine treatments for tropical fruits entering the U.S. market, it seemed appropriate to conduct this seminar on all aspects of the hot water treatment and other viable methods for fruit fly control. Emphasis was on mangoes though the treatments will be similar for other fruits.

The report is an overview of the principle speeches at the meeting. Some are verbatim and some are summaries, according to what was available from the speaker. Talks not included are closely related to the country work plan developed between the Ministry of Agriculture (in this case SARH of Mexico) and the Animal and Plant Health Inspection Service (APHIS) of USDA.

The report will be useful to countries on the threshold of entering the U.S. market with fruits treated in a new way. It cannot replace in any way the necessary direct contact with the APHIS Officer covering programs in your country, however.

A limited number of copies of the report are available in Spanish and English from:

Private Sector Relations
Office of International Cooperation and Development
U.S. Department of Agriculture
McGregor Building, Room 342
Washington, DC 20250-4300

Telephone (202) 653-7873

ACKNOWLEDGMENTS

Just as the process for entering the U.S. with fresh fruits that are considered fruit fly hosts is a complicated task, the preparation of this seminar necessarily involved a number of groups and entities. Special appreciation goes to the Government of Mexico, the National Confederation of Producers of Fruits and Vegetables (CNPH), and the Escuinapa Growers Association for their support and collaboration. Mr. Gonzalo Espinoza was especially helpful in coordinating contacts in Mexico. Thanks are also due to Dr. Milton Ouye and Dr. Jennifer Sharp of the Agricultural Research Service (ARS); Dr. Joseph F. Karpati, Mr. Nathaniel Perry, Mr. Scott Wood, and Ms. Joan Sills of the Animal and Plant Health Inspection Service (APHIS); Mr. Max Castillo and Ms. Maritza Colon Pullano of the Food and Drug Administration (FDA); and Dr. Kiran Shetty of the Post Harvest Institute for Perishable Products, for contributing to the success of the program. From the private sector, Mr. James Pandol of the North American Mango Importers Association (NAMIA), Mr. Fernanado Cespedes, Dole Fresh Fruit, and Chiquita Tropical Products were very supportive and added a valuable perspective to the discussions. Numerous other people contributed to the program.

The Private Sector Relations Office (PSR) of USDA organized this seminar as part of its role in promoting trade with the Caribbean Basin countries and as a link between the government and U.S. private sector. The meeting was conducted by Dr. Theodore Freeman, Director, PSR. Ms. Mary Quinlan coordinated with interest groups and government agencies to design the seminar, Ms. Ellen McCloskey assisted in the program, and Ms. Celia Heil contributed substantially to the preparation of this report. Translations were done for the most part by Ms. Mayela Madriz, translator, and Ms. Celia Heil, Private Sector Relations.

Most importantly, the Regional Office for Central American Programs (ROCAP) of U.S. AID should be recognized for their sponsorship of the seminar and for allowing participants to attend from outside of their targeted region.

United States Department of Agriculture

Office of Internationa Cooperation and Development

Washington, D.C. 20250-4300

SEMINAR ON TREATMENTS FOR FRESH TROPICAL FRUITS ENTERING THE UNITED STATES OF AMERICA

JULY 10 - 14, 1989
MAZATLAN, MEXICO

CONDUCTED BY THE OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

U.S. DEPARTMENT OF AGRICULTURE

SPONSORED BY

THE REGIONAL OFFICE OF CENTRAL AMERICA AND PANAMA

U.S.A.I.D.

COOPERATING ORGANIZATIONS

USDA AGRICULTURAL RESEARCH SERVICE
USDA ANIMAL PLANT HEALTH INSPECTION SERVICE
POST-HARVEST INSTITUTE FOR PERISHABLES, MOSCOW, IDAHO
NORTH AMERICAN MANGO IMPORTERS ASSOCIATION
MINISTRY OF AGRICULTURE, MEXICO
FRUIT AND VEGETABLE GROWER ASSOCIATIONS OF MEXICO

Location

REINO DE ARAGON
HOTEL EL CID

The Office of International Cooperation and Development
is an agency of the
United States Department of Agriculture

H

Monday, July 10

1:00 p.m.	REGISTRATION
8:00 p.m.	WELCOME & ORIENTATION "La Pergola"

Tuesday, July 11

8:30 a.m.	OPENING SESSION WELCOME REMARKS Dr. Theodore R. Freeman Director, Private Sector Relations Office of International Cooperation & Development (OICD) U.S. Department of Agriculture Dr. Alejandro Ortiz Martinez Director of International Cooperation International Foreign Relations Government of Mexico Mr. Gale Rozell Director, USAID/Latin America and Caribbean/Rural Development/Natural Resources
9:00 a.m.	"Mexico, An Export Marketing Success Story" Mr. Gonzalo Espinoza, Fruit and Vegetable Grower Associations of Mexico (CNPH) and Mr. Fernando Cespedes, Dole Fruit Co. Mexico
10:00 a.m.	COFFEE BREAK
10:15 a.m.	"Field Practices Adapted for Fruit Requiring Treatment" Mr. Gonzalo Espinoza, CNPH
11:20 a.m.	"U.S. Regulations on Pesticides and Labelling" Ms. Maritza Pullano Compliance Officer U.S. Food and Drug Administration Dallas, Texas
12:30 p.m.	LUNCH (On your own)

Tuesday, July 11, continued

1:30 p.m.	"An Overview of the Role of USDA in Entering Fruit to the United States" Dr. Theodore R. Freeman Director, Private Sector Relations (PSR)
2:00 p.m.	"Research on the Hot Water Dip and Viable Alternatives" Dr. Jennifer Sharp, USDA/Agricultural Research Service (ARS) Coral Gables, Florida
3:00 p.m.	COFFEE BREAK
3:15 p.m.	Questions and Answers on Research Shared Experience of Various Countries Dr. Jennifer Sharp, Moderator
5:00 p.m.	Announcements and Adjournment
Evening	"Optional Round Table on Research Procedures and Experiences for Participating Scientists."

Wednesday, July 12

8:00 a.m.	Greetings and Announcements
8:05 a.m.	"What is APHIS Role in Entering Fruit into the United States" Dr. Joseph F. Karpati, APHIS/Mexico
9:00 a.m.	"Hot Water Treatment Facilities: Design, Operation and Approval" Mr. W. Scott Wood, USDA/APHIS/ New Jersey
10:00 a.m.	COFFEE BREAK
10:15 a.m.	"The role of SARH and the Mexican Inspector" Ing. Jorge Garcia Usher, Chief Sanidad Vegetal, Sinaloa Mexico
11:00 a.m.	"The role of the USDA/APHIS/Mexico Inspector" Mr. Nathaniel F. Perry, USDA Guadalajara, Mexico
12:00 noon	LUNCH
1:30 p.m.	"Other Post Quarantine Treatment Considerations" Mr. Frenando Cespedes, Dole Fresh Fruit - Grades and Standards - Packaging - Transportation

Wednesday, July 12 continued

3:00 p.m.	COFFEE BREAK
3:15	General Discussion of Post Quarantine Issues Messrs. Pandol, Cespedes, and Espinoza
4:00 p.m.	"Experiences of Specific Countries Regarding Inspection and/or Post Harvest Handling" Ing. Jorge Garcia Usher, Moderating
5:00 p.m.	ADJOURN FOR DAY

Thursday, July 13

8:00 a.m.	Field Trip to Local Production Area and Hot Water Treatment Facilities Nathaniel F. Perry, Field Guide W. Scott Wood, Commentator LUNCH IN ESCUINAPA
5:00 p.m.	Return to Hotel
7:00 p.m.	"Optional Round Table on Facilities Design, Equipment, and Suppliers for Industry Participants."

Friday, July 14

8:00 a.m.	"Studies on the Use of Shrink Wrap for Tropical Fruit" Dr. Kiran Shetty Post Harvest Institute for Perishables University of Idaho, Moscow, Idaho
9:00 a.m.	"The U.S. Demand for Exotic Fruit, Including Mangoes" Mr. Jim Pandol, President NAMIA
10:00 a.m.	COFFEE BREAK
10:15 a.m.	CONFERENCE WRAP-UP
12:00 noon	ADJOURN

SPECIAL APPRECIATION TO OUR HOSTS THIS WEEK

The Confederation of Mexican Fruit and Vegetable Growers Associations

The Growers Association of Escuinapa

Empacadora Frutico

Frutas y Legumbres El Rodeo

SPR de Sinaloa, Mazatlan, Sin.

SPR el Zipizape, Mazatlan

The Government of Mexico

Chiquita Tropical Brands, Inc.

The Regional Office of Central American Programs, USAID

FIELD TOUR

THURSDAY, JULY 13

1. SPR de Sinaloa, Mazatlán, Sinaloa
   Manager: Jose Luis Rice G.
   System: Continuous
   Recorder: Flotek Computer

2. SPR El Zipizape, Mazatlán, Sinaloa
   Manager: Raul Ibarra S.
   System: Continuous DICA
   Recorder: Flotek Computer

3. Frutas y Legumbres El Rodeo, Rosario, Sinaloa
   Manager: Marco Antonio Wong Urrea
   System : Batch, one big basket
   Recorder: Honeywell circular chart

   LUNCH: Compliments of the Escuinapa Growers Association
   Asociación de Agricultores del Rio de las Cañas

   President: Arq. Ernesto Rivera Valdez

4. Empacador Frutico, Escuinapa, Sinaloa
   Manager: Gonzalo Espinoza
   System: Jacuzzi, 12 baskets
   Recorder: Flotek Computer

RETURN TO HOTEL

One Bus and Refreshments compliments of CHIQUITA TROPICAL PRODUCTS.

"MEXICO, AN EXPORT MARKETING SUCCESS STORY"

FERNANDO CESPEDES
DOLE FRUIT COMPANY
BAKERSFIELD, CALIFORNIA

A. <u>Why Mangoes Can Be Success Story</u>:

1. - Natural, no additives, especially now after the banning of EDB.

2. - Wholesome, self-contained.

3. - Nutritious, high in vitamins.

4. - Appealing to the eyes, colorful.

5. - Exotic.

6. - Tasteful and aromatic.

7. - Some even say it has aphrodisiac properties.

Very few fruits can be readily associated with the tropics and their exotic magic.

B. <u>Why Mexico must be a Tropical Fruit Marketing Success Story</u>:

1. - <u>Location</u>: Both geographic, especially suited for production of tropical fruits, and political, sharing approximately 3,00 km of border with the world's biggest market and greatest source of technology with a large, heterogeneous population.

2. - <u>Wealth</u>: There is investment capital, natural resources and the entrepreneurial style required to develop the infrastructure necessary for a successful export business.

3. - Experience: Unlike some of our other developing nations, Mexico has been in the business of treating and exporting commodities for quite sometime.

C. <u>Mangoes - How Successful Are We?</u>

We are currently in the second year of what I feel is a three year program. The first year was only partly successful, due by enlarge to the courage of the exporters, who were willing to invest on unproven technology without any knowledge of the customer's reaction to the final product. As a result, we experienced a reduction of 30-35 percent in the volume exported and a reduction of the number of shippers to less than one half the 1987 number. The quality of the product shipped was not up to part with the market demands.

The current year is one of the continuous growth and acquisition of knowledge and experience; refinement of equipment and techniques; and communication and understanding with the agricultural authorities of the final markets. During this year, we have established the hydrothermal system as a reliable, viable quarantine treatment for mangoes, with the added bonus that the acceptance of this method, we have started on the path to regain the confidence of distributors and consumers on the quality of our product. This process continues to evolve at this moment.

during 1990, we will determine whether we will be able to recuperate the pre-treatment quality of the fruit to the degree necessary to reach the most difficult markets with confidence and whether we will be able to cut costs to levels which will make the business viable, even during the peak production periods.

The new treatment has greatly increased the stress on the already tense relationship between the exporter and the distributor, but has definitely established the mango as a permanent, stable business, with an attractive future. The all natural, organic condition of the treatment is greatly attuned with the times and the demands of the consumer. We no longer have to worry about the possibility of losing the business because the quarantine treatment is determined unhealthy to the consumers.

D. Mango Marketing:

1. Sales - Traditional mango marketing relationships are based on mutual district; a vicious circle where;

- The grower thinks the packer/exporter makes all the money;

- The packer/exporter thinks the distributor makes all the money, and the distributor thinks the packer/exporter makes the greatest proportion of profit. Obviously, these feelings have evolved from past experiences of all involved.

There are basically three types of sales:

A. Director consignment commission sales.

B. Point of shipment fixed sales price.

C. Border warehouse fixed sales price.

2. The great variety of labels and qualities make a successful marketing program a very difficult task. The USDA stamp which identifies the shipper is an important tool, introducing a measure of stability. The fruit labels, further assist in tracking problem fruit at the retail level.

In order to develop mango markets, I will suggest different areas which must be addressed.

A. Marketing Order

The establishment of minimum quality standards required for exportation is extremely necessary. This effort would facilitate the marketing of the fruit and would ease the communication between the exporter or shipper and the distributors of the fruit.

An example of the positive impact of such an order is clearly seen in the marketing order of Mexican grapes in the state of California, known as the Coachela Valley marketing order.

B. Product Promotion & Development

An orchestrated effort by the official national organizations and the distributors associations in the market, (i.e. Namia and the equivalent organizations in Europe and Asia) should concentrate on promoting consumption of the fruit through:

1. Point of sales advertising,

2. Consumer education, and

3. Market expansion through wider distribution channels.

The examples of avocados and kiwis in the U.S. and world markets are fine examples to follow and should provide incentives for all of us to put mangoes in their rightful place.

HOW THE MEXICAN MANGO EXPORT INDUSTRY MANAGED TO STAY IN THE U.S. MARKET

Mr. Gonzalo Espinoza
Fruit and Vegetable Growers
Association of Mexico (CNPH)

Introduction

During the 1989 season, Mexico used for the first time the hydrothermic method of quarantine control treatment for the export of mangoes.

In April 1988, a work plan was signed that was used as a guide for the treatment and certification of mangoes for exportation to the U.S. during the 1988 season. It was developed in conjunction with the U.S. Department of Agriculture (USDA/APHIS/IS) and the General Directorate of Sanitation, Farming and Forestry Protection (Dirección General de Sanidad y Protección Agropecuaria y Forestál).

The process used was developed in Weslaco, Texas, by USDA Agricultural Research Service (ARS), in collaboration with the Metapa laboratory in Chiapas, and by producers represented by their organizations -- CUNPH, CAADES, and CIFIDEN. The results of the research for Mexican mango treatment for export came during the second half of the 1986 and the beginning of 1987 seasons.

The research was hurriedly carried out and legally implemented so that Mexico would not lose any exportation of mangoes in 1988. For this reason the research was centered on the larger sizes of mangoes for export. Average size considered for export should be size No. 8 (650-700 grams.)

The Role of Producers in Resolving the Problem

The mango export industry is organized at the national level through the Confederation of Orchard and Fruit Producers (Confederación de Productores de Hortalizas y Frutas (CNPH)). The research to substitute EDR for the hydrothermic treatment was carried out through CNPH with the support of the General Directorate of Vegetable Sanitation (Dirección General de Sanidad Vegetal (DGSV)), under the Secretariat of Agriculture and Hydraulic Resources (Secretaría de Agricultura y Recursos Hidráulicos (SARH)).

During the first meeting in Weslaco, Texas in 1986, the work plan was formulated to implement as soon as possible a viable hot water treatment for Mexican mangoes. Participants in the project were the Agricultural Research Service, APHIS, PPQ, DGSV, North American Mango Exporters Association (NAMIA), and the Mexican producers represented by CNPH.

DGSV in Metapa, Chiapas requested the responsibility for the research action in Mexico, such as the collection of specimens of larvae of fruit flies from the states of Chiapas, Guerrero and Nayarit. Metapa also took the responsibility for transporting the samples to the U.S.-Mexican border at Ciudad Reynosa, and at the Tamaulipas-Texas border where the samples were given to a representative of NAMIA to be properly stored until they were picked up by the Agricultural Research Service laboratory in Weslaco. Approximately 300,000 larvae specimens A. ludens and A. obliqua were collected to make it possible to carry out the experiment. Another important aspect of the experiment was to send fruit to the Weslaco laboratory, to be purposely infested with the fruit fly larvae collected in Mexico. To achieve this, export quality and fruit size was requested from several participating packing plants.

International Cooperation

We also had the cooperation of the mango industry in Haiti, who provided a large quantity of larvae A. obliqua to complement the research and help reach our goals.

The results of the experiment done by ARS in Weslaco were sent to APHIS/IS in Washington, and were the base for the development of a work plan for the exportation of mangoes to the U.S. The plan was implemented as follows:

- ARS based the effectiveness of the treatment on the larger sizes of mangoes to be exported - size 8, between 650 and 700 grams.
- ARS proved the effectiveness of the treatment by making it go through "Probit 9."
- The number of larvae eliminated in the configuration test was:

Wild A. obliqua	110,700
Haitian Lab Cultivated A. obliqua	116,000
Wild A. luden	226,085
Lab Cultivated A. ludens	187,500

- ARS turned in to APHIS/IS the results of the recommended time and temperature required for each of the species of fruit fly A. ludens and A. obliqua, (A. suspensa was also included for Florida).
- APHIS/IS received ARS recommendations and the work plan was set for 90 minutes of treatment with a temperature of 115°F.

Treatment Effects

Since experimentation was with the large size mangoes, the smaller sizes were treated at the same temperature with the same duration of treatment time. It may be seen that when all sizes of mangoes are treated the same way, the pulp of the smaller mangoes reaches its point of treatment at different periods depending on its size (see table 1). This demonstrates that all sizes cannot be treated the same way. To do that will cause a great loss of fruit quality. Even in the larger sizes the time period indicated in the work plan may be excessive, also affecting the quality of the fruit.

The experience obtained in Mexico during the 1988 season demonstrates that time parameters and temperature can be closely set at the levels indicated by the ARS laboratory, without working the hydrothermic equipment at a "set-point" above what is indicated by the laboratory and its certification. It should be set in accordance with the parameters fixed for commercial treatment. Having one standard for certification and another for commercial operation is not practical. When the equipment is programmed for commercial use, it has a more rigorous standard than that for certification and can result in damaging the fruit.

In other words, once the equipment has been set, the parameter cannot be changed for commercial treatment. The equipment maintains the temperature at the fixed set-point of certification.

Probability Risk Standards

The following considerations should be noted to determine proposed changes for the 1989 work plan. The recommended temperature and time parameters for Mexican mango treatment are based on the supposition that mangoes to be treated are totally fruit fly infested, or infested at a much higher level than in reality are found in lots of fruit that pass the testing stage by the Vegetable Health before being treated. Therefore, the time and temperature are too high for the majority of mangoes.

A shipment of mangoes to be accepted by Vegetable Health for export must meet the following conditions.

A) The orchard must be registered with SARH-DGSV and PAF, and approved to have been "trampeada," and to have been treated under sanitary control.

B) The fruit arriving from the field to the packing plant must have passed a random test previous to treatment, thus guaranteeing that the mangoes are: 1) completely free of plague, and that 2) the fruit is from orchards of low or no fruit fly infestation.

During the research experiments, the mango with induced infestation produced a larger rate of infestation (approximately 30 larvae per fruit). It is highly improbable that fruit with that high infestation rate would be permitted to reach the treatment plant. It would be easily detected and rejected. Generally, when fruit is found to be infested with larvae at the packing stage, only 2 or 3 larvae are found. It is very rare to find a high rate of infestation at that stage.

Another factor to consider is the level of the maturity of the fruit. To be commercially acceptable to a packing plant, the fruit should be approximately one to three-fourths mature (physiological maturity), since the quality of ripe fruit is highly damaged by the heat of the treatment. At the same time the less mature fruit is not affected by fruit-fly with the same intensity as ripe fruit.

Another important factor is that in fruit one to three-fourths mature the larvae is found in its first or second stage of development, and still very close to the skin. Therefore, the heat of the treatment affects it more rapidly without regard to the size of the fruit. According to information presented at the first international conference of ANASTREPHA in Tapachula, in the state of Chiapas, in September 1987, page 18, paragraph 6.3.3, says that the Probit 9 standard refers to a probability of survival of 99.9968 over 100,000 insects exposed in fruit size 8/9, at an acceptable risk in regulated treatment.

At this time Mr. Jim Fons explained that the Probit 9 is an absolute standard that must be applied when there is no information available on the levels of infestation of the orchard. It was said that to be able to apply a different standard is necessary to have a great deal of information on each shipment, from the "trampeo" stage, to harvest, and testing, etc.

The mango export industry in Mexico has reached a "developed" stage although it is still improving sanitary control in the orchard with chemicals, biological as well as cultural control, and putting each shipment through a rigorous testing on arrival to the treatment and packing site. The testing is performed by DGAPAF inspectors and it is done based on a formula of probability of risk developed by USDA/APHIS/IS. It has been 100% precise in determining the presence or absence of larvae in the fruit.

The solution to the problem is an example of international cooperation and demonstration of goodwill. We believe that the success of the Mexican mango export to the U.S. would not have been possible without the assistance and cooperation of the different divisions of the Department of Agriculture of the U.S., especially APHIS International Services, the Agricultural Research Services, METHODS Development Center, and others.

All this was achieved, thanks to the opportune and decisive intervention of our Secretariat of Agriculture and Hydraulic Resources, through the General Directorate of Sanitation and Farming Protection.

(Translated by Celia Heil)

AGRICULTURAL ASSOCIATION OF CANES RIVER (ASOCIACION DE AGRICULTORES DEL RIO DE LAS CANAS (AARIC))

Arq. Ernesto Rivera Valdéz
President

We want to thank you for your presence and welcome the presence of the Agricultural Association. We know how important this type of seminar is at the international level. It is where strategy is defined.

The area of Sinaloa is without doubt one of the best in Mexico for the production of mangoes for export. Our fruit has been sent to international markets for approximately 19 years. We have conquered the markets of the United States, Japan and Europe. The same high quality of mangoes are exported and constitute 40 percent of the total number of bushels of mangoes produced in the country.

The investment has been high. What we thought at the beginning to be an expensive acquisition of hydrothermic equipment, presently treats from 200 to 300 percent of the mangoes we export. Those who have been dedicated to the export of fruit made the investment to create jobs in this area.

During the two years of working with the new system, we found that the fruit was arriving damaged. We think that the irreversible damage was caused by excessive exposure to hot water.

Up to now, in the four central packing plants with hydrothermic equipment, approximately 10,000 tons of mangoes have been processed with not a single larva of fruit fly found in the tested fruit. In 1987, 56 larvae were found in 24,645 tons of tested fruit, while in 1988, 6 larvae were found in 14,203 tons of tested fruit. With this we are demonstrating that with hard work and struggle we, the producers, are improving the quality of the fruit.

In 1987 we exported 17,011 tons, and in 1988, 9,436 tons. The cause for the reduction was that we did not enter the international market early in the season because we did not have the equipment installed in time. Up to now we have exported a total of 4,948,420 kilograms, the equivalent of 989,684 bushels. We expect that by the end of this season we will have exported 24,000 tons of mangoes. This will give us 3.5 million bushels commercialized in the international market. This is the situation with our mango export, and we are still working to upgrade our fruit quality.

At this point I want to thank the health authorities in the General Directorate of Vegetable Sanitation for their support in developing the field control against fruit flies. I want to thank CIFIDEN for organizing the work carried out to control plague in our State. Our recognition goes to those present who made it possible for us to enter the U.S. market, especially USDA and APHIS. We are thankful to USDA for giving us their assistance in channelling our product through positive publicity. We ask NAMIA for their influence in order to be channeled to an open trade promotion with its members; and we ask CNPH to give us more support to achieve the best price in the market at the international level.

Thank you very much.

"U.S. REGULATIONS ON PESTICIDES AND LABELING"

BY

MARITZA COLON-PULLANO
COMPLIANCE OFFICER/MEXICAN LIAISON
FOOD AND DRUG ADMINISTRATION

18

GOOD AFTERNOON. I APPRECIATE THIS OPPORTUNITY TO PARTICIPATE IN THIS SEMINAR. I WANT TO ESPECIALLY THANK THE USDA FOR ORGANIZING THE SEMINAR AND FOR PROVIDING THE FORUM FOR THE FOOD AND DRUG ADMINISTRATION TO MEET YOU .... THE ORGANIZATIONS THAT HAVE AN INTEREST IN ASSURING THAT FRUIT AND VEGETABLE EXPORTS CONFORM WITH THE PESTICIDE REQUIREMENTS OF THE UNITED STATES.

FROM FDA'S SIDE, I CAN TELL YOU THAT WE SHARE THE SAME CONCERNS THAT YOU HAVE ABOUT YOUR EXPORTS, PERHAPS FROM A DIFFERENT PERSPECTIVE, BUT NONETHELESS, I THINK IT IS SAFE TO SAY THAT WE BOTH HAVE THE SAME OBJECTIVE OF ACHIEVING COMPLIANCE WITH THE LAW. THEREFORE, I AM PLEASED TO BE PART OF THIS COOPERATIVE EFFORT AND TO HAVE THE OPPORTUNITY TO PROVIDE, TO THE EXTENT NECESSARY AND APPROPRIATE, THE GUIDANCE FOR ACHIEVING THIS OBJECTIVE.

LET ME NOW TURN TO THE MAIN ORDER OF BUSINESS -- U.S. REGULATIONS ON PESTICIDES AND LABELING... A SUBJECT I DEAL WITH ON DAILY BASIS. I WILL BRIEFLY OUTLINE THE SYSTEM OF LAWS IN THE UNITED STATES THAT GOVERN THE PRESENCE OF PESTICIDE RESIDUES IN FOOD, THE GOVERNMENT AGENCIES RESPONSIBLE FOR ADMINISTERING THESE LAWS, HOW FDA CARRIES-OUT ITS RESPONSIBILITY UNDER THIS SYSTEM, AND FINALLY WHAT I BELIEVE ARE THE PROPER STEPS THAT MUST BE CONSIDERED IN THE USE OF PESTICIDES IN THE PRODUCTION OF FRUITS AND VEGETABLES THAT ARE DESTINED FOR EXPORT TO THE UNITED STATES.

IN ORDER FOR A PESTICIDE TO BE USED IN THE UNITED STATES, IT MUST BE REGISTERED BY ENVIRONMENTAL PROTECTION ADMINISTRATION FOR THAT SPECIFIC USE UNDER THE FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT, BETTER KNOWN AS "FIFRA." EPA REGISTRATION CAN ONLY BE GRANTED BASED ON A SHOWING THAT THE PESTICIDES'S USE WILL NOT CAUSE AN UNREASONABLE ADVERSE RISK TO MAN OR THE ENVIRONMENT. EPA ALSO HAS THE RESPONSIBILITY FOR SETTING TOLERANCES UNDER THE AUTHORITY OF THE FEDERAL FOOD, DRUG, AND COSMETIC ACT IF THE PESTICIDE IS TO BE USED IN FOOD PRODUCTION.

A TOLERANCE DESCRIBES THE MAXIMUM AMOUNT OF A PESTICIDE RESIDUE THAT MAY BE SAFELY AND LEGALLY PRESENT IN A FOOD WHEN INTRODUCED INTO COMMERCE, AND IN THE CASE OF IMPORTS, AT THE POINT OF ENTRY INTO THE UNITED STATES. I WANT TO EMPHASIZE THAT WHILE MOST EPA TOLERANCES CORRESPOND TO REGISTERED AGRICULTURAL USES OF PESTICIDES IN THE UNITED STATES, THEY APPLY EQUALLY TO IMPORTED AGRICULTURAL COMMODITIES.

FDA'S DUTIES UNDER THE REGULATORY SYSTEM INVOLVE THE ENFORCEMENT OF EPA TOLERANCES. THIS RESPONSIBILITY EXTENDS TO ALL DOMESTICALLY PRODUCED AND IMPORTED FOOD AND ANIMAL FEED COMMODITIES EXCEPT FOR MEAT, POULTRY, AND EGG PRODUCTS WHICH ARE SUBJECT TO THE JURISDICTION OF THE U.S. DEPARTMENT OF AGRICULTURE.

FDA'S ENFORCEMENT AUTHORITY IS DERIVED FROM SECTION 402 OF THE FEDERAL FOOD, DRUG, AND COSMETIC ACT. ACCORDING TO THIS SECTION, FOOD CONTAINING A PESTICIDE RESIDUE AT A LEVEL GREATER THAN THAT SPECIFIED BY A TOLERANCE IS ADULTERATED, OR IF THE FOOD CONTAINS A PESTICIDE RESIDUE FOR WHICH THERE IS NO TOLERANCE, ANY AMOUNT OF RESIDUE CAUSES THE FOOD TO BE ADULTERATED. THE ACT AUTHORIZES FDA TO SEIZE ADULTERATED FOOD THAT IS IN INTERSTATE COMMERCE WITHIN THE UNITED STATES AND TO INITIATE INJUNCTION PROCEEDINGS TO PREVENT FURTHER SHIPMENT OF ADULTERATED FOOD. WE ARE ALSO AUTHORIZED TO INITIATE CRIMINAL ACTION AGAINST A PERSON OR COMPANY THAT CAUSED A FOOD TO BECOME ADULTERATED. FOR IMPORTED FOOD FOUND TO BE ADULTERATED WITH A PESTICIDE RESIDUE, FDA IS AUTHORIZED TO REFUSE ENTRY OF THAT FOOD INTO U.S. COMMERCE.

FDA CARRIES OUT ITS PESTICIDE ENFORCEMENT RESPONSIBILITIES BY MONITORING FOODS IN COMMERCIAL CHANNELS OF TRADE. EACH YEAR OUR TWENTY-ONE DISTRICT OFFICES, WHICH ARE LOCATED THROUGHOUT THE COUNTRY, SAMPLES MORE THAN 12,000 SHIPMENTS OF FOOD, OF WHICH APPROXIMATELY 5,000 REPRESENT IMPORTED FOOD COMMODITIES, MAINLY FRUITS AND VEGETABLES. THE SAMPLES ARE USUALLY ANALYZED BY MULTIRESIDUE ANALYTICAL METHODS THAT GIVE USE THE CAPABILITY TO MONITOR FOR A LARGE NUMBER OF DIFFERENT PESTICIDES IN A SINGLE ANALYSIS. WHAT I WILL EXPLAIN ARE CERTAIN OPERATIONAL ELEMENTS OF THE FDA PROGRAM AND RELATED POLICIES.

OUR PESTICIDE MONITORING AND ENFORCEMENT PROGRAM USED TO BE DIVIDED INTO TWO MAIN COMPONENTS -- SURVEILLANCE AND COMPLIANCE.

UNDER THE SURVEILLANCE PHASE, EACH FDA DISTRICT OFFICE HAD THE PRIMARY RESPONSIBILITY FOR SELECTING FOOD COMMODITIES FOR RANDOM SAMPLING; HOWEVER, THEY WERE INSTRUCTED TO GIVE EMPHASIS TO COMMODITIES HAVING MAJOR DIETARY IMPORTANCE, RELATIVELY HIGH IMPORT VOLUMES, AND A HISTORY OF PESTICIDE RESIDUE PROBLEMS. BY DEFINITION, HOWEVER, SURVEILLANCE SAMPLING MEANT THAT WE HAD NO EVIDENCE THAT THE SHIPMENTS OF FOOD BEING SAMPLED CONTAIN ANY ILLEGAL PESTICIDE RESIDUES.

FOR THIS REASON, FDA USED TO ALLOW IMPORT SHIPMENTS OF PERISHABLE FOODS SAMPLED ON A SURVEILLANCE BASIS TO ENTER DISTRIBUTION CHANNELS WHEN THERE WAS THE POSSIBILITY THAT THE FOOD WOULD DETERIORATE OR SPOIL BEFORE FDA COMPLETES ITS ANALYSIS. IN THIS SITUATION, HOWEVER, THE IMPORTER WAS REQUIRED TO AGREE TO RECALL THE FOOD SHIPMENT IF OUR ANALYSIS SUBSEQUENTLY REVEALS THE PRESENCE OF ILLEGAL PESTICIDE RESIDUES.

WHEN AN ILLEGAL RESIDUE WAS FOUND IN A SURVEILLANCE SAMPLE, THE COMPLIANCE COMPONENT OF THE PROGRAM WAS INITIATED. COMPLIANCE SAMPLING REPRESENTED INTENSIFIED AND SELECTIVE COVERAGE OF SHIPMENTS OF THE SUSPECT COMMODITY FOR

THE PESTICIDE RESIDUES IN QUESTION. THESE SHIPMENTS ARE HELD PENDING COMPLETION OF FDA ANALYSIS, AND IF ILLEGAL RESIDUES WERE DETECTED, THE SHIPMENTS WERE REFUSED ENTRY.

WE ARE IN THE PROCESS OF MODIFYING OUR PROCEDURE FOR PERISHABLE PRODUCTS WHICH ARE THOSE LISTED IN THE USDA HANDBOOK AS HAVING A STORAGE LIFE OF LESS THAN ONE WEEK INCLUDING BOTH SEAFOOD AND FRESH FRUITS & VEGETABLES. WE WILL REQUIRE THAT SHIPMENTS OF SUCH PRODUCTS BE HELD INTACT AFTER SAMPLING SO THAT DISTRIBUTION CAN BE HALTED IF WE FIND VIOLATIVE LEVELS OF PESTICIDE RESIDUES.

THESE PROCEDURES WILL ALLOW US THE OPPORTUNITY TO PERFORM NEEDED ANALYSIS TO PROTECT THE PUBLIC HEALTH WHILE ALSO ASSURING THAT PERISHABLE ITEMS TRAVEL TO THE MARKET PLACE AS QUICKLY AS POSSIBLE.

FDA DOES NOT WISH TO SAMPLE ALL INCOMING SHIPMENTS OF FDA REGULATED PRODUCTS. TOO OFTEN IN THE PAST, FOREIGN FIRMS WERE SHIPPING POOR QUALITY FOOD INTO THE UNITED STATES, AND FDA RESOURCES WERE SPENT SAMPLING AND ANALYZING THESE PRODUCTS. FOUND VIOLATIVE, WE WOULD THEN DETAIN THESE SHIPMENTS, AND FIND THE FIRM REPEATING THE PROCESS WITH THE NEXT SHIPMENTS. I AM SURE YOU WOULD AGREE WITH ME THAT THE FDA SHOULD NOT BE A QUALITY CONTROL PROCESS FOR FIRMS WHO DON'T WISH TO PERFORM THEIR OWN QUALITY CONTROL.

LAST YEAR FDA TOOK A MAJOR STEP TO RESOLVE THAT PROBLEM. WE HAVE CHANGED OUR CRITERIA FOR AUTOMATIC DETENTION. WHAT THIS MEANS IS THAT NOW WE SAMPLE FEWER SHIPMENTS AND IN MANY INSTANCES WITH ONLY ONE VIOLATIVE SAMPLE, PUT THE FIRM ON AUTOMATIC DETENTION. ONCE ON AUTOMATIC DETENTION, THE IMPORTER, SHIPPER, PRODUCER, OR A RESPONSIBLE AGENCY OF THE EXPORTING COUNTRY MUST CERTIFY TO FDA THAT THE SHIPMENTS CONFORM WITH THE REQUIREMENTS OF THE LAW.

I WANT TO NOTE THAT THE AUTOMATIC DETENTION AND CERTIFICATION REQUIREMENTS FOR IMPORTS ARE, IN EFFECT, THE SAME AS AN INJUNCTION THAT FDA WOULD SEEK IF DOMESTICALLY PRODUCED FOOD IS FOUND TO CONTAIN ILLEGAL PESTICIDE RESIDUES. BOTH AUTOMATIC DETENTION AND INJUNCTION ARE DESIGNED TO PREVENT THE INTRODUCTION OF ADULTERATED PRODUCTS INTO CONSUMER CHANNELS.

OF COURSE YOU CAN SEE THAT RELIANCE ON PRIVATE LABORATORY ANALYSIS, INSTEAD OF FDA ANALYSIS, OPENS THE DOOR TO NEW PROBLEMS. WE FEEL, HOWEVER, THAT BY AUDITING THESE LABORATORIES WE CAN ADEQUATELY ASSURE THEIR QUALITY. AS A MATTER IN FACT, WE CURRENTLY WILL NOT ACCEPT CERTAIN TYPES OF ANALYSIS FROM INDIVIDUAL PRIVATE LABORATORIES WHERE WE FOUND UNACCEPTABLE PROCEDURES BEING FOLLOWED.

FOR THOSE OF YOU THAT ARE FAMILIAR WITH THE EVENTS THAT SURROUNDED THE OMETHOATE IN PEPPER PROBLEM, YOU WILL RECALL THAT THE OPERATIONAL ELEMENTS OF THE FDA PROGRAM THAT I JUST DESCRIBED WERE FOLLOWED IN DEALING WITH THIS PROBLEM. AS YOU MAY ALSO KNOW, FDA USED A LIMIT OF 0.05 PART PER MILLION (PPM) IN DETERMINING WHETHER INDIVIDUAL LOTS OF PEPPERS UNDER DETENTION WOULD BE RELEASED INTO COMMERCE. I THINK IT IS IMPORTANT FOR YOU TO UNDERSTAND THE POLICY CONSIDERATIONS BEHIND THIS LIMIT.

AS I STATED EARLIER, UNDER U.S. LAW A FOOD CONTAINING A PESTICIDE RESIDUE FOR WHICH THERE IS NO TOLERANCE IS ADULTERATED AND SUBJECT TO FDA ENFORCEMENT ACTION. THEREFORE, BECAUSE THERE WAS NO TOLERANCE FOR OMETHOATE RESIDUES IN PEPPERS, ANY DETECTABLE AMOUNT OF THIS RESIDUE WOULD PROVIDE A LEGAL BASIS FOR CONSIDERING THE PEPPERS TO BE ADULTERATED.

HOWEVER, IN DECIDING WHAT CONSTITUTES "ANY DETECTABLE AMOUNT," THE AGENCY IS GUIDED BY THE LEVEL THAT FDA LABORATORIES CAN DETECT, MEASURE, AND CONFIRM FOR ENFORCEMENT PURPOSES. FOR THE OMETHOATE PROBLEM, THIS LEVEL WAS JUDGED TO BE 0.05 PPM. THUS, ONLY PEPPERS THAT WERE FOUND TO CONTAIN OMETHOATE RESIDUES AT 0.05 PPM OR GREATER WERE REFUSED ENTRY.

I WANT TO EMPHASIZE, HOWEVER, THAT THIS LEVEL WAS BASED ON FDA'S ANALYTICAL EXPERIENCE WHEN THE OMETHOATE PROBLEM WAS FIRST ENCOUNTERED. THEREFORE, IT IS VERY POSSIBLE THAT A LOWER ENFORCEMENT LIMIT WOULD BE USED BY FDA IF ILLEGAL RESIDUES OF OMETHOATE ARE ENCOUNTERED AGAIN IN PEPPERS OR IN OTHER FRUITS OR VEGETABLES.

THERE IS NO QUESTION, HOWEVER, THAT THE OMETHOATE PROBLEM WAS EXTREMELY DISRUPTIVE OF TRADE AND COSTLY TO BOTH FDA AND INDUSTRY. IN THIS REGARD, THE BEST ADVICE THAT I OR ANYONE ELSE CAN GIVE YOU, IS VERY SIMPLE -- APPLY PESTICIDES ONLY TO CROPS THAT ARE APPROVED FOR THAT USE, USE PESTICIDES IN ACCORDANCE WITH THEIR LABELED INSTRUCTIONS, AND CARRY OUT A QUALITY CONTROL PROGRAM TO ENSURE THAT ONLY APPROVED PESTICIDES ARE BEING PROPERLY USED AND THAT RESIDUES RESULTING FROM THESE USES CONFORM WITH ESTABLISHED TOLERANCES. I RECOGNIZE THAT FOLLOWING THIS ADVICE IS NOT ALWAYS AS SIMPLE AS IT MAY SOUND, BUT THE ADVERSE CONSEQUENCES THAT CAN RESULT FROM DOING OTHERWISE CAN BE QUITE SUBSTANTIAL.

I ALSO RECOGNIZE THAT BECAUSE OF VARIATIONS IN CLIMATIC CONDITIONS, PEST PROBLEMS, AND AGRICULTURAL PRACTICES, THESE CAN BE DIFFERENCES BETWEEN YOUR COUNTRY AND THE UNITED STATES IN THE CHOICE OF PESTICIDES FOR FOOD PRODUCTION, PESTICIDE APPLICATION RATES OR PATTERNS OF USE, AND THE AMOUNT OF RESIDUES OF PESTICIDES THAT MAY REMAIN ON FOOD. AS SUCH, THE PESTICIDE USES REGISTERED BY

EPA UNDER FIFRA MAY NOT ALWAYS MEET THE PESTICIDE AND AGRICULTURAL NEEDS OF YOUR COUNTRY. IN THIS SITUATION, AND WHEN THE FOOD COMMODITY IS BEING GROWN FOR EXPORT TO THE UNITED STATES, IT IS ABSOLUTELY ESSENTIAL THAT EPA TOLERANCES FOR RESIDUES OF THE PESTICIDES BE SOUGHT.

THEREFORE, THE CONCERNED ORGANIZATIONS MUST TAKE THE STEPS NECESSARY TO PUT INTO PRACTICE THE BASIC ADVICE THAT I HAVE GIVEN YOU. THIS IS THE ONLY WAY OF AVOIDING ANOTHER OMETHOATE TYPE INCIDENT.

LET US NOW DISCUSS LABELING REQUIREMENTS:

THE REQUIREMENT FOR THE LABELING OF CONTAINERS OF RAW AGRICULTURAL COMMODITIES WITH RESPECT TO PESTICIDES APPLIED AFTER HARVEST IS CONTAINED IN SECTION 403(1) OF THE FEDERAL FOOD, DRUG, AND COSMETIC ACT (FD&C ACT). THE REQUIREMENT FOR THE LABELING OF WAXES IS BASED ON THE AUTHORITY OF SECTION 403(i)(2) and 403(k) OF THE FD&C ACT. IT IS IMPORTANT TO RECOGNIZE THAT THERE ARE DIFFERENCES IN THE APPLICATION OF THESE REQUIREMENTS.

SECTION 403(1) REQUIRES THAT THE SHIPPING CONTAINERS OF RAW AGRICULTURAL COMMODITIES, TREATED WITH A PESTICIDE CHEMICAL AFTER HARVEST, BEAR LABELING DECLARING THE COMMON OR USUAL NAME OF THE PESTICIDE AND ITS FUNCTION.

HOWEVER, SUCH DECLARATION IS NOT REQUIRED ONCE THE RAW AGRICULTURAL COMMODITY IS REMOVED FROM THE SHIPPING CONTAINER AND DISPLAYED FOR SALE AT RETAIL IN ACCORDANCE WITH THE CUSTOM OF THE TRADE. THIS MEANS THAT ONLY BULK SHIPPING CONTAINERS ARE REQUIRED TO DECLARE THE PESTICIDES APPLIED AFTER HARVEST. RETAIL/CONSUMER PACKS ARE NOT REQUIRED TO BEAR SUCH LABELING.

FOR EXAMPLE, A CONTAINER OR A SACK CONSISTING OF 50 TO 100 lbs MUST BEAR A DECLARATION OF THE POST HARVEST PESTICIDE. THE INDIVIDUAL CONSUMER PACKAGES OF 1 TO 10 LBS, WHICH ARE CONTAINED IN THE MASTER CONTAINER ARE NOT REQUIRED TO BEAR SUCH DECLARATION. IN THIS RESPECT, THE FOLLOWING WORDING IS APPROPRIATE FOR DECLARING POST HARVEST PESTICIDES:

"TREATED WITH (STATE THE NAME PESTICIDE) TO INHIBIT MOLD"

"TREATED WITH (STATE THE NAME PESTICIDE) AS A FUNGICIDE".

IN THE EVENT THAT ALTERNATIVE PESTICIDES MAY BE USED, ALL OF THE PESTICIDES THAT MIGHT HAVE BEEN USED SHOULD BE LISTED. FOR EXAMPLE, "MAY HAVE BEEN TREATED WITH BENOMYL, DICHOLORONITROANALINE OR TRIFORNINE TO INHIBIT MOLD."

IN STATING THE NAME OF THE COMMON OR USUAL NAME OF THE PESTICIDE, PLEASE NOTE THAT ABBREVIATIONS SUCH AS DCNA ARE NOT APPROPRIATE. THE COMPLETE NAME MUST BE PROVIDED, e.g., DICHLORONITROANALIINE.

WAXES AND OTHER COATINGS APPLIED TO FRESH FRUITS AND VEGETABLES ARE NOT PESTICIDES AND THUS ARE NOT EXEMPTED BY SECTION 403(1). WAXES ARE SUBJECT TO THE PROVISIONS OF SECTION 403(i)(2) WHICH REQUIRES THAT A FOOD FABRICATED FROM TWO OR MORE INGREDIENTS BEAR A LIST OF EACH INGREDIENT BY ITS COMMON OR USUAL NAME. THIS MEANS THAT ALL BULK AND INDIVIDUAL RETAIL/CONSUMER PACKAGES OF RAW AGRICULTURAL COMMODITIES WHICH HAVE BEEN WAXED MUST DECLARE ALL OF THE INGREDIENTS IN THE WAX PRODUCT USED.

WAXES ARE PRESERVATIVES AND THUS MUST ALSO BE IDENTIFIED BY THEIR PRESERVATIVE FUNCTION IN ACCORDANCE WITH SECTION 403(k). THE TERMS WAXES AND COATINGS BY THEIR VERY NATURE, HOWEVER, CONSTITUTE AN APPROPRIATE DESCRIPTION OF THE PRESERVATIVE FUNCTION.

FOR YOUR INFORMATION, I BROUGHT COPIES OF THE FDA'S COMPLIANCE POLICY GUIDE 7120.28, WHICH FULLY DESCRIBES OUR POLICY ON THE LABELING OF WAXED FRUITS AND VEGETABLES. PLEASE NOTE THAT THIS POLICY PROVIDES FOR THE USE OF COUNTER CARDS OR SIGNS AS AN ALTERNATE MEANS TO PROVIDE THIS INFORMATION TO CONSUMERS WHEN THE FRESH PRODUCE IS NOT PACKAGED IN INDIVIDUAL RETAIL CONTAINERS. THIS

POLICY CONSTITUTES AN OFFICIAL INTERPRETATION OF THE REGULATION

IN DECLARING WAXES AND COATINGS, THE FOLLOWING WORDING IS CONSIDERED APPROPRIATE:

WAXES AND OTHER COATINGS: (LIST EACH WAX OR COATING INGREDIENT) EXAMPLE, SOYBEAN OIL, CARUBA WAX.

PLEASE NOTE THAT ~~MAY~~ any FAT OR OIL INGREDIENT CONTAINED IN A COMMERCIAL WAX PRODUCT OR APPLIED IN CONJUNCTION WITH A WAX MUST BE DECLARED.

WHEN A RAW AGRICULTURAL COMMODITY IS TREATED WITH PESTICIDES AND WAXES AFTER HARVEST, WE HAVE NOT OBJECTED TO A COMBINED STATEMENT ON THE SHIPPING CONTAINER, SUCH AS "MAY HAVE BEEN TREATED WITH (<u>LIST EACH PESTICIDE</u>) TO INHIBIT MOLD AND COATED WITH (<u>LIST EACH WAX AND COATING INGREDIENT</u>) AS A WAX". IT WOULD NOT BE APPROPRIATE TO USE THE PHRASE "MAY HAVE BEEN COATED" WHEN DECLARING THE WAX OR COATING INGREDIENTS. THE SPECIFIC WAX INGREDIENTS USED MUST BE DECLARED. IN SUCH CASES, ANY INDIVIDUAL RETAIL/CONSUMER PACKAGE CONTAINED IN THE BULK OR MASTER CONTAINER IS REQUIRED TO DECLARE THE WAX INGREDIENTS.

THE INTENT OF THE REGULATIONS IS TO ESTABLISH SAFE CONDITIONS FOR USING SPECIFIC FOOD ADDITIVES. SOME OF THOSE REGULATIONS MAY INCLUDE LABELING REQUIREMENTS RELATED TO SAFETY ISSUES. IN THE CASE OF THE LABEL DECLARATION OF WAXES AND COATINGS USED ON FRESH FRUITS AND VEGETABLES, THE LABELING REQUIREMENTS ARE BASED ON THE MISBRANDING PROVISIONS RATHER THAN ON THE SAFETY PROVISIONS OF THE FD&C ACT. I HOPE THIS CLARIFIES THE LABELING REQUIREMENTS FOR PESTICIDES AND WAXES IN RAW AGRICULTURAL COMMODITIES.

IN SUMMARY, THE REGULATION OF IMPORTS BY FDA IS A DYNAMIC AND EXCITING AREA. IN THE PAST YEAR WE HAVE MADE MAJOR STRIDES IN OUR EFFORTS TO POLICE THE IMPORT WORLD OF FDA. YET THE CHANGES IN THE WAY WE HANDLE IMPORTS ARE IN THEIR INFANCY. COMPUTERIZATION WILL BRING US INTO EVEN BETTER ENFORCEMENT. I LOOK FORWARD TO THAT FUTURE.

I THANK YOU, AND WILL TAKE ANY QUESTIONS YOU MAY HAVE AT THIS TIME.

An Overview of the Role of USDA in Entering Fruit to the United States

Dr. Theodore R. Freeman
Director, Private Sector Relations
Office of International Cooperation and Development

Before the break we heard from representatives of the private sector in both the U.S. and Mexico. We then proceeded with a representative from the U.S. Government out of the Department of Health and Human Services. The role of the Food and Drug Administration is often confused with that of the Department of Agriculture's regulatory agencies. To make matters more confusing, we have representatives from several agencies within USDA with us in the meeting. The rest of the speakers from the U.S. Government will all be USDA employees.

Before introducing the first of these speakers, I would like to explain the role of each of the USDA agencies here today to avoid confusion. After the Environmental Protection Agency prohibited the use of ethylene dibromide (commonly known as EDB) as a fumigant for products for consumption, there were no treatments on record for several products, principally mangoes. A number of other fruits requiring treatment continued to be treated with methyl bromide but not all fruits maintain acceptable quality with that fumigant.

Normally, the Agricultural Research Service of USDA, referred to as ARS, carries out research on new treatment methods. Over time, however, there have been far more demands for research than can be met with the time and staff available. Since the ban affected only tropical fruits, which are not of great importance for the United States in terms of production, the approach for research on this topic has been initially projects dominated by ARS and later projects carried out by the country of origin with ARS supervision and approval.

The first country to complete this research for an alternative treatment for mangoes was Haiti. Mexico followed a couple of years later.

The Agricultural Research Service has headquarters in Beltsville, Maryland at one of the largest agricultural research stations in the world. A number of stations exist throughout the country, however. Today we have with us the next speaker, Dr. Jennifer Sharp, from the research station in Coral Gables, Florida and the new head of research at the Tropical Research Center in Weslaco, Texas, Dr. Robert Mangan. Most of the scientists who worked on the research for their own countries received some training or guidance from one or both of these stations, in addition to the final guidance of Dr. Milton Ouye, the head of post-harvest research for ARS, who regrets being unable to be with us today.

For the mango treatment, ARS is in charge of the research to the extent that they give guidance in methodology and equipment for the research phase, and analyze the results collected or reported to them by cooperating scientists. If the results are satisfactory from the point of view of achieving a mortality rate of prohbit 9 statistically speaking, then ARS will recommend to a separate agency, the Animal and Plant Health Inspection Service

(APHIS), that the treatment be approved.

At that point in time, the technology assessment branch of APHIS asks the question if the treatment carried out under laboratory conditions can be made into a commercial operation. And what equipment or design or precautions are needed to ensure that the treatment is as effective in the commercial setting as it was in the laboratory.

When the technology assessment branch becomes satisfied that the biological integrity of the treatment can be maintained with x commercial treatment (in other words that the fruit flies will die at the same mortality rate), then the treatment is written into the form of a schedule or a series of instructions regarding the treatment, in this case a certain temperature of water, and the time required for the treatment. The treatment schedule was previously considered an amendment to the existing quarantine manual. The past couple of years, however, interpretation of the laws has become stricter and APHIS is now required to publish any such change in the Federal Register.

Now, all changes in the quarantine schedules must appear in the Federal Register before taking effect. This requires preparation in a certain format, review by the legal office of the agency involved, and then submission for publishing by that agency. This often takes some time for an agency such as APHIS which has so many notices to publish that it must submit them in priority order and await the space for publishing.

After the notice appears in the Federal Register, there is a period of 30 days for commentary. Any US citizen can submit commentary during this time. A board of experts on the topic then review the commentaries and request responses as deemed necessary.

You may recall that the first notice on the hot water treatment for mangoes which was published in 1987 received extensive commentary from U.S. industries concerned with infestation by the Mediterranean fruit fly and other fruit flies that would affect their own production.

At this time there is a proposed treatment schedule for mango hot water treatment for shipment from Central America north of Panama and the Caribbean excluding those islands near the South American coast, such as Trinidad. A copy of the treatment schedule which is being submitted for publishing is in your registration packet. This notice will probably not be published until the end of this year, and then will only take effect after commentaries have been addressed in a satisfactory manner.

After the treatment schedule is officially approved. There is still the need for APHIS to approve the design and construction of the treatment facility and to set up an inspection program in conjunction with the Plant Health Service of the country involved. Details on these requirements will be given by representatives from different sections of APHIS later this afternoon.

As you see from this introduction, the process to arrive to the point where Mexico and Haiti are today, and where many of you are fast approaching, is a long and complicated one which often creates frustration.

The role of the agency I am representing and which organized this meeting, the Office of International Cooperation and Development (OICD), has been to facilitate the arduous process as much as possible by coordinating training and technical assistance, increasing communication during the research phase, and organizing this meeting to provide an overview of the process at a critical time for many of you here. My particular division, the Private Sector Relations Division, carries out this work in the interest of promoting the success of the Caribbean Basin Initiative, which is our mandate. We recognize, of course, in a area such as treating tropical fruits for entering the U.S. market, that the issue extends to Mexico and the rest of Latin America as well and we welcome the participation of so many countries.

RESEARCH ON THE HOT WATER DIP AND VIABLE ALTERNATIVES
Current and Future Quarantine Research and Alternative Treatment Certification

Dr. Jennifer Sharp
Agricultural Research Service

In her presentation for Dr. Milton Ouye on this topic, Dr. Sharp discussed the purpose of quarantine and commodity treatments. The National Program Staff of the Agricultural Research Service (ARS) is in charge of assessing any data on commodity treatments on a biological and technical basis. This agency then recommends the procedure to the Animal and Plant Health Inspection Service (APHIS) for adoption. Before accepting the treatment, APHIS reviews the work on an operational basis to ensure its viability.

Research provided by countries for ARS is particularly demanding because the United States, as other countries such as Canada, Japan, and Korea, requires that the commodity be completely free of the pest in question (100% kill). To determine the parameters needed to reach this standard, researchers use prohibit nine mortality level. This means that, after the treatment parameters have been determined in a laboratory phase, confirmation tests must be conducted on 100,00 insects with 100% mortality for fruit flies.

The current demand for research in commodity treatments is due in part to the prohibition of ethylene dibromide as a fumigant for products that will be consumed. The fumigants remaining for use on commodities include phosphine, hydrogen cyanide, and chloropicrin. The only common fumigant being used and researched now, however, is methyl bromide (MB). It is an acceptable treatment for Anastrepha spp in citrus, and for other pests that attack many different commodities. Research at this time is to expand the use of MB to commodities that have no listed treatment, and to identify and develop non-chemical treatments. Where long treatment time is commercially practical, phosphine fumigation is also researched.

Non-chemical treatment methods include host resistance, biological control, temperature manipulation, modified atmosphere, radiation, and physical barriers.

Biological control is a useful method for diminishing the amount of infestation, but is not generally reliable for achieving the necessary results of 100% kill or absence of the pest. Host resistance can be used to eliminate the need for treatment if no quarantine pest survives in/on the host. For example, two varieties of tomatoes are completely resistant to the Mediterranean fruit fly. Little research has been done by ARS on modified atmosphere. It would also appear to be a useful method for combining with other methods. One physical barrier method being reviewed is shrink wrap. This method would be useful with commodities that have a long shelf-life. Also, this method would appear to be a useful method for ensuring that commodities treated in some other manner be protected from reinfestation. Irradiation has been approved for papaya in Hawaii, but has not yet been used commercially. Tests on irradiation as a treatment for the Caribbean fruit fly in mangoes is almost complete. There is some question on consumer acceptance of this method, however.

The most promising non-chemical is temperature manipulation. This would include using vapor (saturated air), immersion in heated water, dry heat (e.g. very high temperatures of 100°C of 212°F for an hour), or heated air (hot air with dew point set lower than the ambient temperature). For perishable commodities, the dry heat is not practical. A vapor treatment is approved for controlling the Mexican fruit fly (*A. ludens*), for example, in mangoes, grapefruit and oranges, but it requires 14 hours of treatment at 43.3°C which is also not practical. The hot water treatment is approved for mango and a similar one is approved for papaya. Some companies have been satisfied with the performance and results of this treatment for mangoes. Others have had problems with phytotoxicity. At this time, it would appear that the forced hot air treatment would be the best for treating sensitive tropical fruits in the control of fruit flies.

The heated air treatment has enough humidity to prevent desiccation during treatment as well as the direct heat, that occurs with hot water. The hot air treatment allows the fruit to continue normal respiration during treatment while respiration is hindered by the hot water dip. The time needed for a hot air treatment is longer than for the hot water dip. The hot air treatment under study for mangoes is 115°F (46.1°C) for 2 hours. Confirmatory tests using the hot air method on mangoes, carambola, and citrus should be completed within a year.

The ARS is interested in a systems approach to host fruit treatments as well. The degree of ripeness of a fruit has been accepted in place of treatment after research showing that, for example, tomatoes harvested green and shipped immediately are not hosts to the Mediterranean fruit fly. Research has also shown that the Cayenne variety of pineapple is not a host to the Med Fly.

The optimal approach is to incorporate something already used by the industry to eliminate the need for treatment. For example, culling of fruit at the packing shed. Another possibility already in practice is the establishment of an area free of the pest in question. This can be accomplished by eradicating the pest, or by trapping to show that the pest is not in the area. At times, a treatment is required only after a certain number of pests have been trapped, thus showing that the pest has returned to the area. Southern Texas, citrus does not need to be treated for the Mexican fruit fly but a trapping program is maintained. When these flies are seen to be entering the area, treatment is then required.

A detailed summary of the status on the hot water treatment for mangoes appears an article from the Proceedings of the Florida State Horticultural Society. This article covers work up through the Puerto Rican research. In December 1989 two more articles will be out in the Journal of Economic Entomology. These last two will cover the research in Chiapas, Mexico, and the work done north of Chiapas.

Based on all data to date for fruit flies in Mexico, Haiti, Puerto Rico, Texas, and Florida, USDA - NPS, along with APHIS, has proposed two hot water treatment schedules according to the size of the mangoes and will allow treated mangoes from Costa Rica north through Mexico, and all West Indies countries, except Trinidad, to export mangoes to the USA. Dr. Sharp concluded her talk by responding to a number of questions from the floor.

PRESENTATION BY DR. JOSEPH F. KARPATI

Area Director, Mexico

USDA/APHIS

1. INTRODUCTION

Mangoes are regulated under the fruits and vegetables quarantine 7 Code of Federal Regulations (CFR) 319.56. Plant Protection and Quarantine (PPQ) policies related to preclearance programs also apply. As a condition of entry into the U.S., mangoes are required to be subjected to a hot water treatment as specified in the USDA/APHIS/PPQ Treatment Manual, which has been incorporated by reference into the APHIS regulations at 7 CFR 300.1. By regulation, the treatments until recently were limited to all mangoes, except mangoes from the state of Chiapas in Mexico, and mangoes larger than size 8.

However, research proved it feasible to extend treatment to all of Mexico and for Central American Countries from Costa Rica through Mexico and all Caribbean Countries as well. Treatments and associated safeguarding activities are conducted by the host country under policies and conditions of the treatment and preclearance programs, and all actions will be carried out in the host country of origin under the supervision of APHIS officers. Mangoes will also be subject to inspection and other action at the port of arrival in the U.S. and shall be subject to reinspection at destination at the option of PPQ under regulations of 7 CFR 319.56-6.

2. TREATMENT CHANGES AND THE AREA OFFICE IN MEXICO.

Upon the banning of Ethylene Dibromide on September 30, 1987, the Area Office in Mexico had to advise mango exporters about the need for new treatments, the one that is used now, the hot water treatment. There are other experiments also going on, especially in Mexico by personnel from Sanidad Vegetal. Japan and Thailand are also doing experiments with vapor treatment, but they are cooking about 25 percent of the fruit treated.

Mexico is treating with Methyl Bromide, which is actually used for mangoes for national consumption. The hot water treatment which currently is in force, is also undergoing constant review, and as a result some changes have arisen. The Area Office and the offices in the Republic of Mexico advise the growers and exporters of all these changes as well.

3. WORK PLAN FOR MANGO TREATMENT

Before we can start talking about construction of facilities, treatments, certifications, etc., we have to have a plan in force; a work plan that is negotiated and agreed upon by both countries, both exporting countries and the importing country, in this case the United States. APHIS International Services and the Director General of the Sanidad Vegetal in Mexico have developed and signed such a work plan for the treatment, certification, and exportation of Mexican mangoes to the United States, first in 1988 and again in 1989 which is currently in effect. In Mexico the organizations participating in the preclearance program included the Director General of the Sanidad Vegetal and the Mexican mango exporters association. This, The Work Plan, establishes the participant's responsibilities, the operational procedures for the treatment, certification and exportation for the Mexican mangoes. Treatment Facilities and Packing Houses are individually approved for participation in the program subject to compliance with the requirements of the work plan. The work plan can be amended at any time by mutual consent, and in fact, some changes have been made in Mexico based on new findings by ARS.

The work plan worked out for Mexico is intended to serve as a prototype and most countries will be able to adapt it to their individual situation by making some minor changes.

4. APPROVAL OF ENGINEERING CONSTRUCTION PLANS

A hot water treatment plant must have adequate water heating capacity, insulation and thermostat control to hold the temperature at or above temperatures prescribed in the treatment schedule for the given duration of time for the commodity. Proper design of components is necessary including high capacity water heating equipment, and a circulation system that will assure uniform temperatures throughout the treatment. An accurate recording device is required to record simultaneously on the same chart, water temperatures and the time for each treatment, and the speed of the conveyer belt in the continuous system. When a mango packer or exporter wants to construct a facility, he must send the plans for approval, showing dimension, water circulation and other details of the heating and temperature recording system. First it goes to the Sanidad Vegetal Office in Mexico City, where a general review is conducted of the design to assure that it is not just a variation of previous designs. Once this is accomplished it is sent to the APHIS IS Officer in Charge of the work Unit. The specialist at the Area Office reviews the plans, makes sure that everything that is needed is included in the package, and if everything is ready, it is sent to the Hoboken Methods Development Center in New Jersey. If it is not complete, the exporter or the packers will be notified to send along the necessary information or additions to the plans.

5. CONSTRUCTION OF FACILITY

Once the engineering plans are approved, the treatment plant will be constructed accordingly; during the plant construction period, plant operators should consult with the APHIS IS Officer in charge and request periodic on-site review at the expense of the owner of the facility. Officers from the Area Office may visit the construction site at the request of the owner, as well as personnel from the office of Officers in Charge in order to assure that our requirements are met. Any modifications to the original specifications and/or the equipment may require advance approval from the cooperators including the Area Officer and the Methods Approval Office in Hoboken.

6. REVIEW OF CERTIFICATION REQUEST OF FACILITY

After construction and installation of hot water tanks and related equipment is completed, non-treatment areas (screened holding room, office, etc.) should be checked to see if they meet standards required in the plan. Plant operators may begin equipment performance tests by conducting test treatments in accordance with the treatment requirements outlined in the work plan. In order to obtain APHIS services for conducting a treatment plant certification test, the exporter should submit a letter of request to the OIC. The letter should include: listing of names, addresses and phone numbers of the plant, facilities manager, and the supervisor and plant construction engineer. The letter should also include assurance that the facilities manager accepts the responsibility for facilities operations and compliance with program work plan; assurance that required equipment is on site; data from at least two preliminary performance tests indicating that the plant meets performance requirements for certification. Also, included should be copies of completed treatment data sheets and related temperature printout sheets, a letter of authorization from the cooperator, and a written certification from an electrical engineer that the facility meets electric safety requirements specified in the work plan. The OIC or his designee shall review all the information sent by the packer requesting a plant certification. The OIC has to determine whether the hot water treatment facility is certifiable under the requirements of the work plan. If one or more elements, as required, are missing or not satisfactory according to the work plan, the OIC immediately has to point out the deficiencies to the packer. The packer can then proceed to correct the deficiencies.

7. CERTIFICATION TESTS/PLANT CERTIFICATION
(See summary sheet and App. C & D of work plan)

APHIS will take into consideration another request for certification from the packer, documenting that the deficiencies have been corrected. When all the information by the packer or the exporter is sent to the OIC, the OIC proceeds with the scheduling of a certification test of the hot water treatment facility by APHIS personnel. Before proceeding with the certification the packer is instructed to initiate a simulated commercial treatment. APHIS personnel monitors the overall treatment and record times and temperatures from the portable heads placed in the treatment tank in order to identify any possible cold spots. When two consecutive treatment certification tests indicate that the treatment standards are met, and the non-treatment facility requirements are met, and in place, the facility receives a temporary certification. If any facility operates more than one individual tank, regardless of whether other components are common, each tank must be tested. The data sheets, charts, and related information of the certification test are sent to the Hoboken Methods Development Center for final approval. If the HWT standards are not met during the certification tests, the APHIS inspector records the test as not acceptable for certification. A copy of the data sheet, with an explanation as to why the tests were not acceptable is provided to the facility operator for corrective action.

8. RE-CERTIFICATION

Hot water treatment facilities are re-certified and approved annually by APHIS at the beginning of the packing season. Re-certification may be required at any point after the initial re-certification, when treatment performance does not meet required treatment standards. Certification checks are also carried out every two months by APHIS.

9. ASSIGNMENT OF AN APHIS INSPECTOR/TREATMENT
(See App. A & B of work plan)

Once an HWT facility has been certified, an APHIS inspector or technician shall be assigned to the facility. The principal activities of the inspector or the technician are the daily checking of the HWT Plant before the treatments start. The inspector also reviews the performance of each treatment and approves those that meet the requirements of the work plan. The summary of the treatment procedures is in appendix B (of the work plan).

10. POST TREATMENT ACTIVITIES
(See PPQ 540-Form which accompanies shipment)

Post treatment activities are extremely important; the APHIS Officer or technician must move the treated fruits immediately to screened holding rooms. The treated fruit may be subjected to hydrocooling with 70°F or above water for the first 30 minutes. Each carton of approved treated fruit will be stamped with an APHIS USDA TREATED WITH HOT WATER stamp, and the stamps will be controlled by the OIC or his designee. The treated fruit in stamped boxes shall be in a screened holding area until it is loaded for shipment. Mixing of treated fruit with untreated or improperly treated fruit is absolutely prohibited. The treated mangoes shall be palletized and corner posted and double strapped or banded. The strapping required will be two sets of bands or straps, three in each set vertically and perpendicularly. They will have two horizontal bands or straps. The top row of each pallet must be turned upside down to insure no tampering with the shipment.

Now we come to the latest development; until very recently, each pallet was required to be taped with a clear tape, with the seal showing through. The NAMIA was very outspoken in fighting this requirement saying that it made the boxes useless. However, before this requirement was rescinded, there had bee no findings of fruit flies in the United States on imported mangoes. The use of plastic tape remains an option. The screened and holding rooms where these mangoes are stored must be secured at all times in order to prevent fruit fly infestation and contamination of treated fruit with untreated fruit.

11. RESPONSIBILITY AT PORT OF ENTRY TO THE UNITED STATES

Generally the APHIS inspectors select a fruit from each of 30 boxes in a shipment. It is somewhat up to the discretion of the inspector. If a live larvae is found, they reject the shipment and notify port operations. The Port Operations officer notifies the International Services staff. The International Services notifies my office and I notify the OIC. The area director also notifies the foreign cooperator (in this case the Government of Mexico), the packers are notified and action is taken in accordance with the Workplan. If the larvae is alive, the shipment is secured, and the port officer waits for instructions from the biological assessments office in Hyattsville. If a dead larvae is found the port officer will release the shipment and notify the area director, who in turn notifies the OIC, the exporter and the government. This may seem like a lot of policing but it lets me know that the hot water treatment is working. Also the fruit is very easily traceable and corrective action can begin immediately.

12. CORRECTIVE ACTION AND PENALTIES

APHIS is involved not only in the approval, the treatment and post-treatment activities, but we also have to keep an eye on possible

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violations at the plant or the packing facilities. If an inspector finds any deficiencies, he will immediately notify the OIC who will order a corrective action. If the treatment is inadequate for any reason but the fruit is not rejected by the exporter prior to packing, there are strict penalties including closing down of the facilities. If they substitute untreated fruit for treated fruit, again plants can be shut down for up to a year. The screened holding rooms must be maintained correctly or the shipment may be rejected. If a detection of live larvae is found in a certified fruit, an investigation takes place and until the packing house is cleared of any wrong doing, shipments from there are suspended.

13. PROGRAM REVIEW AND EVALUATION

The HWT activities and operations will be reviewed and evaluated annually by an APHIS Technical Review Team to ensure that all aspects of operations and related activities are conducted effectively in accordance with applicable procedures and standards. The review team will consist of the Area Director, and at least two representatives of the PPQ techincal and operations staff, such as the Hoboken Methods Development Center, Port Operations and International Operations, as may be required. At least two foreign cooperator representatives will also be included in the review team. The review will be scheduled by the OIC and coordinated by the Area Director and with the Cooperators. This review will be submitted to the Regional Director for Latin American Region for approval and distribution.

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There will be also supervisory and management visits from time to time, and the Regional Director and the Area Director and other PPQ officials may make periodic visits to review the treatment facilities. During such visits meetings may be held to discuss problems or issues of mutual concern.

SUMMARY

I would like to point out that when we talk about involvement of APHIS in treatments it is very cumbersome. APHIS is involved from the minute the exporter or the packer decides that he wants to export to the U.S. It is not something that comes in during the middle of the operations and leaves when it is halfway done. As you can appreciate, we are very closely involved with it, from the moment the exporter thinks about building a facility, throughout until the product reaches the U.S.; actually until it reaches the markets because inspection is done until the last minute at the border. We feel that this exercise is very important, very complete, and it is necessary for the protection of U.S. agriculture. It also greatly benefits the Mexican Government and Mexican exporters, because they are assured that only insect free mangoes will leave the Republic of Mexico, and there will be no accusations from anyone to the contrary.

Thank you very much.

HOT WATER TREATMENT FACILITIES:

DESIGN, OPERATION, AND APPROVAL

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U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
SCIENCE AND TECHNOLOGY
HOBOKEN METHODS DEVELOPMENT CENTER
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The hot water dip treatment process involves the principal of submerging mangoes under a minimum of four inches of water held a 115°F (46.1) or above for a specified period of time. This treatment time, ranges form 75 minutes in Haiti to 90 minutes in Mexico. PPQ Treatment Manual Section VI details the specifications for treatment time and mango weight range for each country. Today, the only published schedules are for the countries of Haiti and Mexico. In the near future, hot water treatment is expected to be approved for mangoes exported from both Central American countries located north of and including Costa Rica and other countries in the West Indies. The proposal is attached. The schedules will contain different lengths of treatment time depending on geographic origin and mango variety. For example, in Mexico the treatment is for size 8 (size 8 fruits comprise an 11 pound wet weight package). When each mango weighs no more than 700 grams the treatment is 90 minutes at 115°F. For mangoes weighing no more than 500 grams, it is 75 minutes at 115°F.

The Department of Agriculture does not provide construction details for a hot water system. The construction of the hot water facility is the responsibility of the owner/builder to allow flexibility for facility size, economic feasibility and individual preference. Industry submits detailed plans, technical information and recorder specifications prepared by a licensed/certified engineer to the Hoboken Methods Development Center for review. A second handout titled H.W.T. Facilities outlines specific recommendations and requirements, in addition to section III Part 14, IV Part 5.

In general there are two basic design concepts for hot water systems: batch and continuous. The batch system consists of a single tank (2400 to 2800 pounds capacity) where 1 to 3 baskets are submerged under 4" of water for the duration of the treatment. These baskets are lowered into the water either simultaneously or individually. The largest batch system has 12 individual tanks with a treatment capacity of approximately 2400 pounds per tank.

Continuous systems consist of a single tank usually 27 to 32 meters in length. A conveyor belt with metal cleats or a basket attached to an overhead chain carry the mangoes through the tank under 4 inches of water. Conveyor belt systems have the capacity to treat 5 to 8 tons per hour. The prices for both types of systems range from $100,000 to $200,000 (U.S.). When designing a system the following should be considered:

1. To maintain quality, the fruit should be handled and processed very gently during treatment. All hot water treatment systems should include machinery which handles the fruit with a gentle touch during the treatment and packaging process. This would help to improve product quality by reducing bruising, scaring, and damage to fruit just removed from 115° + F water.

2. PPQ treatment specifications do not provide an upper temperature limit for treatment of mangoes. However, the higher the temperature, above 117°F, the greater the possibility of having heat damage to the product.

The design of the treatment system must allow for the installation of numerous hand held portable probes. These probes will be installed by APHIS officials during the approval process (certification or re-certification process). These portable probes are carefully placed in various parts of the load, with emphasis on what is known from experience to be the coldest part of a particular tank during treatment. These probes are closely monitored throughout the treatment. Particular emphasis is placed on water temperature recordings of the first 5 minutes after the fruit has been lowered into the tank. All temporary probes and permanent probes must show that the temperature remained constant at 115°F or above, throughout the treatment. The water temperature differential (temperature difference between lowest and highest readings cannot exceed 1.8°F (1° C) after the first 5 minutes of the treatment and for the duration of the treatment. APHIS approving officials will record actual water temperatures on APHIS forms throughout the treatment.

In the design for the hot water tanks, adequate water heating capacity, circulation capabilities and thermostat controls to recover the temperature to above 115°F and maintain it at this level throughout the treatment, must be provided. Proper design of components is necessary, including high capacity water heating equipment and a circulation system that will assure uniform temperatures throughout the treatment process.

The thermostat temperature controls must be automatic and run continuously throughout the treatment process without manual readjustments. Recording equipment used for thermostat control of the heating units must be designed to prohibit manipulation of the temperature set points. These set points should not be adjusted or altered at any time during the treatment process. The numerical set point is determined when the certification is conducted.

The temperature in the hot water tanks is automatically recorded a minimum of every two minutes. This is accomplished by installing Platinum Resistance Temperature Detectors which are evenly spaced around the perimeter of the tank. These sensors send a signal to the microprocessor where the temperatures, time and speed of the belt (continuous systems) are recorded on a permanent chart. The exact number of RTD detectors necessary for the system will be determined when the plans are submitted for approval. Approved systems are re-approved annually with a re-certification conducted every two months. Final approval of a particular hot water tank is based upon the satisfactory performance of two typical hot water treatments using maximum loads. If a facility operates more than one individual tank, regardless of whether the other components of the system are common, two tests must be performed for each tank. Treatment facility approval will be granted only when all requirements (treatment and non-treatment) of the work plans and treatment manual are met.

Fruit must be maintained in an insect free enclosure immediately after treatment and throughout the shipping process. The space in the packinghouse where the fruit is brought in for processing, treated and removed to the screen room, must be designed to prevent mixing of treated and untreated fruit. The flow pattern of the fruit moving through the hot water treatment process should be such that fruit waiting to be loaded into a tank for treatment cannot become mixed with previously treated fruit. Physical barriers must be developed in order to prevent movement of untreated fruit directly into the screen room thus bypassing the treatment.

The screened holding room/area must be secured at all times to prevent fruit fly infestations. An APHIS controlled seal is required to prevent unauthorized entry during all periods when an APHIS treatment technician or officer is not present.

Each treatment plant should have an individual who is responsible for conducting commercial hot water treatments as outlined in the APHIS work Plans and the PPQ manual specifications. This responsibility includes operating microprocessors. printers, and hot water processing equipment.

"Post Quarantine Treatment Considerations - Grades and Standards, Packaging, Transportation

Mr. Jim Pandol
President
North American Mango Imports Association (NAMIA)

Fernando Gonzalo was talking earlier about some of the problems you can run into with a hot water treatment and some of it was not real rosy. Much of this difficulty had to do with how the fruit is handled before treatment. I am a receiver in the United States and a marketer of these mangoes and can give you a perspective of what the costs and damages are when poorly treated fruit enters the United States.

For one thing, when the fruit gets to the border and enters the country, we see that from the time the fruit leaves the packing house to the time it arrives at the border, it could have changed quite a bit, between losing condition, the fruit getting soft or black marks, or the fruit somewhat collapsing, which is what we call shrunken shoulders. These various problems are caused by some of the different things that were earlier described as far as either over maturity, under maturity or rough handling of the fruit. Keep in mind that the American public has got lots of money and is willing to spend this money on fruit that they want to eat that looks attractive. They will not touch something that doesn't look attractive. It becomes all the more critical to properly treat the fruit. Most of the industry is doing some form of repacking after the fruit enters the United States due to the changes that occur after the fruit leaves. We go through the boxes and find that some of the fruit has discoloration. The fruit that has shrunken shoulders will also be cleaned out and replaced with good fruit.

If you start looking at the numbers when you go through and clean out the boxes, you might lose 5% or even 1% of your fruit versus up to 50%. You can see that to lose 1% probably doesn't make any difference, it's not that big a deal. If you lose 50% on some of the load you sold, you may have gotten $10, but because you only sold half of it, you really averaged about $5, so there can be some real big losses if the fruit is not handled properly. By the time it gets to the United States, you've already invested money into freight and duties, depending on what country you are shipping from. There are a lot of expenses without receiving the big revenues.

There is an expression in the United States that the mango industry is feeling; "The good fruit opens markets, bad fruit closes them." Last year was the first year Mexico used that hydrothermic treatment and there were a lot of problems in the industry, in general. This year a lot of the problems have been resolved; the fruit is coming in a much, much better condition.

The industry has really gained some good experience in one year, but we feel we've lost some of the demand. Some stores and people that were using mangoes last year had problems and either they don't want to stock mangoes, or we use the expression "They have a bad taste in their mouth" from some of those problems. The industry is doing a much better job for both countries that are trading with the United States -- Haiti and Mexico -- and we're going to recover that demand, but there was a cost there. Some of the cost happened immediately in fruit that was lost and some of the cost is coming further down, even into the next year, in the loss of market.

One thing to keep in mind that we're seeing done now, is that some of the countries that have been described are going to be coming on stream for hot water treatment. There is fruit going through this process and coming out very well. We see a lot of processing units where people really don't have the experience or don't realize that there is a difference between high maturity and low maturity fruit or fruit that may have fallen on the ground and had some rough handling, and they process everything. Those are going to have problems. You really need to do your homework and make sure you know how to properly handle the fruit, and even then, leave yourself a good margin of error. When you first start you know that until you have your harvest crews and your inspection people better trained, there's going to probably be some rough starts.

NAMIA, The North American Mango Importers Association, of which I am presently chairman, has done whatever it can for any of the countries that are looking to start in mango processing and in so doing, has passed along all information they have. NAMIA is mostly made up, as far as its membership, of U.S. receivers. They can really give you some ideas of what the fruit needs to look like, even though our membership doesn't have a lot of the packing house and fruit handling expertise from the field and packing house, as you heard earlier. We do what we can to disseminate information to all that are interested because it is in everybody's best interest that any of the fruit coming into North America that is treated, is in good condition and looks good, because it will expand the market. Anytime we have fruit coming in poor condition, it just serves to diminish the market. It's in our best interests to make sure that everybody is doing the job right.

"The Use of Shrink Wrap on Tropical Fruit"

Dr. Kiran Shetty
Postharvest Institute for Perishables

Thank you, Ted. Buenos dias.

Before I do what I'm supposed to do, I'd like to take a few minutes and introduce the Postharvest Institute for Perishables which I represent. This Institute was established in 1980 in the College of Agriculture at the University of Idaho and the primary objective of this Institute is to reduce postharvest losses in perishable crops around the world, especially in the developing world. The primary source of funding for this Institute comes from USAID, the United States Agency for International Development. The college staff and the operations are funded by the University of Idaho and the USAID Bureau of Science and Technology. The field operations are funded by international development agencies and other government agencies and missions around the world. This organization cooperates with international donor organizations, the U.S. Peace Corps and other private sector firms in its efforts to reduce postharvest loss. There are several kinds of assistance offered by the Institute, mainly technical assistance. It helps in adaptive research, in conducting short courses, seminars, workshops and library services, and information networking around the world in the field of postharvest technology.

This is a picture of the University of Idaho Administrative Building at Moscow, Idaho, which is about 300 miles east of Seattle. It aids in graduate level education for those people who meet requirements for entry to U.S. universities. They permit study for master's degree only, and they emphasize postharvest work. Students must return to their respective countries after completion of the course of study. The University provides nondegree programs for those who do not meet the requirements for graduate-level degree and again this covers postharvest technology specifically, and involves study of field work both short term and long term. Students receive a certificate on completion, and again, they have to return back to their country after completion. The Institute has an excellent information service. It acquires, indexes and stores worldwide literature in postharvest technology, and it provides it free of cost to people from developing countries upon request. The Institute also prepares bibliographies on request and accesses other databases for worldwide network. It publishes new titles every four months. Attached is a list of references in postharvest, again, in fruits, vegetables, beverage crops, roots, tubers, you name it, and this is also sent to you free of cost on request.

The research work that I am about to present is also funded by the Institute. I was at a conference a couple of weeks back in Honolulu, on international trade of tropical fruits, and during this conference, there were some alarming statistics presented. Of course, Mexico and Chile are still the leading exporters of tropical fruits to the United States. But one statistic that really struck me was the growth of the mango industry in the last nine years. It has been just 6.4 percent, from 1980 to 1989. And this is nothing compared to what has happened, for example, in the pineapple, or even in the banana industry.

I'm sure most of you will agree that at least one of the factors for this is because of the quarantine inspections on this crop. If you closely observe the proceedings of this meeting, it is obvious that quarantine treatments are neither a perfect art nor a perfect science and we are still left with a problem. How do we combat this fruit fly menace? It's true that this is one of the widely discussed and hotly debated topics in the problem of fruit commerce around the world. In the recent past, fruit flies have threatened fruit industries around the world repeatedly and often called for remedial action and these responses have been primarily chemical responses. There was treating with EDB and things like that, but of course EDB was banned later. But use of chemicals, of course, is not a healthy sign and especially for a growing industry such as the mango industry. The hazard of introduction of these fruit flies into noninfested areas is not going to decrease at all, because there is increasing trade and there are a lot of people traveling these days so we have to have a broader approach and find new methods. At least we have to have another bag of tricks to combat this problem and more arsenals to combat this problem.

My presentation today will focus on one set of techniques that has the potential, now I repeat, it has the potential, to be used as a quarantine treatment. Talking quarantine is like talking religion. Some people just overlook the merits of some techniques and may accept or may disagree with some of the merits of this technique, but it's left for us to decide whether this will fit into a system. Most of you will agree with me that in today's produce marketing system, some of the important factors are to preserve the quality and freshness of the produce. By and large, the postharvest techniques that are available are centered around assuring this freshness and preserving it. We have developed a lot of postharvest techniques--refrigeration, controlled atmosphere storage, modified atmospheres, and hypothermia, and all kinds of other techniques. The changing trends, however, the lifestyles, and the demographics suggest that we have to get innovative. And again, all these innovations are centered around assuring freshness, quality and another factor which is convenience. When people walk into supermarkets, they like their produce to be easily handled, so again convenience is a factor. In this context, there is one technique that is really coming into the limelight; it's the use of individual film wrapping or what is popularly known as shrink wrapping. The developments in packaging technology, particularly the nonfactional films and the hardware to go with it, suggest that these individual films can be tailored around each fruit or vegetable and it's really worth a second look. There are wide ranges of fruits being wrapped now.

Fruit packaging per se began in the 1930s, but then the films available did not match the specific needs of the product. In the last few years the improvements in film manufacturing processes have provided us with films that would match specific needs of this product or of any kind of fruit or vegetable. And ever since the introduction of these selectively permeable films, the advances in modified atmosphere film packaging has been dramatic and you can see there's a wide range of fruits and vegetables that are being wrapped and marketed these days. You will be interested to know how this system works. Well, most of it is not very well understood, but at least there are some things that I've noticed myself. The principle is simple. We let the product do the work, in this case. In other words, it is a dynamic system where the respiratory gases, oxygen and carbon dioxide, the permeation of these respiratory gases are regulated by the property of the film. Now it's assumed that after a short period of adjustment there is an equilibrium in the movement of these gases from the interior to the exterior and vice versa. The movement of oxygen which is the prime entity for respiration, is restricted but not completely inhibited. At the same time, carbon dioxide which evolves due to respiration, accumulates up to a certain point and then permeates outside. The increase in resistance in the movement of these gases is counteracted by some inhibition of the respiratory process, and when you do that you will extend the shelf life of the product. When these things happen, this concurrent restriction of decrease in the loss of water, of moisture from the fruit, even at temperatures which would otherwise speed transpiration losses, the shelf life of the product is extended.

There are several advantages of film wrapping. One of the things it does is save money. You need little or no refrigeration if you use this technique. Secondly, it maintains quality, because metabolism is reduced. It increases the chances of reducing some of the compositional changes that take place such as shrinkage. Shrinkage is weight and weight is money. So when water loss is restricted from the fruit it improves your chances that it will maintain the quality as well. It provides structural protection to the fruit, particularly during transit against drops and against bruises and other things. It prevents infection, because when you wrap a product it provides a barrier that will prevent transporting of diseases and other pathogens. There's a chance that it will help with chemical incorporation also because films are being manufactured that can be extruded with bactericides and fungicides that can control some of the diseases that occur and at very low concentration. So the idea is to apply this not on the product, but in the film itself. And this film packaging is acceptable where others are not. Some of the techniques such as the use of waxing and antitranspirants are limited. Film packaging is also very appealing to the consumers.

It's very attractive to look at. It dramatically improves shelf life. It's clean. It sanitizes the product and it provides labeling and branding possibilities which are also key factors in today's produce marketing systems.

And the ease of operation. It's easily automated. You can do it at a very high speed. The fruit passes through a cylindrical chute and as the sleeve slips from the outside, the fruit drops and seals individually. The size of the bag is about 20 percent larger than the fruit itself, and then it's passed into a shrink tunnel for a very short time, for about five seconds, and the temperature inside this tunnel is about 350 degrees Fahrenheit. In a very short time, this is a shrunk product. But only the wrap, not the product. Now you have the advantage of putting labels and prints on the surface which is important today in maintaining the identity of the product. This is state of the art which is completely automatized. It does everything at one stretch like you saw yesterday on the line itself. It wraps, it seals and shrinks at one stretch, and I believe this particular machine can operate at a speed of about 130 to 140 fruits a minute. And this began, of course, in the grapefruit business when they were shipping grapefruit to Japan, and today there's a wide range of fruits and vegetables that are being wrapped, like zucchinis, cucumbers and papayas. Other fruits are being tested including mangoes and there are some reports on mangoes too, published in the last two years or so.

So we at the University of Idaho have studied this technique for a different purpose. Now we have worked with potatoes and other products as well, but my research was concerning use of this technique for disinfestation against fruit flies. As I said, this film on tropical fruits specifically produces a change in the respiration rate and there is change in the internal atmosphere of the fruit. In the past, they've used artificial atmospheres like increased carbon dioxide or decreased oxygen that would have some influence on the development and the subsequent survival of these insects, at least in the immature stages of these insects. So we hypothesized that if you have a changing atmosphere inside this fruit, there's a possibility that it might have some impact on the development and the subsequent survival of these insects. We set two objectives: first, to examine the influence of shrink films on the immature stages of the fruit fly. After we did this we formulated our second objective. We started noticing that at these immature stages, the larvae could die after a certain period of time.

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So we went on to determine the exposure time needed to kill the larvae. We did two experiments: one with <u>Drosophila melanogaster</u>, again we used this as a scapegoat like any other signs in mangoes at the University of Idaho. We used <u>Drosophila</u> because we couldn't take the real pest to that area. And then after we determined and used that as a model system, we went and worked with papayas in Hilo, Hawaii. At that time we did use the real pest, the Oriental fruit fly. In our study of mangoes, with the <u>Drosophila</u> of course, you can see the y-axis shows the percent infestation and the x-axis shows the hour of unwrapping. What we did was, we infested each mango with a certain amount of larvae of the <u>Drosophila</u> and we noticed the change of what was happening to these larvae. We could see that if the fruit was unwrapped half an hour after it was wrapped, the infestation was almost 100 percent. In a batch of ten fruits, all still had live larvae. And as time progressed, as we held the wrap longer, 6, 12, 24, and 48 hours we started seeing kills of these larvae. So we determined that at least in this case, in this model study, that after about 48 hours, no fruit had live larvae inside.

So we went on to study the infestation problem in papayas at the Tropical Fruit and Vegetable Research Laboratory at Hilo, Hawaii. And here we used the study of the Oriental fruit fly, the <u>Dacus dorsalis</u>. We put some papayas in an infestation cage for about 24 hours and as flies merrily left their eggs we took them out and this is what we did. After 24 hours from the time of wrapping those papayas had the eggs only. We left a few papayas just sitting out in a cabinet and to prevent any reinfestation we wrapped them at Bay 3 which had the first instar larvae. And then we had a bunch of other papayas which were wrapped at Bay 5, which had the second instar larvae. Now each of these groups were unwrapped at either zero, 48, 96, 120 or 144 hours after they were wrapped. That was to determine at what time you would start seeing killed larvae. And between the time they were wrapped and unwrapped, these papayas were put in these cabinets to prevent any reinfestation.

We did three of these trials. Again you see the percent infestation on the y-axis and the hour of unwrapping on the x-axis, and you can see the controls showing 100 percent survival of the larvae. And in the case of the eggs, you don't see the eggs of course, they hatch in three or four days. In a day or two and you can see the high infestation at 0 hours and 48 hours, but by 96 hours most of these larvae were dead. The black spots are dead larvae. They look kind of off-color, I don't know why, but we are starting on those factors now. And this is, of course, the second instar larvae which is killed after 96 hours. And there are no live larvae at all in this fruit and there are several other sample units which have the same kind of illustration.

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Another interesting thing we noticed in this study was the behavior of the larvae itself. Soon after they were wrapped, they would just remain inside for about a minute or two and they would just shoot outside to the surface of the fruit and remain there until they became sluggish and eventually died. So the movement of the larvae was peculiar. Even if it was inside the cavity of the papaya, papayas have got a big cavity inside. Even despite that, they moved to the surface and they remained under the wrap. I told you we did three trials. In the second trial, we started seeing the same kind of response but with a little change. We used a little riper fruit in this case. And you might ask me why the controls had just 80 percent infestation, why not 100 percent, why not all fruits? When you infest these fruits the fruit flies are very selective in choosing which papava to lay their eggs on. So some fruits did not have eggs at all. So that's why you see a drop. When you have a sample unit of ten fruits, only eight were infested. So it's short infestation, that's why you see 80 percent infestation. But we corrected it eventually. Again you can see that as the length of leaving wrap on the fruit increased, there was a decrease in the infestation or there were less fruits showing live larvae.

But there were some problems. You can ask me why is this showing there were live larvae at 96, 120 and 144. Well, in this case we used a little riper fruit, so the two things to notice here are: first, when you wrap a fruit you have to punch a hole before you shrink it. Only then can the air escape when the thing shrinks. So these larvae were smart enough to track those holes and survive. And that's why you see this percentage of increase of infestation even after 96 hours. Where we kept track of those holes and then plugged them with cellophane we could kill these larvae.

And secondly, I mentioned that in my experimental methods at Bay 5, some of the fruits were wrapped at Bay 5, we could not shrink it at all because they were overripe at that stage, so this indicates that the metabolism of the fruit is also important. That is also a key point to understand. In our second set of experiments, what we did was we plugged the holes, using a cork borer we made some holes on the surface of the papaya and into each of these holes we put about say 100, 150 live larvae, first instar larvae, and then we plugged the holes and shrink-wrapped them later. Again, we noticed the same behavior of these insects. We put the larvae inside the cavity of the papaya, and yet you could see live larvae on the surface just below the wrap where they were plugged. The papaya was held for four days. There was a color transformation--it's still kind of ripe but not fully ripe and those larvae were dead by the time it was unwrapped. But in the case of the nonwrapped fruits, the fruit was overripe and live larvae could be seen at the surface. They completed development and pupated eventually. So this is a clear indication of what the wrap is doing to the papaya.

Our studies continue. In fact, my coworker is now studying some of the mode of action and the principle behind what is happening inside the fruit. We also worked with medfly and we had similar results. Because we didn't have the proper wrapping machine we had some problems, we just received it later so I think we can improve the wrapping processes. However up to day four the medfly started dying. And we also worked with the melon fly and the results are similar. After about day four or day five, they started showing death.

In summary and conclusion, I would like to point out a few things here. Film wraps contain the existing infection of the fruit fly. When the fruits are infested and shrink-wrapped, there's less chance that they might complete the development and survive. Even if they survive they will be inside the fruit. They will not help the spread of these flies. The film wrap kills the existing Oriental fly.

The migration of the larvae to the surface aids easy detection. We know that there might be larvae somewhere in the millions of fruits that have been exported, but they'll die. Film wrapping aids detection because of the migration of these insects to the surface. So while the fruit is being inspected in the packing line it will aid detection and you can just discard the fruit and prevent it from being exported or moved to another point. This technique, because it shows the potential of being used as a quarantine treatment, can either supplement or replace some of the quarantine methods that already exist. So the salient features of this work are: we should understand that it is the interaction of the fruit and the permeation properties of the film that is effective. We have not yet determined what exactly is happening but we are working on it. That's what we are studying now. And larvae migration to the surface, of course, is an abnormal behavior of the insect. They normally don't move to the surface and remain there, at least in the case of papayas. This feature of the film wrap has wide application. So now at this stage I wish to point out that we all are left with a lot more questions than answers in this technique.

"The U.S. Demand for Exotic Fruit, Including Mangoes"

Mr. Jim Pandol
President
North American Mango Importers Association (NAMIA)

I'm going to make a few comments on where I see the demand for exotic fruits, where I think they are going, what the future would be for increasing demand and markets, and then open it up for questions and comments.

One thing I find interesting is calling the fruit we are discussing "exotics." For many of you from your respective countries, a lot of these fruits that we are calling "exotic' here, are some of your basic, day-day-day fruits that you are consuming. In fact, the major consumers of these fruits are the Caribbean, Latin American or Asian populations that are living in the United States, that want to have the fruits they had back home. This conference is centering quite a bit around the mango industry. According to the United Nations, the mango is the most consumed fresh fruit in the world. I would hardly consider it exotic at this point. In Mexico the per capita consumption is in the neighborhood of probably 10, 12 kilos a person, which is very high. In the United States and Europe, it's not well known yet. A lot of other fruits, such as we've talked about here, whether it's cheramoya, horned melons and various other fruits, have their place in the markets too, a much smaller place. One thing about the demand for these fruits is that it's the ethnic populations, as we've put it, that are mostly eating them, plus a segment of the U.S. population that is looking for something new, a new flavor, color or a convenience to eat.

As far as increasing demand, there was one thing we brought up yesterday at the conference that I really want to mention. It's that good quality increases demand and increase the market. Bad quality or bad condition of the fruit closes markets. It's something that really has to be well understood. If you give the consumer something that looks good, smells good and taste good, they'll come and get it again. If it's marked up, over ripe, been poorly handled and now has a funny flavor because it's starting to ferment, they probably aren't ever going to try it again. One of the big things that we've been talking about with some of these quarantine treatments is that these quarantine treatments are here. We're having to live with them. We're doing what we can as an industry to try to make things better so the fruit will get to the consumer and get to its destinations in better quality condition. It's a day-to-day struggle and we're learning, but yet the more we can do, the more confidence we can gain with the consumers and distributors, the better we will do. As an example, this year distributors are not handling mangoes or pushing them as hard to the consumer as they did last year. Last year was the first year of the thermic treatment. There were a lot of problems which caused many headaches that they just don't want to put up with. This is one place where we lost ground and we need to work to regain it, and then once we regain it to expand it further.

Outside of just fruit quality and condition, you're going to find the consumer is not used to them. They may see them on a store shelf and think they look interesting, but they don't know what to do with them. Should they peel it before they eat it, can they eat it raw, or should they cook it first? They just don't know. One thing that is very important for increasing demand is educating the consumer. This can be done with pamphlets that will actually accompany the fruit on the store shelf. A lot of times in magazines, food editors are looking for something new to write about. They will do a feature article on new fruits with a special flavor or special colors, where you can add to a fruit salad or just as a garnish on some kind of dish. This goes out to the public and a lot of the public is looking for something new. Restaurants are looking for something new to add, and this is one important thing in developing demand for a new product. One of the keys in food service, which is really the hotel, restaurant and cafeteria industries, is that these food service industries are getting these products, pushing them, showing the public how to prepare them and this is where a lot of your demand starts.

There are a couple of the products that are going to increase your markets and increasing demand for "exotics". That is because they are in such small volumes, and not easily accepted. It is not something where you're selling loads, you're selling boxes. Transportation gets to be a problem. You know it's easy to find transportation for a full load, but how do you find transportation and distribute very small amounts? This gets to be an obstacle. Also a lot of these fruits are very perishable. It's not something where somebody uses 100 boxes in the course of a year. A lot of time it's very perishable and you have to have a fresh supply every week. The transportation and delivery system has to be arranged to be able to get that fruit to them, so they can always have a fresh supply.

This is an overview of the demand. As far as we can see demand, primarily on mangoes, it is not increasing rapidly if you take the last five or six years as an average. It is increasing faster than the population growth, however. The population growth is averaging around 2, 2/1/2% a year and I think that mango consumption per capita is increasing at about 4-5% a year. There are a lot of other fruits out there and I tried to tabulate statistics on a few, but on a lot of these less-consumed fruits, there aren't many statistics and I really can't give too good of a number.

Appendices

ESTIMATED PRODUCTION OF COMMERCIAL VARIETIES OF MANGO IN THE COUNTRIES REPRESENTED. USDA Tropical Fruit Seminar. Mazatlán, Mexico, July, 1989.

Country	Area In Production (ha)	Area Being Planted (ha)	Time Until Completed (years)	Varieties	Comments
Belize	600	3,000	5	T.A.*, Haden, Van Dyke, Keitt	
Bolivia	5,000	--	--	"Criollo" Wild varieties	Domestic market
Brazil	500	--	--	T.A.*, Haden	Export to Europe
Costa Rica	3,000	500	--	T.A.*, Irwin	Export to Europe
Colombia	300	2,000	2	T.A.*, Keitt, Haden, Van Dyke	980 ha are already planted but not yet producing.
Dominica	50	100	--	Julie	Export to U.K. and to other islands in the Caribbean.
Dominican Republic	200	600	3	T.A.*, Keitt, Francis	Export to Europe
Ecuador	300	1,000	1	T.A.*, Haden, Keitt, Kent	Export to Europe
El Salvador	300	--	--	Haden, Irwin, Julie, Keitt	Export to Europe
Honduras	400	600	1	Haden, T.A.*	Export to Europe
Guatemala	400	1,000	2	T.A.*, Haden, Kent, Keitt, Irwin, Zill	Export to Europe

*T.A. represents the Tommy Atkins variety.

ESTIMATED PRODUCTION OF COMMERCIAL VARIETIES OF MANGO IN THE COUNTRIES REPRESENTED. USDA Tropical Fruit Seminar. Mazatlán, Mexico, July, 1989. (Continued)

Country	Area In Production (ha)	Area Being Planted (ha)	Time Until Completed (years)	Varieties	Comments
Jamaica	625	--	--	T.A.*	Export to Europe
Haiti	See comments	200	1	Francis, T.A.*	Most fruit is from wild trees. In 1979, 2 million boxes were exported which constituted about 20% of total production. New plantings are in plantations and are Tommy Atkins variety.
Mexico	30,000	--	--	Haden, T.A.*, Kent, Keitt	110,000 ha including wild varieties. 900,000 tons per year are in production, mostly Manila type, but also most minor varieties. Production runs from January-October with most production in March-August.
Peru	2,000	7,500	--	Haden, Kent, Irwin, T.A.*	30% export to Europe
St. Lucia	65	130	5	Julie, Graham	Export to U.K. and Canada
Trinidad	10	--	--	Julie	40 ha with wild varieties
Venezuela	2,200	--	--	Haden, Keitt, Kent, T.A.*	

*T.A. represents the Tommy Atkins variety.

revised 7-5-89

Mangoes

Demand for mangoes has increased about 12 percent per year since 1975, but prices show very little if any upward trend since 1978. Nevertheless, market growth has been primarily filled by imports from 1975-85. But Florida growers have also responded by increasing commercial plantings by at least one-third, and shipments by more than 50 percent, since 1980. The total production estimates for the United States included in this analysis, however, do not include any allowances for California, which unoffically produced 10,000 tons per year in the mid-1980's.

Total consumption: 1975- About 16,000 tons/year.
1985- About 47,000 tons/year.

Per capita consumption: 1975- About 0.076 kilogram/year.
1985- About 0.200 kilogram/year.

Fresh Market Supply

Peak season: June-Aug. Off season: Nov.-Feb.

Production: U.S. (Florida) production of mangoes for fresh market consumption was relatively stable and constant from 1975-83, when output began to rise sharply. This may be attributed to expanded acreage in Florida. Planted area in Florida alone has reportedly increased about 30-35 percent since 1980.

Imports: The United States is a net importer of fresh mangoes. Mexico and Haiti are the primary foreign suppliers, but Mexico's share has increased from about 40 percent in 1975 to 60 percent in 1985. The Environmental Protection Agency's new concern about EDB fumigants also affected the market in 1985 and 1986. Nevertheless, total imports increased nearly 500 percent between 1975 and 1985, and a new hot water treatment to permit entry of mangoes from Haiti and Mexico has apparently restored imports from these two primary foreign suppliers. CBI countries have also increased their share of the U.S. market but still remain in third place behind Mexico and Florida.

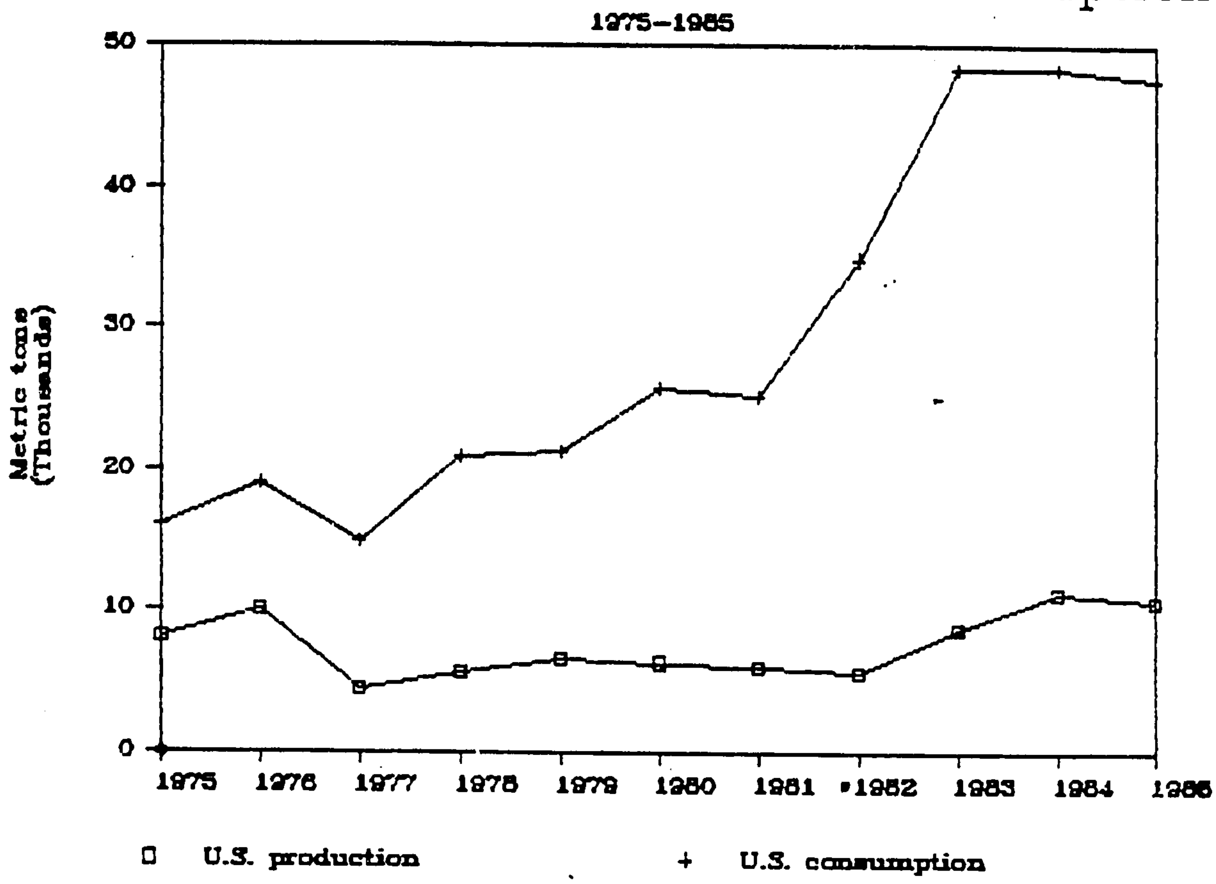
Exports: U.S. exports, if any, remain small and undocumented.

Monthly variability: Less than 3,000 tons of mangoes per month are available for fresh consumption from October through April. Market supplies peak sharply in July at 10,000-11,000 tons per month, and fall virtually to zero in November. CBI mangoes (primarily Haitian) dominate the U.S. market from December to March, before Mexican fruit dominate the market (May to November). Florida fruit shipments are significant only in June, July and August, and even then only supplement the Mexican and Caribbean supplies.

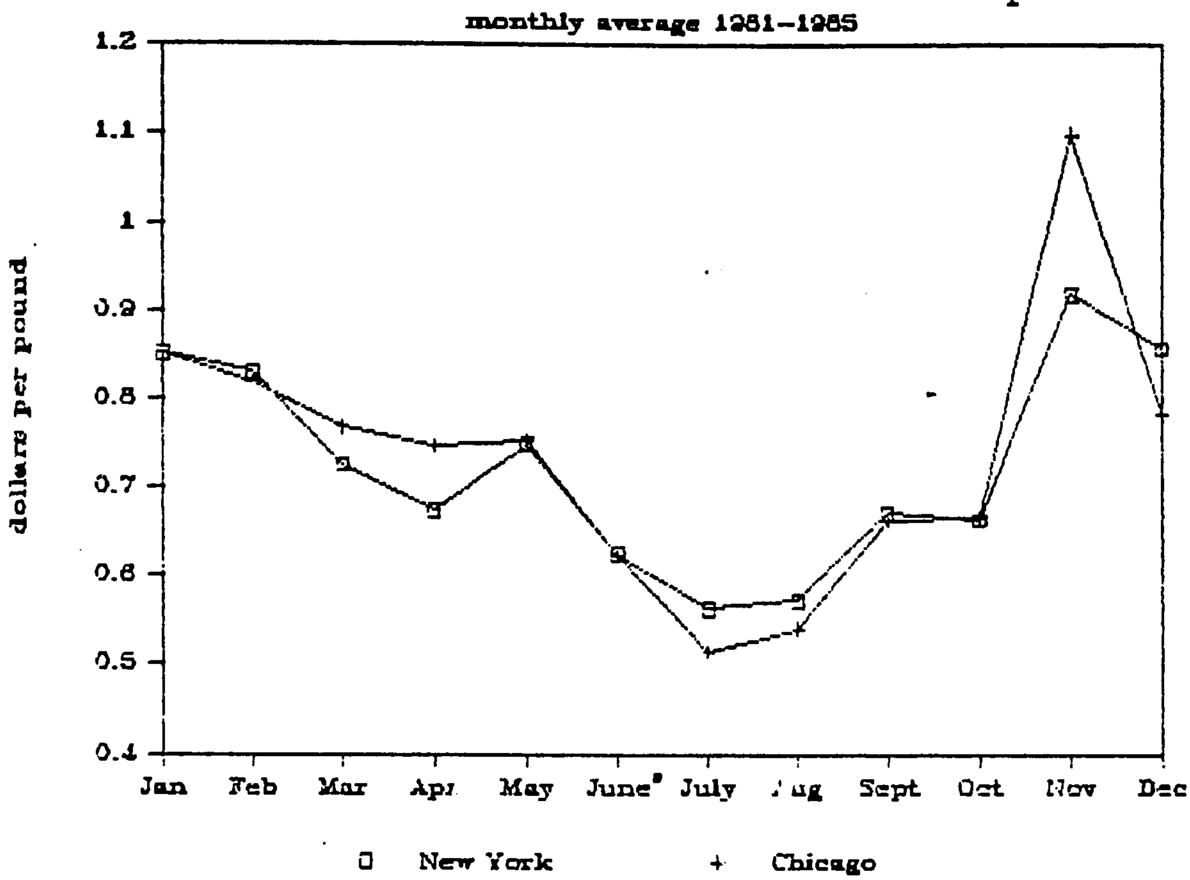
Prices

Wholesale price data are very thin for mangoes from October through March and are nearly nonexistent in any month prior to 1978. New York and Chicago prices, however, appear to peak in November at $1.00 or more per pound and then slowly decline to about $0.50 to $0.60 per pound in July and August, when supplies are most abundant. The nominal annual average, however, has increased very little since 1978.

MANGOES: Production and consumption,

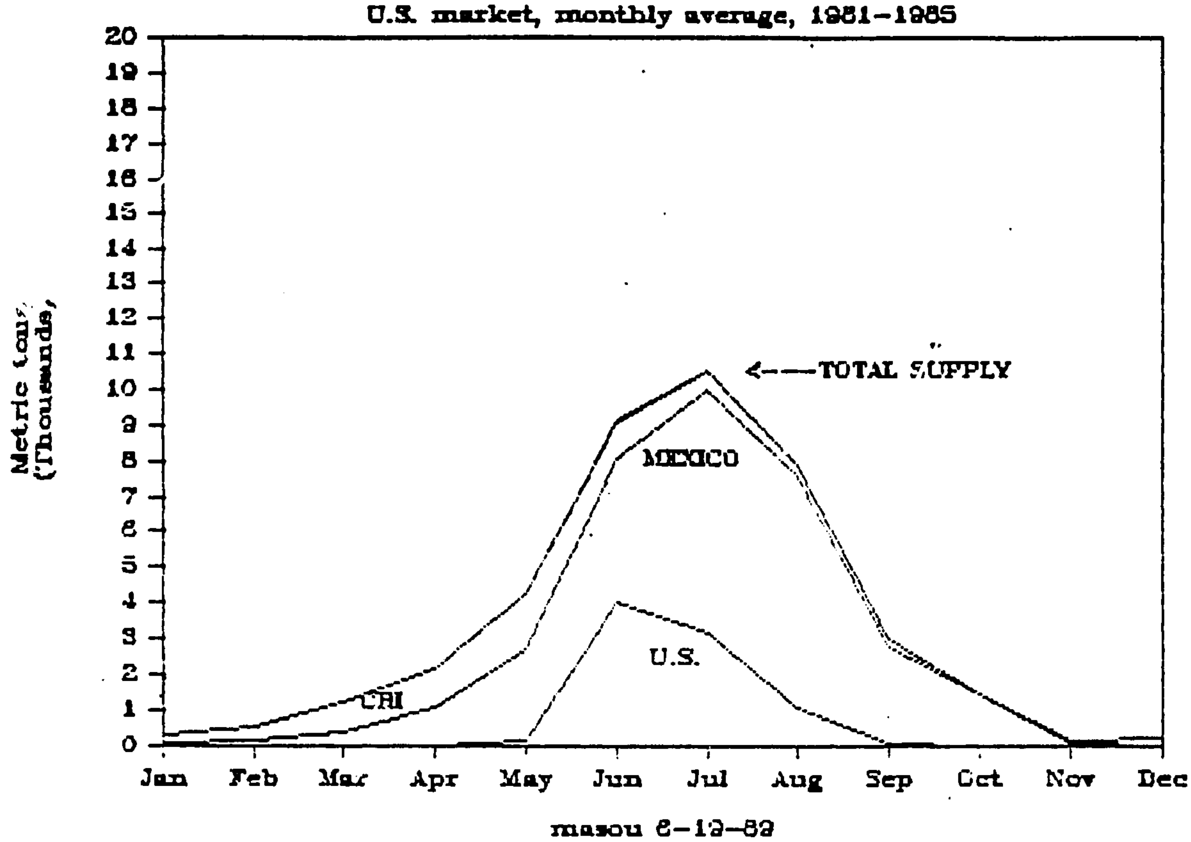


MANGOES: Wholesale market prices

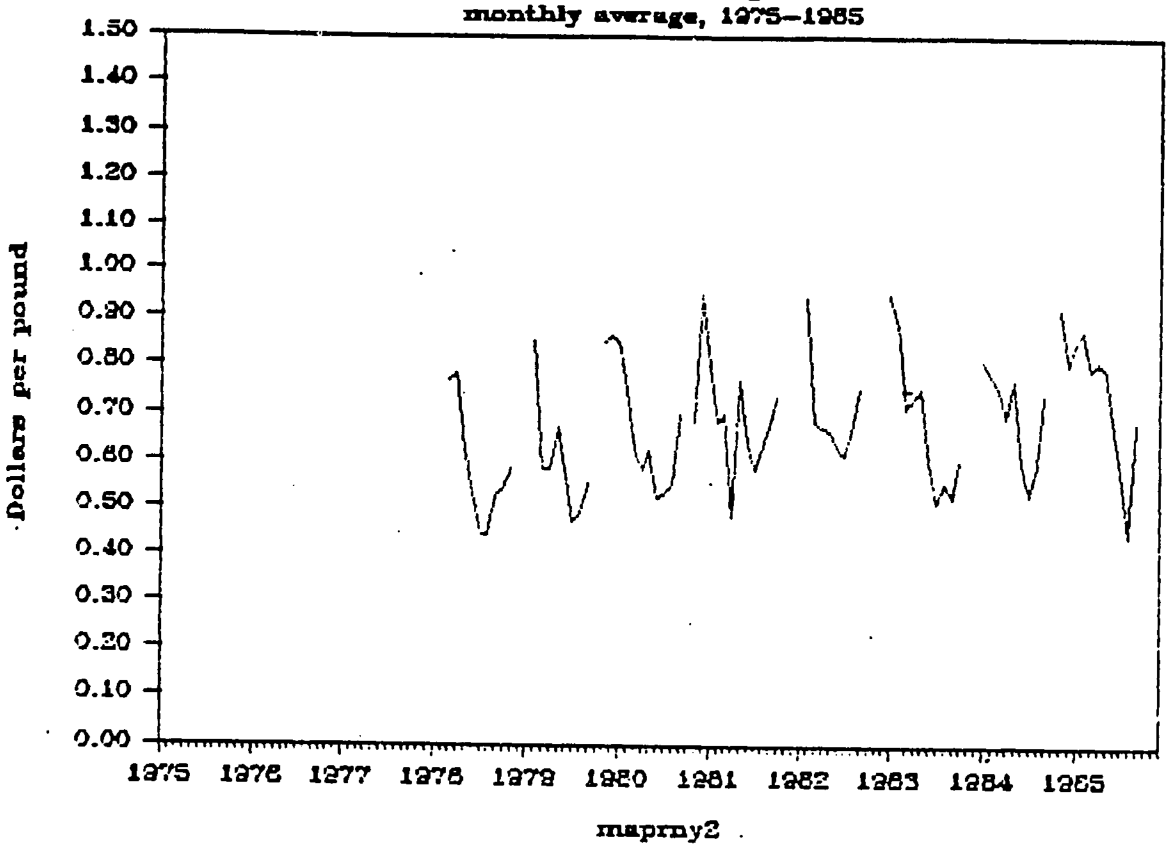


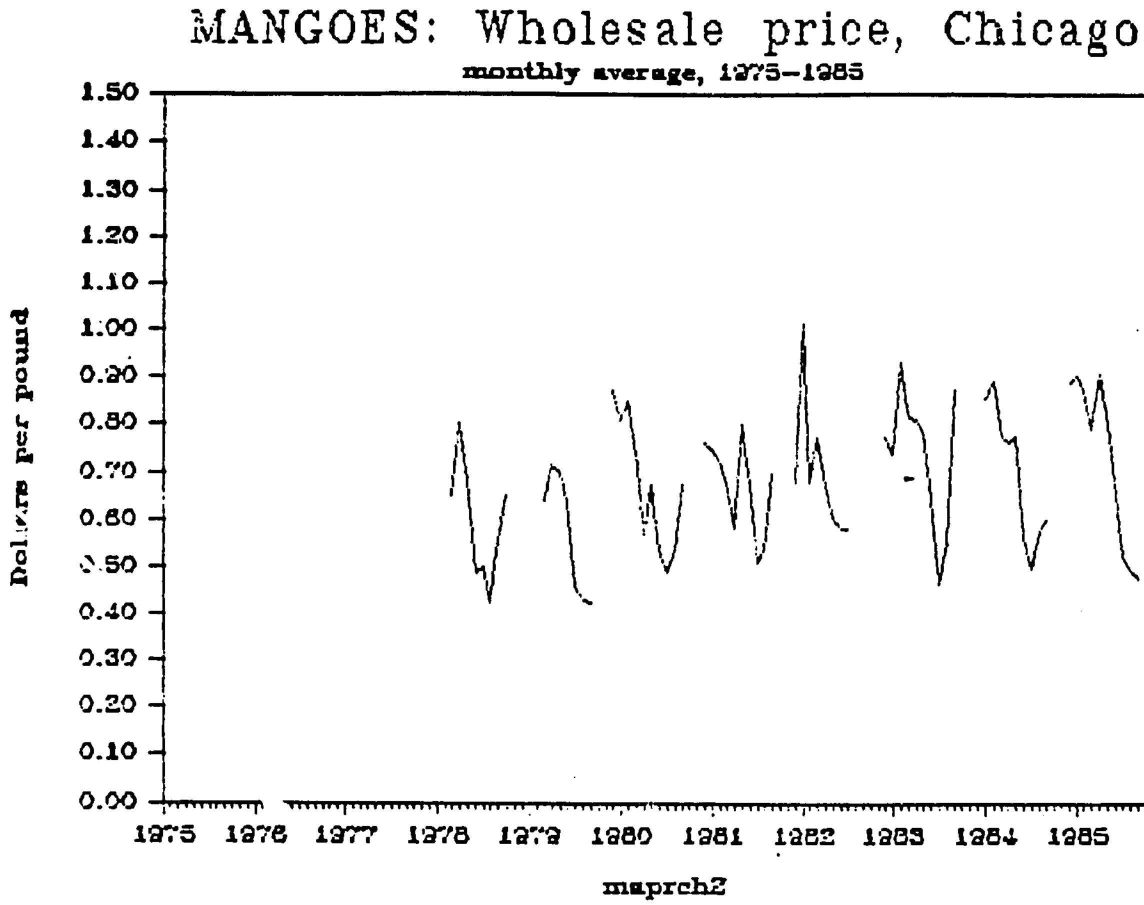
MANGOES: Sources of fresh supply in

U.S. market, monthly average, 1981–1985

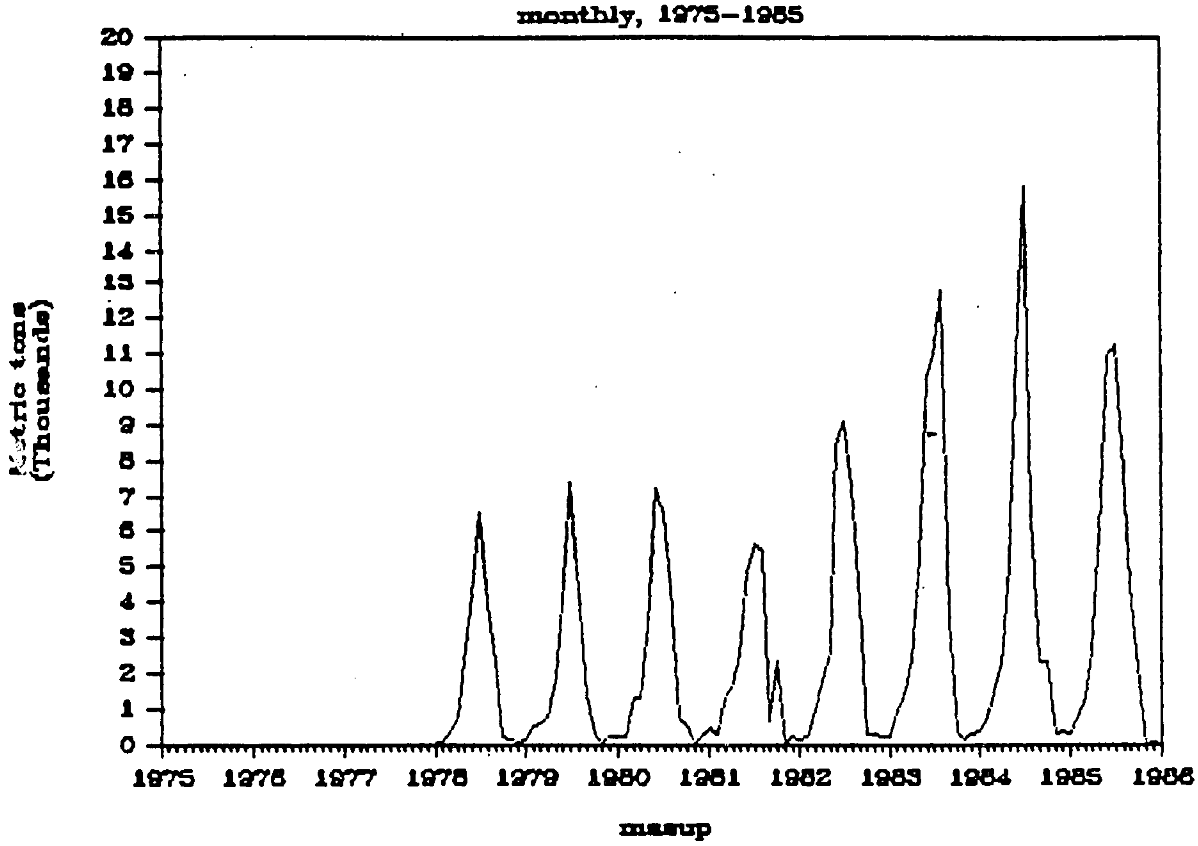


MANGOES: Wholesale price, New York,




MANGOES: Wholesale price, Chicago
monthly average, 1975–1985
Dollars per pound
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
maprch2

MANGOES: Total U.S. market supply,



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pop revised 05-15-89

Appendix table 13--Fresh Mangoes: U.S. production, imports, exports, and consumption, 1975-1987.

Year	(rev. 01/89) Production 1/	Beginning Stocks	Imports 2/	Total U.S. Supply	Exports 3/	Ending Stocks 4/	Apparent Consumption	Per Capita Consumption	U.S. Populati July 1
	Metric tons							Kilograms	Thousand
1975	8108	N/A	8054	16163	N/A	N/A	16163	0.076	213,78
1976	9979		8947	18926			18926	0.088	215,89
1977	4366		10521	14887			14887	0.068	218,10
1978	5613		15295	20908			20908	0.095	220,46
1979	6486		14852	21338			21338	0.096	222,96
1980	6237		19588	25825			25825	0.114	225,65
1981	5987		19238	25225			25225	0.111	227,98
1982	5613		29394	35007			35007	0.152	230,32
1983	8732		39598	48330			48330	0.208	232,56
1984	11227		37087	48314			48314	0.206	234,76
1985	10603		36863	47466			47466	0.200	237,03
1986	9979		44746	54725			54725	0.229	239,35
1987	13721		51999	65720			65720	0.272	241,51

1/ Florida Agricultural Statistics Service.
2/ U.S. Customs Service
3/ U.S. Customs Service
4/ Data for carryover stocks are not available. Carryover stocks for mangoes, however, are not considered significant.

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Appendix table 22--Fresh Mangoes: Source of U.S. supplies, production by major states, and imports by country of origin, quantity, annual, 1975-1985

Source of U.S. Supplies	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
(rev. 01/89)						Metric tons							
U.S. Production 1/ (Florida)	5109	9979	4366	5613	6486	6237	5987	5613	8732	11227	10603	9979	13721
U.S. Imports 2/ From:	3054	8947	10521	15295	14852	19588	19238	29394	39593	37087	36863	44746	51999
Mexico	6577	7692	9066	13151	12225	14930	14916	24377	32364	28577	28478	36686	42613
CBI 3/	1213	1255	1455	2118	2597	4618	4338	4957	7043	8095	8121	7790	9096
Other	264	0	0	26	30	41	34	60	191	415	264	270	290
U.S. Supply, fresh	16162	18926	14887	20908	21338	25825	25225	35007	48330	48314	47466	54725	65720

1/ Fresh market production estimated by ERS from data supplied by Florida Agricultural Statistics Service and Agricultural Marketing Service, USDA.
2/ U.S. Customs Service
3/ See glossary for list of CBI countries

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Appendix table 60--Mangoes: Total U.S. production, quantity, monthly, 1978-1985*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total production for year
						Metric tons							
1978	0	0	0	0	0	1014	3111	1353	135	0	0	0	5613
1979	0	0	0	0	0	1279	3414	1707	137	0	0	0	[illegible]
1980	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	[illegible]
1981	0	0	0	0	255	2166	2739	828	0	0	0	0	5987
1982	0	0	0	0	0	2916	2114	583	0	0	0	0	5613
1983	0	0	0	0	0	2341	3682	1999	210	0	0	0	8732
1984	0	0	0	0	135	6357	4058	676	0	0	0	0	11227
1985	0	0	0	0	357	5638	3098	1310	0	0	0	0	10603
1986	0	0	0	0	135	4990	3776	809	0	270	0	0	9979
1987	0	0	0	0	0	4176	6562	2585	398	0	0	0	13721
Average 1981-85	0	0	0	0	149	4023	3138	1079	42	0	0	0	8432

*National Agricultural Statistics Service and Agricultural Marketing Service, USDA. Florida estimates approximate U.S. production in most years.

Appendix table 61--Mangoes: Total U.S. imports from the world, quantity, monthly, 1978-1985**

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Total
						Metric tons							
1978	17	78	345	769	2292	3126	3431	2598	2225	197	154	62	15296
1979	139	548	600	767	1808	2695	3934	2631	1256	245	22	207	14852
1980	166	219	1287	1279	2672	5213	449?	2943	650	453	32	177	19587
1981	436	270	1310	1655	2309	2657	2929	4562	649	2265	13	182	19238
1982	106	233	880	1808	2532	5532	6940	6701	3926	247	249	240	29394
1983	236	807	1356	2351	5288	7484	7262	10775	3308	342	91	298	39598
1964	397	717	1434	2234	4894	4673	11779	5750	2287	2299	245	378	37087
1985	311	727	1269	2605	5632	5129	8188	6379	4485	2115	1	22	36863
1986	0	0	1117	3463	5512	10425	15483	6369	1357	21	285	714	44745
1987	236	398	924	3131	8099	13286	14220	9759	1878	2	63	3	51999
Average 1981-85	297	551	1250	2131	4131	5095	7420	6933	2931	1454	120	224	32436

**U.S. Bureau of the Census, United States Department of Commerce

Appendix table __--Mangoes: U.S. imports from Rest of World, quantity, monthly, 1970-1985**

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Total
	0					Metric tons							
1978	0	0	0	0	0	19	-0	0	0	0	-0	7	27
1979	-0	-0	1	0	0	5	1	1	18	0	0	2	29
1980	0	0	8	7	1	18	0	5	1	0	0	0	40
1981	0	0	0	0	0	0	0	1	0	0	1	31	34
1982	11	5	0	0	0	12	1	4	0	0	22	5	60
1983	14	5	5	2	54	33	14	9	10	34	4	7	191
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1985	155	71	3	2	15	0	0	1	16	0	1	0	[illegible]
1986	0	0	0	8	2	6	0	18	0	0	23	213	270
1987	92	29	1	0	84	91	0	15	0	2	0	3	317
Average 1981-85	47	22	7	3	24	16	21	4	7	7	6	28	193

**U.S. Bureau of the Census, United States Department of Commerce

Mangoes: U.S. Supply, total, quantity, monthly, 1975-87

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Total
						Metric Tons							
1978	17	78	345	769	2292	4141	6542	3951	2361	197	154	62	20909
1979	139	548	600	767	1808	3924	7348	4338	1393	245	22	207	21338
1980	166	219	1287	1279	3310	7197	6481	4431	721	524	32	177	25624
1981	436	270	1310	1655	2564	4823	5667	5390	649	2265	13	182	25225
1982	106	233	880	1808	2532	8448	9054	7284	3926	247	249	240	35007
1983	236	807	1356	2351	5288	10325	10944	12774	3518	342	91	298	48330
1984	397	717	1434	2234	5029	11030	15837	6426	2287	2299	245	378	48314
1985	311	727	1269	2605	5989	10967	11286	7689	4485	2115	1	22	47466
1986	0	0	1117	3463	5647	15415	19259	7178	1357	291	285	714	54725
1987	236	398	924	3131	8099	17462	20782	12344	2276	2	63	3	65720
Average:													40868
1981-85:	297	551	1250	2131	4281	9118	10558	7913	2973	1454	120	224	40868

Bureau of Census-United States Department of Commerce

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MAPRWSMO   compiled 05-12-89,
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Printed 16 May 89

Appendix Table __--Mangoes, fresh: Prices, wholesale, New York and Chicago, $/10 pound crate and $/pound, 1975-87.

Year, Market and Unit 1/	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
1975													
NEW YORK-$/Crate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$/Pound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHICAGO-$/Crate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$/Pound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1976													
NEW YORK-$/Crate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$/Pound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHICAGO-$/Crate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$/Pound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977													
NEW YORK-$/Crate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$/Pound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHICAGO-$/Crate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$/Pound	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1978													
NEW YORK-$/Crate	-	-	7.71	7.78	6.19	5.28	4.35	4.35	5.19	5.38	5.75	-	5.77
$/Pound	0.00	0.00	0.77	0.78	0.62	0.53	0.44	0.44	0.52	0.54	0.58	0.00	0.58
CHICAGO-$/Crate	-	-	6.50	8.00	6.88	4.99	5.00	4.23	5.56	6.50	-	-	5.94
$/Pound	0.00	0.00	0.65	0.80	0.69	0.49	0.50	0.42	0.56	0.65	0.00	0.00	0.59
1979													
NEW YORK-$/Crate	-	8.49	5.83	5.61	6.65	5.79	4.68	4.99	5.50	-	9.50	8.53	6.47
$/Pound	0.00	0.85	0.58	0.56	0.67	0.58	0.47	0.49	0.55	0.00	0.95	0.85	0.65
CHICAGO-$/Crate	-	-	6.40	7.16	7.00	6.37	4.59	4.29	4.25	-	-	8.70	6.09
$/Pound	0.00	0.00	0.64	0.72	0.70	0.64	0.46	0.43	0.43	0.00	0.00	0.87	0.61
1980													
NEW YORK-$/Crate	8.50	7.50	6.23	5.83	6.18	5.19	5.29	5.51	7.00	-	6.75	9.50	6.69
$/Pound	0.85	0.75	0.62	0.58	0.62	0.52	0.53	0.55	0.70	0.00	0.68	0.95	0.67
CHICAGO-$/Crate	8.10	8.50	7.38	5.70	6.75	5.34	4.86	5.36	6.75	-	-	7.53	6.54
$/Pound	0.81	0.85	0.74	0.57	0.68	0.53	0.49	0.54	0.68	-	-	0.75	0.66
1981													
NEW YORK-$/Crate	8.00	6.76	7.03	4.79	7.72	6.37	5.83	6.20	6.66	7.25	-	9.13	6.89
$/Pound	0.80	0.68	0.70	0.48	0.77	0.64	0.58	0.62	0.67	0.73	-	0.91	0.69
CHICAGO-$/Crate	7.50	7.23	6.90	5.30	8.00	6.76	5.11	5.43	7.00	-	-	6.79	6.64
$/Pound	0.75	0.72	0.69	0.53	0.90	0.68	0.51	0.54	0.70	-	-	0.68	0.66

!R! FONT 23;FTMD 15;EXIT;

Fresh Mangoes, cont'd

Appendix table __--Mangoes, fresh: (Cont'd)

Year, Market and Unit 1/	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
1982													
NEW YORK-$/Crate	-	9.44	6.75	6.66	6.63	6.32	6.15	6.60	7.50	-	-	-	7.01
$/Pound	-	0.94	0.68	0.67	0.66	0.63	0.61	0.66	0.75	-	-	-	0.70
CHICAGO-$/Crate	10.13	6.80	7.75	6.75	6.04	5.79	5.79	-	-	-	-	7.75	7.10
$/Pound	1.01	0.68	0.78	0.68	0.60	0.58	0.58	-	-	-	-	0.78	0.71
[illegible]													
NEW YORK-$/Crate	9.50	8.89	7.07	7.29	7.50	5.96	5.07	5.50	5.24	6.00	-	-	6.80
$/Pound	0.95	0.89	0.71	0.73	0.75	0.60	0.51	0.55	0.52	0.60	-	-	0.68
CHICAGO-$/Crate	7.40	9.30	8.15	8.10	7.88	6.45	4.63	5.50	8.75	-	-	-	7.35
$/Pound	0.74	0.93	0.82	0.81	0.79	0.64	0.46	0.55	0.88	-	-	-	0.73
1984													
NEW YORK-$/Crate	8.06	7.75	7.50	6.90	7.67	6.00	5.31	5.89	7.41	-	9.17	8.00	7.24
$/Pound	0.81	0.78	0.75	0.69	0.77	0.60	0.53	0.59	0.74	-	0.92	0.80	0.72
CHICAGO-$/Crate	8.55	8.90	7.78	7.60	7.75	5.65	4.91	5.74	6.00	-	11.00	8.90	7.53
$/Pound	0.86	0.89	0.78	0.76	0.78	0.56	0.49	0.57	0.60	-	1.10	0.89	0.75
1985													
NEW YORK-$/Crate	8.50	8.65	7.88	8.10	7.90	6.57	5.75	4.41	6.75	-	-	-	7.17
$/Pound	0.85	0.87	0.79	0.81	0.79	0.66	0.58	0.44	0.68	-	-	-	0.72
CHICAGO-$/Crate	9.00	8.70	7.90	9.10	8.00	6.50	5.23	4.95	4.75	-	-	-	7.13
$/Pound	0.90	0.87	0.79	0.91	0.80	0.65	0.52	0.50	0.48	-	-	-	0.71
1986													
NEW YORK-$/Crate	-	-	9.71	8.71	8.91	5.86	4.94	5.57	6.00	-	11.00	7.65	7.59
$/Pound	0.00	0.00	0.97	0.87	0.89	0.59	0.49	0.56	0.60	0.00	1.10	0.77	0.76
CHICAGO-$/Crate	-	-	8.63	9.05	8.05	4.56	3.88	5.40	7.15	-	13.50	9.65	7.76
$/Pound	0.00	0.00	0.86	0.91	0.81	0.46	0.39	0.54	0.72	0.00	1.35	0.97	0.78
1987													
NEW YORK-$/Crate	-	-	-	-	6.56	5.81	4.14	6.00	6.00	-	-	-	5.79
$/Pound	0.00	0.00	0.00	0.00	0.66	0.58	0.41	0.60	0.60	0.00	0.00	0.00	0.57
CHICAGO-$/Crate	*	-	9.15	7.40	6.49	5.35	4.13	4.74	5.75	-	-	-	6.14
$/Pound	0.00	0.00	0.92	0.74	0.65	0.53	0.41	0.47	0.58	0.00	0.00	0.00	0.61

Agricultural Marketing Service, Market News Branch, USDA

1/ Flat, crate, or carton (???? pounds, net)

Average prices, 1981-85 monthly average, for plotting only. *

Year, Market and Unit 1/	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
1981-85 Ave.	-1									-3	-4	-3	
NEW YORK-$/Crate	8.52	8.30	7.25	6.74	7.48	6.24	5.62	5.72	6.71	6.63	9.17	8.57	7.24
$/Pound	0.85	0.83	0.72	0.67	0.75	0.62	0.56	0.57	0.67	0.66	0.92	0.86	0.72
								-1	-1	-5	-4	-2	
CHICAGO-$/Crate	8.52	8.19	7.69	7.47	7.53	6.23	5.13	5.40	6.63	6.65	11.00	7.91	7.35
$/Pound	0.95	0.82	0.77	0.75	0.75	0.62	0.51	0.54	0.66	0.57	1.10	0.79	0.74

Appendix table 85--Mangoes: Value of U.S. imports, by country and port of entry, in dollars

Country / Port of Entry	1983 January-March	1983 April-June	1983 July-September	1983 October-December	1983 TOTAL	1984 January-March	1984 April-June	1984 July-September	1984 October-December	1984 TOTAL	1985 January-March	1985 April-June	19 Ju Sept	5 -ber	1985 October-December	1985 TOTAL	Country / Port of Entry
Mexico-total	312469	4824777	13801508	63057	19001811	133438	3182542	12182317	2163588	17661885	21610	3939747	124	476	1977238	18414071	Mexico-total
Detroit, MI	0	0	0	0	0	0	0	6528	0	6528	0	0		0	0	0	Detroit, MI
El Paso, TX	0	0	0	0	0	0	75450	17691	0	93141	0	15602		0	0	15602	El Paso, TX
Laredo, TX	312469	2368081	1548870	26619	4256039	133438	1718106	1447376	6858	3305778	20000	2099347	17	501	12768	3354716	Laredo, TX
Los Angeles, CA	0	0	0	0	0	0	0	0	0	0	1610	0		0	0	1610	Los Angeles, CA
Miami, FL	0	5456	0	0	5456	0	0	11088	0	11088	0	0		0	0	0	Miami, FL
New York, NY	0	0	0	2534	2534	0	0	7593	0	7593	0	0		0	0	0	New York, NY
Nogales, AZ	0	1292247	11598417	16000	12906664	0	456335	9376193	2156730	11989258	0	1763368	11[illegible]	566	1964470	14928404	Nogales, AZ
Portland, OR	0	0	0	0	0	0	0	0	0	0	0	0		120	0	17120	Portland, OR
San Diego, CA	0	1158468	654221	17904	1830593	0	932651	1315848	0	2248499	0	61430		189	0	96619	San Diego, CA
Seattle, WA	0	525	0	0	525	0	0	0	0	0	0	0		0	0	0	Seattle, WA
Bahamas																	Bahamas
Miami, FL	0	0	0	0	0	0	0	0	0	0	0	0		250	0	5250	Miami, FL
Belize																	Belize
Miami, FL	0	310953	27475	0	338428	0	206643	83700	0	290343	0	0		0	0	0	Miami, FL
Dominican Republic																	Dominican Republic
Miami, FL	0	18892	4393	0	23285	3750	0	3000	0	6750	0	0		0	0	0	Miami, FL
New York, NY	824	3024	36753	0	40601	4115	22545	3365	0	30025	0	0		0	0	0	New York, NY
Portland, ME	0	0	0	0	0	0	280	0	0	280	0	0		0	0	0	Portland, ME
Virgin Ils, US	0	4398	870	0	5268	0	5700	10532	0	16232	0	0		0	0	0	Virgin Ils, US
Guatemala																	Guatemala
Los Angeles, CA	0	0	0	0	0	0	0	0	0	0	1200	0		1500	0	25700	Los Angeles, CA
Miami, FL	0	0	0	0	0	0	0	2400	0	2400	0	25035		838	0	86873	Miami, FL
New York, NY	0	0	0	0	0	0	270	0	0	270	0	0		0	0	0	New York, NY
Nogales, AZ	0	0	0	0	0	0	0	0	0	0	[illegible]	13055		985	0	43040	Nogales, AZ
Haiti																	Haiti
Boston, MASS	0	0	5250	3500	8750	2500	28213	16889	0	47602	0	0		0	0	0	Boston, MASS
Los Angeles, CA	2760	0	0	0	2760	0	0	0	0	0	0	0		0	0	0	Los Angeles, CA
Miami, FL	725266	1694719	447551	156337	3023873	910186	1729157	361327	261664	3262334	1020617	2397494		493	0	3810604	Miami, FL
New York, NY	10450	270025	76528	0	357003	0	278449	98812	2904	380165	15425	28749		0	0	44174	New York, NY
Tampa, FL	0	0	0	0	0	5250	10500	0	0	15750	0	0		0	0	0	Tampa, FL
Virgin Ils, US	0	0	0	0	0	0	0	11775	0	11775	0	0		0	0	0	Virgin Ils, US
Honduras																	Honduras
Miami, FL	6000	0	0	0	6000	0	0	0	0	0	0	0		0	0	0	Miami, FL
Jamaica																	Jamaica
New York, NY	0	1112	6395	0	7507	1220	3180	1739	0	6139	0	0		0	0	0	New York, NY
St Lucia																	St Lucia
New York, NY	0	0	0	0	0	0	0	0	1176	1176	0	0		0	0	0	New York, NY
Trinidad and Tobago																	Trinidad and Tobago
New York, NY	0	0	0	0	0	0	0	2509	0	2509	0	0		0	0	0	New York, NY
Carib. Basin-total	745300	2303123	605215	159837	3813475	927021	2284937	596048	265744	4073750	1037242	2464333		4066	0	4015641	Carib. Basin-total
Boston, MASS	0	0	5250	3500	8750	2500	28213	16889	0	47602	0	0		0	0	0	Boston, MASS
Los Angeles, CA	2760	0	0	0	2760	0	0	0	0	0	1200	0		1500	0	25700	Los Angeles, CA
Miami, FL	731266	2024564	479419	156337	3391586	913936	1935800	450427	261664	3561827	1020617	2422529		9581	0	3.92727	Miami, FL
New York, NY	11274	274161	119676	0	405111	5335	304444	106425	4080	420284	15425	28749		0	0	44174	New York, NY
Nogales, AZ	0	0	0	0	0	0	0	0	0	0	0	13055		9985	0	43040	Nogales, AZ
Portland, ME	0	0	0	0	0	0	280	0	0	280	0	0		0	0	0	Portland, ME
Tampa, FL	0	0	0	0	0	5250	10500	0	0	15750	0	0		0	0	0	Tampa, FL
Virgin Ils, US	0	4398	870	0	5268	0	5700	22307	0	28007	0	0		0	0	0	Virgin Ils, US
Other-total	26814	125859	17610	27439	197722	106305	94178	157284	77077	434844	141915	8946		0423	2500	173784	Other-total
Baltimore, MD	0	0	0	0	0	0	0	0	550	550	0	0		0	0	0	Baltimore, MA
Buffalo, NY	0	3494	0	0	3494	0	0	0	0	0	0	0		0	0	0	Buffalo, NY
Chicago, MI	320	0	0	0	320	0	0	0	0	0	2608	0		0	0	2608	Chicago, MI
Great Falls, MT	0	0	0	0	0	0	0	0	0	0	2814	0		0	0	2814	Great Falls, MT
Laredo, TX	0	3377	949	0	4326	0	8066	0	0	8066	0	3588		0	0	3588	Laredo, TX
Los Angeles, CA	350	262	0	0	612	1000	0	382	0	1382	4428	0		1022	0	5450	Los Angeles, CA
Miami, FL	2100	0	0	0	2100	0	0	0	29848	29848	33863	0		0	0	33863	Miami, FL
New York, NY	23194	118726	14999	26318	183237	105014	86112	156902	46199	394227	98202	5358		4441	2500	110501	New York, NY

!R! FONT 28;FTMD 15;EXIT;

Appendix table 62--Mangoes: U.S. imports from Mexico, quantity, monthly, 1978-1985**

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Total
						Metric tons							
1978	0	0	325	627	1834	2573	2855	2518	2213	181	25	0	13151
1979	21	499	396	403	992	2092	3723	2618	1238	245	0	0	12225
1980	0	158	669	531	1482	4401	4170	2875	524	116	3	0	14930
1981	0	213	424	719	1392	2002	2721	4522	584	2240	0	0	14816
1982	24	164	409	1239	1539	4622	6246	6256	3633	245	0	0	24377
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
1984	44	74	278	639	2850	3704	11096	5424	2124	2297	47	0	28577
1985	0	0	83	1163	3267	3854	7641	6024	4309	2115	0	22	28478
1986	0	0	418	1416	3432	8834	15024	6146	1295	0	36	79	36656
1987	0	152	0	650	4671	11786	13937	9639	1878	0	0	0	42613
Average 1981-85	14	151	397	1032	2523	3995	6858	6523	2772	1437	17	4	25722

Appendix table 63--Mangoes: U.S. imports from Caribbean Basin, quantity, monthly, 1978-1985**

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Total
						Metric tons							
1978	17	78	20	142	458	534	576	80	13	16	130	55	2115
1979	119	49	203	364	815	598	210	12	0	0	22	205	2597
1980	166	61	610	740	1189	795	327	63	125	337	29	177	4619
1981	436	56	887	937	917	655	208	39	64	26	12	151	4388
1982	71	64	471	569	993	898	693	441	293	2	227	235	4957
1983	222	497	562	949	1666	1659	662	375	90	22	48	291	7043
1984	300	615	1128	1584	1991	935	592	319	156	0	195	280	8095
1985	156	656	1183	1440	2350	1275	547	354	160	0	0	0	8121
1986	0	0	699	2039	2072	1585	459	205	62	21	226	422	7790
1987	144	217	923	2481	3344	1409	383	105	0	0	63	0	9069
Average 1981-85	237	378	846	1096	1583	1084	540	306	153	10	96	191	6521

**U.S. Bureau of the Census, United States Department of Commerce

SUBJECT: Safety and Labeling of Waxed Fruits and Vegetables

BACKGROUND:

Food additive regulations prescribing safe conditions for use of waxes for coating fresh fruits and vegetables are established on the basis of data demonstrating that the proposed use is safe. Only waxes which are safe are permitted for coating fresh fruits and vegetables.

Substances that are generally recognized as safe (GRAS) are currently under review to affirm their safe use in or on food. With respect to waxes applied to fruits and vegetables, the Select Committee on GRAS substances of the Life Science Research Office, Federation of American Societies for Experimental Biology is currently reviewing the safety of substances used for waxing fresh fruits and vegetables.

If as a result there are substantial scientific data demonstrating that an additive presents a hazard to consumers all necessary measures provided by law will be undertaken to protect consumers.

Regulations governing the use of chemicals as coatings for fresh fruits and vegetables are in 21 CFR Part 172. Particularly in Sections 172.210, 172.886 and 172.890.

To ensure that the food additive regulations for coatings are observed, FDA investigators check the use of coatings at packing facilities to verify that only approved coatings are being used and that they are used in accordance with the food additive provisions of the regulations.

Section 403(i)(2) of the Act requires that the label of a food bear a statement of ingredients and, to the extent that compliance with the requirements *** is impracticable *** requires the Secretary to establish exemptions. Accordingly, FDA has provided for an exemption from such labeling in 21 CFR 101.100(a)(2) as follows:

> "A food having been received in bulk containers at a retail establishment, is displayed to the purchaser with either (i) the labeling of the bulk container plainly in view or (ii) a counter card, sign, or other appropriate device bearing prominently and conspicuously the information required to be stated on the label pursuant to section 403(i)(2) of the Act."

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Waxed fruits and vegetables are subject to the requirements of section 403(i)(2). When in package form the label shall declare the fact that wax has been applied. When received in bulk by the retailer it is his responsibility to display the food to prospective purchasers either with the labeling of the bulk container plainly in view or with a counter card bearing the required information.

POLICY:

Waxed fruits and vegetables are subject to the requirements of section 403(i)(2) of the Act and 21 CFR 101.100(a)(3) of the regulations. Therefore, the absence of a proper declaration of ingredients by retail establishments on the sales bin or counters renders the food misbranded under section 403(i)(2) of the Federal Food, Drug, and Cosmetic Act.

FDA encourages enforcement action by the states as the most efficient and manageable approach to achieving compliance with the requirement at the retail level.

SECTION III

Treatment Procedures

Part 14 - Hot Water Dip Treatment (HW)

Principle - HW uses heated water to raise the temperature of the commodity to the required temperature for a specified period of time. HW is used primarily for fruits that are hosts of fruit flies but may be used for vegetables and nursery stock for a variety of pests.

Schedules - The time-temperature relationship varies with the commodity and the pest involved. Typically the pulp temperature is raised using water heated to 46.1 to 49 °C (115 to 120 °F) for periods of 40 to 90 minutes. The start of cooling after treatment is specific for each commodity. See the PPQ Treatment Manual Section VI for approved HW schedules.

Procedures:

1. All treatments will be conducted in an approved tank.

2. The facility will be checked for proper operation of the heating, circulation, and recording equipment before the start of each treatment. Continuous slow equipment will be checked at the start of each day or run.

3. Commodity will not be refrigerated before treatment and will be at or above the prescribed minimum temperature.

4. Commodities subject to size restrictions require a preliminary culling procedure to eliminate oversized fruit prior to treatment.

5. Dip tanks will be loaded in a manner approved by the U.S. Department of Agriculture (USDA), using containers that allow adequate water circulation and heat exchange.

6. Treat the lot at the approved schedule. Treatment shall begin when the entire lot is submerged in the tank. Heat recovery period during the first 5 minutes may be slightly lower than prescribed temperature.

7. Each treatment container or lot shall be given an identifying number at the time it is placed in the hot water dip.

8. An automatic temperature recording system shall record the temperature and duration of each hot water dip. A responsible employee of the packing company shall indicate on the printed temperature record the starting time, lot number, duration of each treatment and initial each entry. An alternative recording system may be used with prior Animal and Plant Health Inspection Service approval.

9. All boxes will be marked "Treated with Hot Water, APHIS, USDA."

10. Commodities treated at origin will be maintained in an insect free enclosure immediately after treatment and throughout the shipping process. This insect-free condition may be accomplished through insect-proof containers, screened or otherwise enclosed areas, or a combination of both.

11. The entire treatment will be under the general supervision of PPQ, APHIS, USDA under a specific compliance agreement.

SECTION IV

Treatment Facilities

Part 5 - Hot Water Dip Tanks

Introduction

Treatment by submersion in hot water is used primarily for fruit and vegetables that are hosts of fruit flies. Exposing infested fruit to temperatures near 46.0 °C (115 °F) for specific periods of time, dependant upon the fly species and commodity, results in quarantine control of this group of agricultural pests. The U.S. Department of Agriculture (USDA) incorporates this principle of insect control in its regulations to facilitate the importation or interstate movement of certain fruits from areas where tropical fruit flies are among the significant pests of concern.

Facilities for hot water treatment are subject to approval. This approval is given solely in conjunction with quarantine requirements and is not to be interpreted as a general approval for treatment for other purposes.

General Requirements for Approval of Hot Water Dip Tanks

A hot water dip tank must have adequate water heating capacity, insulation, and thermostatic control to hold the temperature above specified limits for a given duration of time for that commodity. Proper design of components is necessary, including high capacity water heating equipment and a circulation system that will assure uniform temperatures throughout the commodity being treated. An accurate recording device is required to record water temperature and time for each batch of commodity treated. Both batch and continuous treatment equipment is eligible for approval. The USDA does not provide construction details. Construction details are the responsibility of the owner/builder to allow flexibility for facility size, material availability, economic feasibility and individual preference.

Hot water dip tanks must be approved prior to use for APHIS treatments. Plans and specifications showing dimensions, water circulation, and other details of the heating and temperature recording systems should be sent to the Center Director, Hoboken Methods Development Center, 209 River Street, Hoboken, New Jersey 07030. An on-site approval survey will be conducted which will:

1. Compare the installation to the submitted plans.

2. Check the heating and water circulation system.

3. Check the calibration of the temperature and time monitoring systems.

Upon successful completion of the performance survey, PPQ Form 480 (Treatment Facility) and a Certificate of Approval (PPQ Form 482) will be issued and valid for 1 year.

Approval Procedure for Hot Water Treatment Tanks 1/

1. Maintain a water temperature of 45 °C (113 °F) ± 0.5 °C, after item 3 is met, and for the remainder of the treatment while containing a typical load of fruit. 1/

2. Water temperature differential throughout the treatment shall not be more than 1 °C after item 3 is met.

3. Recovery of the water treatment temperature shall be within 5 minutes after placing the fruit in the tank.

4. Temperature differential among fruit in all areas of the tank at completion of treatment shall not be more than 3 °C. Temperature will be measured 1 cm below the surface of the fruit.

5. Temperature of the fruit at the completion of treatment shall be a minimum of 36 °C (96.8 °F). 2/

6. An automatic strip chart or similar alternative recording system shall record the temperature and duration of each hot water dip.

7. The recorder will meet the following standards:

   a. Accuracy within 0.27 °C (0.5 °F).

   b. Temperature for each sensor shall be recorded a minimum of every 2 minutes.

   c. Scale deflection of not less than 0.10 inches for each degree Fahrenheit or 5mm for each degree centigrade.

   d. Each sensor print must be easily identified.

   e. Each dip tank must have at least two sensors.

8. The fruit must be kept 4 inches below the water level.

9. Final approval will be given after a temperature survey monitoring two typical hot water treatments using standard loads meets the above requirements.

[1]Procedures for all fruits are identical except that the treatment temperature prescribed in Section VI for the fruit(s) to be treated shall be used for the approval procedure.

[2]Minimum temperatures for different fruits vary and will be prescribed by the Hoboken Methods Development Center. The 36 °C temperature is the minimum for papaya.

Post-treatment aeration: Forced circulation in the fumigation chamber for 1/2 hour following treatment and then placed in a well ventilated area. Aeration must be in compliance with OSHA and State requirements.

(6) Grapefruits, oranges, and tangerines from Mexico for Anastrepha spp.

MB at NAP--Chamber only

40 g/m^3 (2 1/2 lb/1000 ft^3) for 2 hours at 21 - 29 °C (70 - 85 °F)

Load not to exceed 80% of the chamber volume.

A lot of grapefruit, oranges, or tangerines shall only be eligible for fumigation if a representative sample of the fruit is inspected and the level of fruit infested with fruit flies is less than 0.5% for the lot.

(c) Mango

(1) Reserved*

(2) Alternate Vapor Heat Treatment from Mexico......T106(a)

(3) Reserved*

(4) Reserved*

(5) Hot Water Dip

(i) Treatment for certain varieties of mangoes from Haiti for Anastrepha spp. (A. obliqua and A. suspensa).

"Francis" variety--treat fruit no larger than size 10 (10 fruits comprise 12 pounds net weight package). Each mango must be no larger than 570 grams in weight.

"Carrot" variety and other similar varieties--these varieties must be smaller than size 10 with a pulp depth less than size 10 "Francis".

Keep all fruit at 21.1 °C (70 °F) or above until treated.

Submerge fruit at least 4 inches under the surface of the water at: 46.4 °C (115.5 °F) for 75 minutes. (Lower limit of 45.6 °C (114 °F)). The aggregate time of temperatures between 45.6 °C (114 °F) and 46.1 °C (115 °F) may not exceed 10 minutes of the total treatment time.

19 SEP 1988

(ii) Treatment for mangoes from Mexico, except the St of Chiapas for Anastrepha spp. (A. ludens and A. obliqu

Treat fruit no larger than size 8 (8 fruit comprising a maximum 11 pound net weight package but no individual fruit to exceed 1.56 pounds).

Keep fruit at 21.1 °C (70 °F) or above until treated. Submerge fruit at least 4 inches under the water surface at 46.1 °C (115 °F) for 90 minutes. Water temperature will be no less than 45.4 °C (113.8 °F). The aggregate time the water may be at temperatures between 45.4 °C (113.8 °F) and 46 °C (114.8 °F) may not exceed 15 minute of the total treatment time.

(d) Pineapple

(1) MB at NAP--chamber or tarpaulin

32 g/m^3 (2 lb/1000 ft^3) for 6 hrs at 21 °C (70 °F) or above.
(26 g (oz) minimum gas concentration at 1/2 hr)
(22 g (oz) minimum gas concentration at 2 hrs)
(16 g (oz) minimum gas concentration at 6 hrs)

(2) Vapor Heat.........T106

(e) Papaya

For Ceratitis capitata, Dacus dorsalis, D. cucurbitae

(1) Reserved*

(2) Reserved*

(3) Vapor Heat Treatment

For movement from Hawaii.........T106(

(4) Double hot water dip

Papayas that are less than 1/4 ripe as determined by an approved colorimeter may be treated as below if treatment is completed within 18 hours of picking and if fruit is kept at 18.3 °C (65 °F) or above until treated.

Submerged at least 4 inches under the surface of water at:

42 °C (107.6 °F) for 30 minutes;
and transferred within 3 minutes to water at
49 °C (120.2 °F) for 20 minutes.

*Ethylene Dibromide previously authorized is no longer approved f use.

United States Department of Agriculture
Animal and Plant Health Inspection Service
Science and Technology
Hoboken Methods Development Center
209 River Street
Hoboken, NJ 07030

Subject: Hot Water Treatment Facilities

The Department of Agriculture does not provide construction details. The construction of the hot water facility is the responsibility of the owner/builder to allow flexibility for facility size, economic feasibility and individual preference. Industry should provide detailed plans and specifications prepared by a licensed/certified engineer for submission to the Hoboken Methods Development Center for review.

In addition to the specifications outlined in the PPQ Treatment Manual under Sections III, Part 14 and Section IV, Part 5, the following requirements are necessary:

1. Brochures, technical information and correspondence submitted to Hoboken Methods for approval must be in English so that an accurate appraisal of the proposed hot water system can be performed.

2. When the proposal plans, written description of the system and brochures are submitted, a sample of the printout made by the recording equipment is to be submitted. This printout should include the format to be used at the facility for printing time and temperature during the treatment cycle.

3. The thermostatic temperature controls must be automatic and run continuously throughout the treatment process without manual readjustments. Recording equipment used for thermostatic control of the heating units must be designed to prohibit manipulation of temperature set points. These set points must not be adjusted or altered at any time during the treatment process. The numerical set point will be determined during the certification process and must not be changed unless re-certification is conducted.

4. The treatment system must be designed to allow for the installation of numerous portable probes throughout the load. The probes must be evenly spaced and must include the center and the perimeter of the treatment tank. These probes will be positioned at the direction of APHIS personnel during the (Re)certification process.

5. Electrical wiring throughout the hot water facility must meet local and international safety code requirements. Earth grounding of all electrical wiring located in the vicinity of the water treatment tanks is required. Wires located either near machinery or in a high traffic area must be shielded in metal conduit to prevent damage.

6. In order to notify packinghouse employees that a treatment is finished, either an audible alarm or highly visible light attached to a timing device located on the time and temperature indicating equipment should be installed.

7. Platinum Resistance Temperature Detectors (RTD) sensors are to be utilized in order to meet our accuracy specifications. Major advantages of resistance elements are long term stability, high signal levels and overall accuracy of the system. The exact number of RTD Sensors required for a particular system will be determined when the plans and equipment brochures are submitted for approval.

8. The instruments utilized to record time and temperature must be capable of automatic operation whenever the hot water treatment system is activated. The recording equipment must be capable of non-stop recording of time and temperature utilizing a minimum time interval of two minutes. Conveyor belt systems run continuously and will require recording equipment capable of operating for up to 12 consecutive hours.

9. A hot water treatment plant must have adequate water heating capacity and thermostatic control to hold the temperature at or above temperatures prescribed in the treatment schedule for the given duration of time for the commodity. Proper design of components is necessary including high capacity water heating equipment and a circulation system that will assure uniform temperatures throughout the treatment process.

10. The combined accuracy of the entire temperature recording system (i.e. Sensors, Controllers, Recorders) must be within 0.5°F(.27°C.). In addition, the recording equipment must be capable of repeatability to within 0.1°F. of the true calibrated readings when used under field conditions for an extended period of time. This accuracy information

should be listed on the equipment brochures when submitted for approval. Failure to maintain reliability, accuracy and readability in a previously approved instrument will result in cancellation of approval.

11. Batch hot water systems must have identifiable markings on the treatment chart to indicate if a mango basket is prematurely removed from the treatment tank. An alternative to these identifiable markings is either a solenoid switch or sensor which is activated during the treatment process and disengages whenever a basket is removed from the treatment tank. Baskets retrofitted with either a solenoid switch or similar device must be designed so that it is physically impossible to remove the mangoes until the full treatment cycle is completed.

12. The controls for the circulation pumps or propellers are to be designed to be tamper resistant to guarantee that equipment is not turned off during the treatment process.

13. Continuous flow systems require an instrument to monitor the speed of the conveyor belt. This can be accomplished by attaching a speed indicator (i.e. encoder) to the gear mechanism which controls the speed of the conveyor belt. This mechanism would record the belt speed on the same chart as the time and temperatures and indicate when the belt is either started or stopped during the treatment cycle. The gear system used to control the conveyor belts must be capable of being adjusted as needed to meet treatment standards. The cleats on the conveyor must be deep enough to hold the mangoes in their individual lots (groups) during the treatment process. It must prohibit either forward or backward movement of the fruit on the conveyor belt.

14. A commercial line conditioner is recommended for use with computers and microprocessors to provide protection from voltage irregularity, noise reduction and harmonic distortion.

15. Following approval of the plans for a facility by the Hoboken Methods Development Center, an on-site pre-performance survey should be conducted by APHIS personnel when the facility is approximately 50-75% completed. This will enable those involved to ascertain and deal with any potential problems prior to full operation and the final performance survey of the facility.

16. Microprocessors and computers should be located in a climate controlled room to maintain accuracy and reliability. The room should have a clear view of the entire hot water treatment tank and be capable of being locked.

17. Fruit must be maintained in an insect free enclosure immediately after treatment and throughout the shipping process. The space in the packinghouse where the fruit is brought in for processing, treated and removed to the screen room, must be designed to prevent mixing of treated and untreated fruit. The flow pattern of the fruit moving through the hot water treatment process should be such that fruit waiting to be loaded into a tank for treatment cannot become mixed with previously treated fruit. Physical barriers or procedures must be developed to prevent movement of untreated fruit directly into the screen room (bypassing the treatment).

If you have any questions, please feel free to contact me at the above address or telephone me at (201) 659-9099.

W. Scott Wood

W. Scott Wood
Staff Specialist

United States Department of Agriculture

Animal and Plant Health Inspection Service

Room 228, Federal Building
Hyattsville, Maryland 20782

Subject: Hot Water Treatment for Mangoes for Fruit Flies For Central American Countries from Costa Rica through Mexico and all Caribbean Countries

Date: MAY 1 1989

To: See DISTRIBUTION:

This is a follow-up on my memorandum of March 20. Your comments and suggestions have for the most part been included in the suggested schedule. A shortened treatment for mangoes other than "Francis" has also been included.

Suggested schedule:

M390 PPQ Treatment Manual Section V

T102 (c) Mango
(5) Hot Water Dip

(5) Hot Water Dip

(i) Treatment for "Francis" and similar shaped varieties of mangoes ("Manila" type elongate flattened) from the West Indies West Indies for Anastrepha spp.

Treat fruit no larger than size 10 (10 fruits comprise a 12 pound net weight package). Each mango must be no larger than 570 grams in weight.

All fruit must be 21.1 °C (70 °F) or above before treatment.

Submerge fruit at least 4 inches under the surface of the water at: 46.1 °C (115.0 °F) for 75 minutes. (Lower limit of 45.4 °C (113.8 °F)). The aggregate time of temperatures between 45.4 °C (113.8 °F) and 46.1 °C (115 °F) may not exceed 10 minutes of the total treatment time.

or

Treat fruit no larger than size 13 (13 fruits comprise a 11 pound net weight package). Each mango must be no larger than 400 grams in weight.

Submerge fruit at least 4 inches under the surface of the water at: 46.1 °C (115.0 °F) for 65 minutes. (Lower limit of 45.4 °C (113.8 °F)). The aggregate time of temperatures between 45.4 °C (113.8 °F) and 46.1 °C (115 °F) may not exceed 10 minutes of the total treatment time.

(ii) Treatment for all mango varieties from Central America north of and including Costa Rica for Ceratitis capitata and Anastrepha spp., and for mango varieties other than "Francis" or similar varieties from the West Indies.

See DISTRIBUTION

Treat fruit no larger than size 8 (8 fruits comprise an 11 pound net weight package). Each mango must be no larger than 700 grams in weight.

All fruit must be 21.1 °C (70 °F) or above before treatment.

Submerge fruit at least 4 inches under the water surface at 46.1 °C (115 °F) for 90 minutes. Water temperature will be no less than 45.4 °C (113.8 °F). The aggregate time the water may be at temperatures between 45.4 °C (113.8 °F) and 46.1 °C (115.0 °F) may not exceed 15 minutes of the total treatment time.

or

Treat fruit no larger than size 12 (12 fruits comprise an 11 pound net weight package). Each mango must be no larger than 500 grams in weight.

All fruit must be at 21.1 °C (70 °F) or above before treatment.

Submerge fruit at least 4 inches under the water surface at 46.1 °C (115 °F) for 75 minutes. Water temperature will be no less than 45.4 °C (113.8 °F). The aggregate time the water may be at temperatures between 45.4 °C (113.8 °F) and 46.1 °C (115.0 °F) may not exceed 10 minutes of the total treatment time.

Changed items include (1) The removal of the reference to the "Carrot" type mango, which is now included in "Francis" type schedule, lowering of treatment temperature of Haiti (now West Indies) treatment to 115.0 °F from 115.5 °F. Data were acquired at 115.0 °F and the treatment is reported to be efficacious at that temperature by ARS. (2) Inclusion of a 65-minute treatment for Caribbean mangoes smaller than 400 g. (size 14). Inclusion of all of Central America north of but excluding Panama in the former Mexican schedule. (3) Inclusion of a 75-minute treatment for "all other" varieties of mango. The changes that should be especially noted are the 65 or 75 minute schedules for different sized mangoes. (4) Caribbean changed to West Indies to exclude those islands just off South America such as Trinidad.

Please return your comments to me as soon as possible so a work plan for publication can be developed without delay. Thanks.

J. F. Fons
Senior Staff Officer
Plant Protection Methods Development
Science and Technology

DISTRIBUTION:
S. Campbell, IS, Hyattsville, MD
M. Shannon, PPD, Hyattsville, MD
R. Williamson, PPQ, Hyattsville, MD

Section 607(a) Determination
Reimbursable Technical Assistance
by the
U.S. Department of Agriculture, Animal and Plant Health
Inspection Service
to be provided for
Participating Friendly Countries-World Wide

It is hereby determined pursuant to Section 607(a) of the Foreign Assistance Act of 1961 (the Act), as amended, that the provision of technical services by the aforementioned agency of the U.S. Government, in accordance with the requirements set forth below is consistent with, and in furtherance of Part I of the Act and within its limitations.

The U.S. Department of Agriculture is granted Section 607(a) authorization to enable the Animal and Plant Health Inspection Service to continue its ongoing preclearance program in certain countries under which fruits, vegetables, and nursery products are inspected before shipment to the United States. Countries of origin typically are, but not limited to, Argentina, Australia, Belgium, Brazil, Chile, Dominican Republic, France, Haiti, Israel, Japan, Korea, Mexico, Netherlands, New Zealand, and Spain.. The exporting country's national plant protection service must enter into a trust fund agreement to establish a preclearance program.

The U.S. Department of Agriculture is to furnish annual reports of this activity to the Trade and Development Program for the life of the activity being performed. It will also provide confirmed amounts of any follow-on activity performed by U.S. private sector firms or individuals. This Section 607(a) determination is in force for a period of five years, until January 1992.

12-7-87
Date

Director,
Trade and Development Pr...

87/33/WW/04

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Individual Shrink Wrapping: A Technique for Fruit Fly Disinfestation in Tropical Fruits

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Additional index words. *Carica papaya, Mangifera indica, Dacus dorsalis, Drosophila melanogaster*, film wrapping

Abstract. **Papayas (*Carica papaya* L.) that were infested with eggs and first instar larvae of the Oriental fruit fly (*Dacus dorsalis* Hendel) showed a reduction in the number of insects present when the fruits were subsequently wrapped for at least 96 hr with plastic shrink-wrap film. In a related study, individually wrapped mangoes (*Mangifera indica* L.) that were artificially infested with larvae of *Drosophila melanogaster* no longer harbored living larvae when the wrap remained for 72 hr. These studies suggest that further development of individual film wrapping techniques may provide a method for eliminating insect infestation from some edible fruits.**

The exportation of various tropical fruits and vegetables from areas where certain species of fruit flies (Diptera: Tephritidae) are present is restricted because of the possibility that these insect pests may be introduced into the destination markets. For example, Hawaiian-grown papayas cannot be shipped to the mainland United States unless it can be demonstrated that no more than three surviving insects remain after postharvest treatment for each 100,000 originally present, at the 95% level of confidence (9). After the cancellation of ethylene dibromide (EDB) as a postharvest fumigant in the United States (11), alternative postharvest treatments for disinfestation have been sought. Immersion of papayas in hot water at 49C for 20 min kills fruit fly eggs and larvae (1), but this activity is restricted to only the outer 2 to 3 mm of the fruit (9). The two-stage hot water immersion technique that is currently in use for papayas is limited to specific ripening stages of the fruit, and, in some cases, has caused fruit damage (10). Irradiation eliminates fruit fly infestations (4), but the acceptance of this procedure by consumers remains uncertain and the treatment facilities are relatively expensive.

Film wrapping of individual fruits and vegetables is currently being used as a postharvest technique for extending storage life (5). The capability of these shrink wraps to retard ripening appears to depend on the modification of the atmosphere within the fruit. Film wrapping limits the exchange of O_2 and CO_2 and reduces water loss from the fruit. Levels of O_2 inside soft-ripe stage film-wrapped mangoes were shown to be lower than in nonwrapped fruit, with correspondingly higher than ambient levels of CO_2 (12). Similar observations were made with individually wrapped apples (2), bell-peppers (13), and tomatoes (14).

The atmosphere within a shrink-wrapped fruit may also offer a residue-free method of controlling insects that damage harvested crops, in addition to their established role in extending storage life. Decreased levels of O_2 (2% to 5%) in CO_2 atmospheres can cause insect mortality (7). High-CO_2 atmospheres (65%) were shown to be toxic to the eggs, larvae, and pupae of the cigarette beetle (8). We postulated that the modified atmosphere

Table 1. Mean Infestation Index[z] scores for papayas infested with Oriental fruit flies.

Treatment	Score[y]	Time of unwrapping (hr)	Score[y]
Controls (nonwrapped)	4.6	0	4.8
Wrapped on day 1	2.9	48	3.9
Wrapped on day 3	2.8	96	2.1
		120	1.8
		144	1.8
Significance			
Control vs. wrapped	**	Wrapping × time of unwrapping	NS
Day 1 vs. day 3	NS	Linear (time of unwrapping)	**
		Quadratic (time of unwrapping)	

[z]Infestation Index: Live larvae = 5; no larvae present = 3; dead larvae = 1.
[y]Scores are least square means for three trials (10 fruit per treatment combined in each trial).
NS,*,**Nonsignificant or significant at the 5% and 1% levels, respectively.

Received for publication 14 Mar. 1988. Idaho Agricultural Experiment Station contribution no. 87733. We gratefully acknowledge the Cryovac Division, W.R. Grace & Co., Duncan, SC 29334, for providing the L-bar sealer, shrink films, and heating tunnel. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

inside a film-wrapped fruit may also have a bearing on the development and resultant survival of the different stages of the fruit fly. The objectives of this study were to examine the potential of heat-shrinkable polymeric films to kill the immature stages of the Oriental fruit fly in edible fruits and to determine the exposure needed to kill these stages.

Due to mainland United States quarantine restrictions on the importation of the Oriental fruit fly, preliminary studies were conducted in Idaho using the pomace fly [*Drosophila melanogaster* (Diptera: Drosophilidae)] and mangoes imported from Haiti as a model system. Because *Drosophila* is normally a secondary colonizer of decaying fruit, mangoes were damaged with a #1 cork borer (6 mm), artificially infested with first instar larvae placed directly into the fruits, and then shrink-wrapped immediately afterwards. Fruits were wrapped with Cryovac D-955, a cross-linked, 60-gauge polyolefin shrink film (Cryovac Division, W.R. Grace & Co., Duncan, S.C.) using a model 6300 Weldotron L-bar magna lock sealer and model 7001 Weldotron heat tunnel (Weldotron Corp., Piscataway, N.J.). Small holes were made in the bags before shrinking to allow air to escape and ensure uniform shrinkage around the fruit. To determine how long the wrap was necessary to induce larval mortality, the infested mangoes were divided into seven groups of 10 fruit each and then were held at room temperature (24 to 25C) for 0.5, 6, 12, 24, 48, 72, or 96 hr before the wrap was removed. The fruit, after removal of the wraps, was placed in fly-proof cages and examined for infestation or adult emergence 10 days later. Each treatment was replicated three times. Larvae successfully developed to the adult stage in nonwrapped fruits, but none of the insects survived in mangoes that were wrapped for 72 hr or more (Fig. 1). A statistical analysis of the effects of time of wrapping on the infestation was not performed because we were interested only in the elimination of the insects, and intermediate values were not considered to be important.

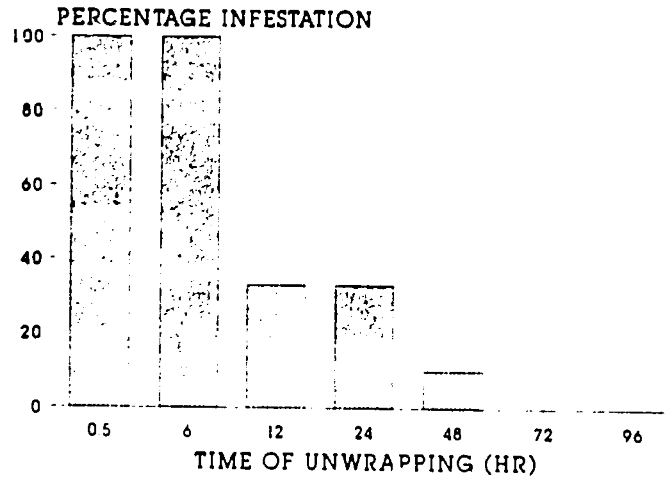

Fig. 1. Percentages of mangoes infested with *Drosophila melanogaster* larvae or that produced adults when shrink-wrapped and then unwrapped at the indicated periods. The three experimental replicates used 84 mangoes.

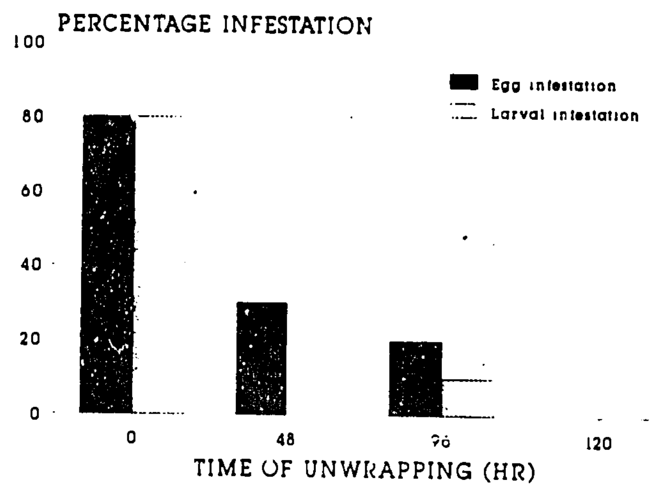

Fig. 2. Percentages of papayas infested with Oriental fruit fly larvae on day 11 after shrink wrapping fruits infested with eggs (solid bars) or with first instar larvae (shaded bars), and unwrapped at the indicated periods. This preliminary experiment used 125 fruit divided among the experimental groups.

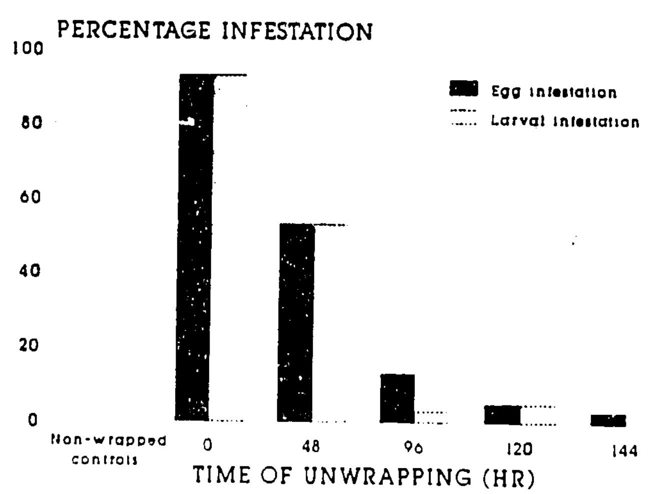

Fig. 3. Percentages of papayas infested with Oriental fruit fly larvae 3 days after unwrapping at the indicated periods. Solid bars indicate infestations in fruit wrapped with eggs present; shaded bars indicate infestations in fruit wrapped with first instar larvae present. The unshaded bar represents the infestation rate in controls infested but not wrapped. Three replications of 120 papayas each are represented.

Once it was determined that *Drosophila* larvae could be killed in shrink-wrapped mangoes, similar trials were performed with the Oriental fruit fly and papayas at the USDA/ARS Tropical Fruit and Vegetable Research Laboratory, Hilo, Hawaii. 'Solo' papayas obtained from a commercial fresh packer were held at 25C until they were about half ripe, a stage appropriate for the female Oriental fruit flies to oviposit (15). The fruits were placed inside an infestation cage containing sexually mature *D. dorsalis* and were exposed for 24 hr, as previously described (16).

The exposed papayas were randomly divided into three groups: Those in the first group were not wrapped and served as controls; in the second group, 50 exposed fruit were wrapped 1 day after infestation, presumably enclosing *Dacus* eggs; in the third group, 50 exposed fruits were wrapped 3 days after exposure, enclosing primarily first instar larvae that developed. In this series of experiments only, pin-holes punched prior to shrinking were covered with cellophane tape after the film wrap was shrunk to tightly fit the fruit. Within each of the latter two groups, there were five subgroups, with 10 fruit each, in which the shrink wrap was removed immediately (0 hr), or at 48, 96, 120, and 144 hr after wrapping. Thus, the groups consisted of fruit that were wrapped while they contained eggs or larvae, and unwrapped after these stages were present under the wrap for certain periods of time. The fruit were held at 27C on fiberglass trays that then were placed in a holding cabinet (3) to prevent reinfestation. Uninfested papayas (10 fruits per replication) were also held in similar cabinets to determine if any natural infestation existed before the start of the experiment. One preliminary test and a larger trial with three replications were conducted.

In the preliminary test, except for the method of infestation, we followed the same protocol as with *Drosophila*, and, on day 11 after wrapping, determined the percentage of papayas that still harbored a *Dacus* infestation after being wrapped for various times. About 80% of the papayas that were infested, wrapped, and then immediately unwrapped, harbored living larvae 11 days later (Fig. 2). However, when the wrap was present for 120 hr, all eggs and larvae were killed. Because we were interested in the complete elimination of the infestation, and not on the relative effects of intermediate times, we did not perform a statistical analysis on these data.

In subsequent tests, the fruit were examined for insect infestation 3 days after unwrapping at each of the time periods. Nonwrapped controls were scored on the day of the first scoring. Because, in some cases, not all fruit were initially infested, a point scoring system was designed to statistically account for all the fruit in a sampling unit, and data were reported both as an Infestation Index (Table 1) and as the percentage of fruit infested (Fig. 3). Fruits found to have live larvae were given a score of 5; a score of 3 if the fruit contained no larvae at all, neither live or dead; and 1 if the fruit contained dead larvae and/or unhatched eggs. Mean scores from each sampling unit were analyzed using a general linear model for unbalanced data.

Noninfested controls did not show any infestation, indicating an absence of natural infestation at the start of the experiment. However, nonwrapped infested controls in all three replications showed a high Infestation Index that was significantly different from other treatments (Table 1), and larvae within them successfully completed development to the pupal stage. Percentage infestations in each sampling unit of three replications ranged from ≈90% at 0 hr of unwrapping to <5% after 144 hr (Fig. 3). Eggs and first instar larvae survived when the wrap was present for <48 hr, but there was a significant decline in the percent survival of the larvae after 96 hr. The infestations observed after 96 hr were, in every case, due to small holes resulting from incorrect sealing that were present in the wrap of those particular fruits. This suggests that the wrap must be completely intact to ensure that all eggs and larvae are killed. Comparisons between the least square means of the Infestation Index scores (Table 1) indicated highly significant ($P > 0.0001$) differences within the main treatment as well as with the length of time the fruit were wrapped.

The effects of the shrink wrap on larval feeding and movement were immediate for both *Drosophila* and *Dacus*. Larvae within the wrapped fruit began to crawl to the surface within 30 min of wrapping, and became immobile, concentrating in the space between the plastic wrap and the fruit. The larvae remained there and died if the wrap remained for more than 96 hr; they regained their activity if the fruits were unwrapped at 48 hr or less. Comparisons of the mean Infestation Index scores among the wrapped treatments show high scores when fruits were unwrapped at 0 and 48 hr and significantly lower scores when unwrapped for 96 hr and beyond (Table 1).

Our study suggests that shrink wrap may create an environment in the wrapped fruits that can affect the survival of insect eggs and larvae, which may be a result of the accumulation or depletion of certain gases and volatile compounds inside the fruit. The precise mode of action of the shrink wrap on the death of *D. dorsalis* and *D. melanogaster* is unknown, but preliminary results from tests using other films suggest that the interaction between the fruit and the selective permeabilities of the individual wrap are important. High CO_2 levels are commonly used as a laboratory anesthetic for insects, and can be toxic when exposure time is prolonged (7, 8). Recent studies using controlled atmosphere glass jars have demonstrated that increased levels of CO_2 (20% to 80%) are toxic to the egg and larvae of the Caribbean fruit fly (6). Increased levels of CO_2 and depleted levels of O_2 have been demonstrated to occur in shrink-wrapped fruit (2, 12, 13). Preliminary investigations with 'Solo' papayas that were individually wrapped in Cryovac D-955 found that levels of CO_2 inside the fruit had increased by 29% over the nonwrapped controls after 24 hr (J.K. Fellman, personal communication). The effect of heat associated with the wrapping procedure was negligible as a source of insect mortality; internal measurements of papayas before and after wrapping showed a temperature increase at the surface of only 1C. Certainly, further study is required to examine the precise cause of insect death under the shrink wrap. So far, our findings are limited to papayas and mangoes, the shrink film Cryovac D-955, and the Oriental fruit fly and *Drosophila*. The efficacy of such a procedure must ultimately be tested using other fruits, appropriate shrink films, and related pests. We believe that with improvements in wrapping and additional data, the more traditional role of shrink wrapping for extending shelf life may be expanded to replace or supplement existing quarantine methods for fruit fly control.

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Exotic fruit fly pests and California agriculture

James R. Carey ☐ Robert V. Dowell

Because of their worldwide distribution and numbers, future introductions of fruit flies into California are inevitable. Infestations of economically important pests, including but not limited to the medfly, Mexican fruit fly, and oriental fruit fly, are expensive to treat, and their elimination is seldom certain. Researchers are seeking to improve detection and control methods.

The frequency of pest fruit fly introductions into the state is on the increase. From the time when records were first kept in the middle of last century until the mid-1980s, eight exotic, or non-native, species were captured, including the Mediterranean fruit fly (medfly), Mexican fruit fly, and oriental fruit fly. In 1987 alone, nine species of fruit flies were captured, three of which had never before been recovered. One of these—an Asian species related to the oriental fruit fly—had never been described by fruit fly taxonomists. That summer the California Department of Food and Agriculture (CDFA) initiated separate eradication programs on five species: the apple maggot, melon fly, medfly, peach fruit fly, and oriental fruit fly. The medfly has been recovered in the state seven times since 1982, when it was eradicated in Santa Clara County.

The 1980-82 eradication campaign against the medfly marked the beginning of a new era in fruit fly research and in the CDFA's detection, quarantine, and eradication protocols. There was a public outcry against chemical sprays, and growers became concerned over the possible permanent establishment of exotic fruit fly pests. Although there were and are no certain solutions, there has been progress on understanding fruit fly biology and ecology as well as advances in control and detection techniques, technologies, and strategies.

Establishment of a major fruit fly pest such as the medfly in California would have widespread effects on agriculture, because this species and others attack a large variety of high-value crops that are exported. Quarantines imposed by the major importing countries would require disinfestation procedures. These would increase costs 10% to 100%, depending on the fly species and commodities affected. The competitive balance of commodity trade would shift temporarily to other states. But a pest established in California is likely to spread rapidly to other states with similar climates and potential hosts. Because of the adverse effects such establishment would have on the U.S. agricultural economy, eradication programs are mandated by the federal government.

This article reviews the status of pest fruit flies in California agriculture. It includes general information on fruit fly ecology and biology and the state of basic and applied research.

Worldwide distribution

Virtually all pest fruit flies are in the dipteran family Tephritidae, whose members are known as the "true" fruit flies. They differ from the more common *Drosophila* species in that adults are relatively large (typically larger than house flies), and females tend to lay eggs in mature rather than in decomposing fruit. About 100 tephritid species are native to California. Most of these feed on flower heads or are gall-formers but do not attack fruit. The walnut husk fly and the apple maggot are the only fruit-attacking tephritids established in the state, having been introduced in the early 1920s and 1980s, respectively.

Most tephritids of economic importance fall into four genera: *Ceratitis*, *Anastrepha*, *Dacus*, and *Rhagoletis*.

The genus *Ceratitis* is one of the best known because of the notoriety of one of its members—the Mediterranean fruit fly. Over 100 *Ceratitis* species have been described, of which six are known pests. The genus is thought to have evolved in Africa, and most species are distributed in regions with Mediterranean climates.

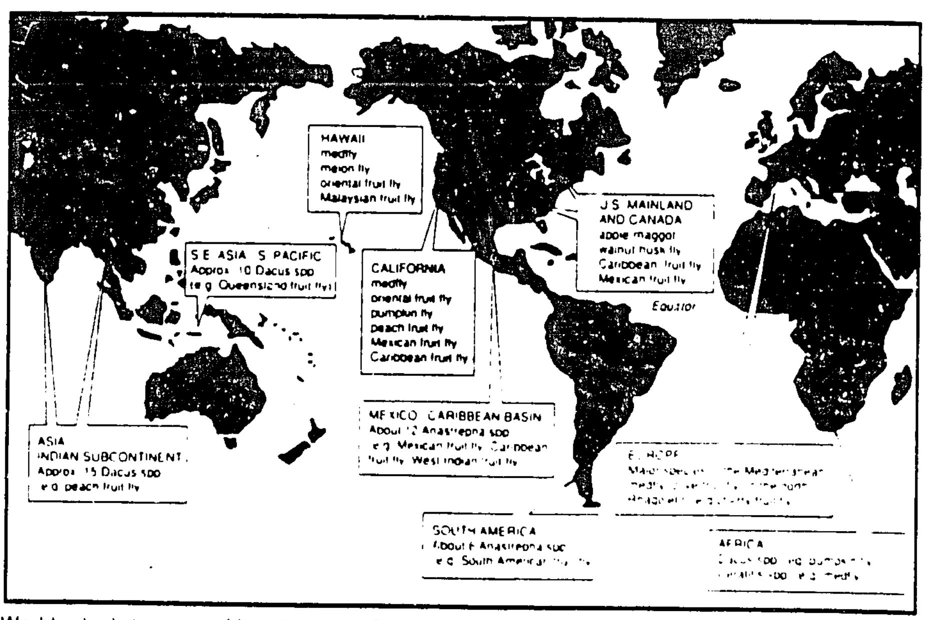
Anastrepha includes 150 to 200 species native to the Caribbean, Mexico, and Central and South America. Two species are now present in the southern United States, through either natural spread or introduction by humans—the Mexican fruit fly in southern Texas and the Caribbean fruit fly in Florida.

Of the approximately 500 *Dacus* species, 30 to 40 are known or potential pests, including the oriental fruit fly, the melon fly, and the Malaysian fruit fly. With the exception of the olive fruit fly found in Europe, most members of this genus are tropical or subtropical and native to Africa, Asia, Australia, and the South Pacific. A close relative of the oriental fruit fly is currently established in the South American country of Surinam.

Around 50 *Rhagoletis* species have been described. Most are widely distributed over the temperate and subtropical regions. These species have only one to two generations per year and tend to attack a narrow range of fruit species. The walnut husk fly and the apple maggot are two of the better known pests in this genus.

Host relations

Fruit flies have evolved to exploit virtually every type of fruit and vegetable found any place in the world. Some species, such as the apple maggot and papaya fruit fly, are highly specialized and attack only one host species or a narrow range of closely related



Worldwide distribution of fruit fly pests. Species listed for California are examples of recent introductions that have subsequently been eradicated ones. Other species attack a wide variety of hosts; these "generalists" include the West Indian fruit fly, the medfly, the Mexican fruit fly, and the oriental fruit fly. Some species attack extremely large hosts; for example, the jack fruit fly, a specialist from Southeast Asia, attacks jack fruit weighing several hundred pounds. Others, such as the medfly, may choose small hosts like coffee cherries that only contain enough food resources for one to three larvae to mature.

No fruit fly species have ovipositors adapted to directly penetrate thick citrus rinds, such as those on citron, or fruit with hard skins, such as pomegranates or avocados. These hard- or thick-skinned hosts are not immune to attack, however, because fruit fly females are usually able to find cracks or soft spots in the host for laying eggs. As a result, even marginal hosts are subject to the same quarantine regulations as more favorable ones.

Movement

Pest fruit flies may enter California by either "jump dispersal" or simple diffusion.

The first refers to movement across long distances in a short time, usually across inhospitable areas such as oceans or deserts. This method of entry is the most serious threat, in part because of its unpredictability. For example, infested fruit may be brought into the state in the mail, by road or railroad, and by air. Air travelers from overseas are among the greatest potential sources of infestations, because (1) fruits and vegetables carried by airplane passengers are often still fresh when they enter the state, so that fruit flies are able to survive, and (2) the sheer numbers of travelers place a heavy load on regulation at ports of entry. For example, in 1987 nearly 7 million air passengers entered California through the Los Angeles International Airport, over a million of whom arrived from Hawaii—a state with four serious pest species. If, as a purely hypothetical number, one passenger in a thousand carried fresh fruit, 7,000 could have been brought in during 1987 alone.

In simple diffusion, fruit fly populations move gradually across hospitable terrain over many generations. For example, the Mexican fruit fly or related species may eventually enter the state near San Diego. Movement of the apple maggot through diffusion from Oregon may partly account for its establishment in northern California.

Climatic requirements

There was controversy during the 1980-82 medfly eradication campaign over whether the medfly could survive the winter in the northern part of the state. Some people maintained that the population might die out naturally even without an eradication program. Part of the problem was that the results of laboratory temperature studies were extrapolated to the natural environment. Many involved in the program ignored the results of long-term studies of the medfly as an introduced pest in other regions of the world. The medfly occurs in regions with climates similar to three of the four major climatic zones in California: climates in most parts of the Sacramento Valley and the coastal regions are classified as Mediterranean, similar to those of Greece and Italy; parts of the San Joaquin Valley near Fresno have climates classified as steppe, similar to many parts of North Africa such as Tunisia; the climate near Barstow and Imperial is classified as hot desert like many parts of Middle Eastern countries such as Egypt and Israel. The medfly abounds in all of those countries.

A number of countries with other serious fruit fly pests have climates similar to those in California. For example, three major pests—the peach fruit fly, the melon fly, and the Ethiopian fruit fly—occur in Pakistan, many parts of which are hot and dry like California's Central Valley. The peach fruit fly and melon fly have both been recovered previously in California.

Irrigation complicates the picture, because it allows the production of crops that would not ordinarily grow in the state. Fruit fly species that specialize in these hosts may or may not be able to survive the climate, but one of the basic conditions is met—host plant availability.

Effect on agriculture

Fruit flies affect agriculture both directly through larval damage to the crop and indirectly through quarantine restrictions. In many parts of the world, fruit flies destroy 100% of the crop. For example, star fruit is a profitable export for Malaysia, but oriental fruit flies destroy every fruit not protected with paper bags. Virtually all unprotected mature peaches grown in backyards in Hawaii become infested with fruit flies.

The quarantine restrictions placed on commodities because of the presence of fruit flies are perhaps even more important. Major markets in other parts of the United States, such as Florida, Arizona, and Texas, and other countries, such as Japan, either totally restrict affected imports or require post-harvest disinfestation treatments.

California crops susceptible to fruit fly infestations are valued at over $4.5 billion and include stone fruit, citrus, safflower, and nuts. Several aspects of this situation merit comment. First, almost every major crop in the state is subject to attack by one or more species. For example, cotton is not noted to be a prime host for any species, but it could serve as a marginal host in the absence of more favorable hosts for fruit fly species such as the Ethiopian fruit fly. Second, not all commodities would be affected in the same way or to the same degree. A generalist species such as the medfly would affect stone fruits by direct attack as well as by quarantine measures. Many citrus varieties would be affected more by quarantine. Cotton would probably be only marginally affected by direct damage and not at all by a quarantine. Third, host records represent realized and not potential hosts and are incomplete for most flies. The reason is that human activity often results in new combinations of flies and hosts. The mango, for example, was not a host of the Mexican fruit fly until it was introduced into Mexico and the Americas in the last century from India. Similar situations certainly exist for many California fruit fly hosts, but in this case, the new pest is brought to the host.

We estimate that roughly 80 species of fruit flies found throughout the world are realized or potential threats to California agriculture. They fall into three categories: (1) introduced species that are currently established in the state (walnut husk fly and apple maggot); (2) introduced species that were subsequently eradicated or died out (total of 12 species including the medfly, Mexican fruit fly, and oriental fruit fly); and (3) species that have never been recovered in the state but are thought to have a high probability of establishment if introduced (including species found in dry, hot summer climates such the Ethiopian fruit fly.

Species not considered serious threats include ones such as the olive fly, whose hosts—raw olives—are seldom carried by air travelers. Species considered unlikely to become established, even if introduced, are those found exclusively in the tropics that specialize in hosts not grown in the state—the papaya fruit fly, for example.

The motive for import restrictions on commodities from an infested region is

Major pest fruit fly species

***Ceratitis*:**
Mediterranean fruit fly, *C. capitata*

***Anastrepha*:**
Mexican fruit fly, *A. ludens*
South American fruit fly, *A. fraterculus*
West Indian fruit fly, *A. obliqua*
Sapote fruit fly, *A. serpentina*
Guava fly, *A. striata*
Caribbean fruit fly, *A. suspensa*
Inga fruit fly, *A. distincta*

***Dacus*:**
Melon fly, *D. cucurbitae*
Ethiopian fruit fly, *D. ciliatus*
Oriental fruit fly, *D. dorsalis*
Malaysian fruit fly, *D. latifrons*
Peach fruit fly, *D. zonatus*
Queensland fruit fly, *D. tryoni*
Olive fly, *D. oleae*
Pumpkin fly, *D. bivittatus*
Chinese citrus fly, *D. citri*
Guava fruit fly, *D. correctus*

***Rhagoletis*:**
Apple maggot fly, *R. pomonella*
European cherry fruit fly, *R. cerasi*
Walnut husk fly, *R. completa*

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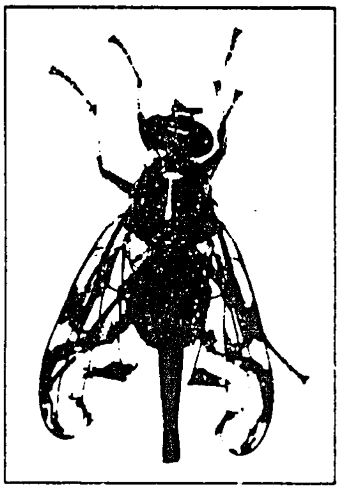
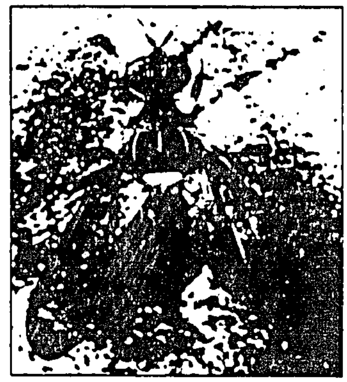


Most major fruit fly pests fall into four genera. Representatives of the four are, from left: Mexican fruit fly (*Anastrepha*), apple maggot fly (*Rhagoletis*), melon fly (*Dacus*), and Mediterranean fruit fly (*Ceratitis*). (Photos by Jack Kelly Clark)



uncertainty about the extent of direct damage that a fruit fly species would cause if it were to become established. This unpredictability extends beyond the obvious cases. For example, melon flies are a more severe pest of tomatoes in Malaysia now than a decade ago because of a trend to grow tomatoes hydroponically. Plants grown by this method tend to have softer, more succulent stems than do plants rooted in soil. Melon flies in Malaysia now attack not only the tomato fruit but also the softened main stem, killing the entire plant. It would have taken a true visionary to have fully anticipated this problem. Similarly unpredictable situations could arise in California with the introduction of certain pest species.

It is also difficult to estimate the seriousness of a pest in its native region to predict how serious it might be if it became established elsewhere. The true pest status of flies is frequently unclear in their native regions. For example, the citrus fly is not a major pest in southern China where citrus orchards are common. But many orchards are sprayed with miticides up to 20 times annually. Without controlled studies, it is impossible to say whether the citrus fly is not a serious pest because of these sprays or for some other reason. Anecdotal information is all that is available for many species.

Detection and eradication

CDFA currently budgets $7 million for fruit fly trapping alone. Three types of traps are used to detect fruit flies: sex lure traps (for medfly, oriental fruit fly, and melon fly); color sticky traps (for apple maggot), and bait traps (for all others including *Anastrepha* spp.). The sex lure traps are the most species-specific but also are sex-specific (mostly males captured). The major shortcoming is the lack of attractants of any kind for a large number of exotic pest fruit fly species.

Eradication strategies are based on the simple premise that the death rate of the target pest must exceed its birth rate for a sustained period. This can be accomplished by increasing deaths, by decreasing births, or by a combination of the two. Basically four tactics are available for controlling or eradicating fruit flies: chemical control, male annihilation, the sterile-insect technique, and parasitoid inundative release.

Chemical control of fruit flies entails applying soil drenches against soil-inhabiting pupae or bait sprays against adults. For the bait sprays, a pesticide such as malathion is mixed with protein hydrolysate and applied by air or by ground rig. Flies are attracted to the bait, feed, and are killed. This approach is more selective than broad-spectrum spraying.

The second method uses a sex lure combined with a pesticide to attract and kill males on contact. If a large enough portion of the male population is killed, females will not find mates and thus will not produce fertile eggs. This method is effective only if a powerful attractant for males is available. It is most commonly used against the oriental fruit fly, which is attracted to an insecticide-laced methyl eugenol lure.

The sterile-insect technique eradicates the target pest through the release of large numbers of sterile flies. It works through direct mating competition between laboratory-sterile males and wild, fertile males for wild, fertile females and through "dilution" of the numbers of wild males. Large numbers of sterile males decrease the proportion of all males that are fertile. It is a nonpolluting technique that is increasingly effective as pest population levels decrease.

Parasitoid inundative release has received only limited attention so far. Massive numbers of parasitoids are required, and technologies for their large-scale production are just now being developed.

Conclusions

Two aspects of the fruit fly problem are fairly predictable: (1) future fruit fly introductions are inevitable because of the worldwide distribution and abundance of large numbers of important species; and (2) the number of introductions is likely to rise as the number of travelers entering the state and commodity imports increase.

Fruit fly eradication programs are constrained technically in the same way as all pest management programs. Progress in detection and control technologies will be almost certainly be made in steps rather than in large technological jumps. Research strategies designed to deal with introduced pests must be tailored accordingly to ensure that no major exotic fruit fly pest becomes established in the state.

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