IAEA

# PANEL ON THE SUSTAINABLE USE OF RADIOACTIVE SOURCES FOR AGRICULTURE, FOOD SECURITY AND HEALTH.

## THE USE OF IONIZING RADIATION TO IMPROVE REGIONAL FRUIT PRODUCTION AND EXPORTS THROUGH MEDITERRANEAN FRUIT FLY PEST CONTROL

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**VIENNA, AUGUST, 21st - 2018**

# INSECT INFESTATIONS – ARTHROPOD INVASIONS

❖**INTERNATIONAL TRADE AND GLOBAL WARMING**. Are two main phenomena leading increased frequency of introductions of the costliest insect invaders (1).

❖**RISING HUMAN POPULATIONS**, movement, migration, wealth and international trade, favor Invasions expansions (1).

❖ **CLIMATE CHANGE PROJECTIONS TO 2050** predict an average increase of 18% in the area of occurrence of current arthropod invaders (1).

❖**INVASIVE INSECTS COST A MINIMUM OF US$70.0 BILLION/YEAR** globally for goods and services (1).

Insect Infestations are a reality and a concern!

# FRUIT FLY INTRODUCTIONS IN THE AMERICAS

PROGRAMA MOSCAMED
LOS FRUTOS DE UN ESFUERZO compartido
SAGARPA MAGA USDA

**Olive Fruit Fly**
California, 1998

**Caribbean Fruit Fly**
Florida, 1965

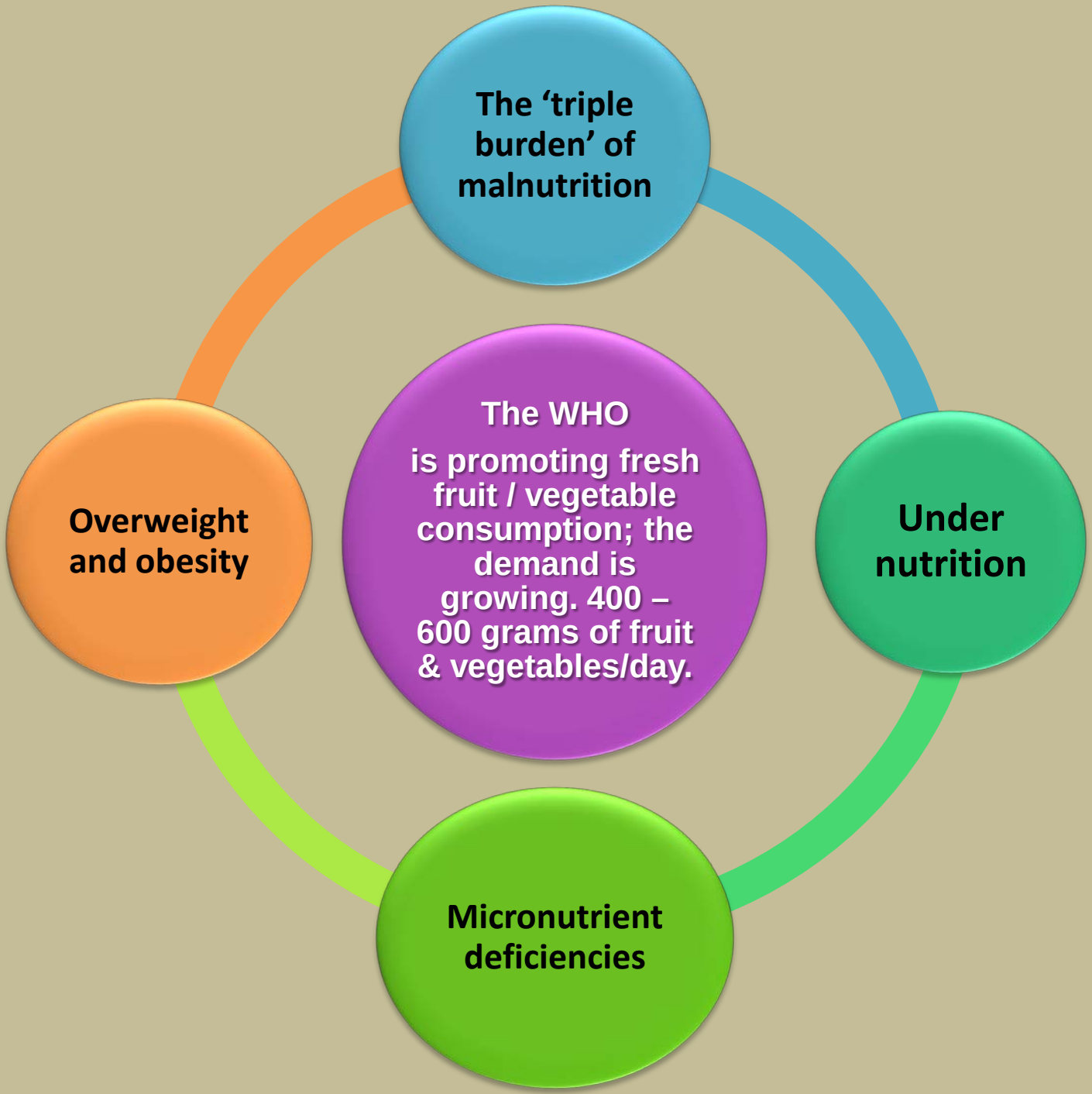
**Mediterranean fruit Fly**
**DR, 2015**

**Mediterranean fruit Fly**
**Costa Rica, 1955, GT, 1975**

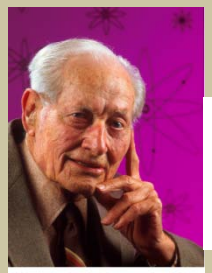
**Carambola Fruit Fly**
Surinam, 1975


**Mediterranean Fruit Fly**
**Brazil, 1901; Peru, 1956 CHILE, 1963.**

❖ Efforts have been made to ***stop the spread of the pest*** and ***avoid production and market losses*** *of the countries involved,* ***by forming a tri-national commission*** **U.S., MEXICO AND GUATEMALA, the REGIONAL PROGRAMA MOSCAMED** to stop the northward movement of the pest.


The ‘triple burden’ of malnutrition
Under nutrition
Micronutrient deficiencies
Overweight and obesity
The WHO
is promoting fresh fruit / vegetable consumption; the demand is growing. 400 – 600 grams of fruit & vegetables/day.

# USE OF IONIZING RADIATION FOR PEST CONTROL




**Knipling E F.** Possibilities of insect control or eradication through the use of sexually sterile males. *J. Econ. Entomol.* **48**:459-62, 1955.
[Entomology Research Branch, Agricultural Research Service, USDA]

*Photo from (2)

- Ionizing radiation and the **Sterile Insect Technique (SIT)** have been used since then for pest control and has allowed successful eradication efforts


- **NEW WORLD SCREWWORM** (*Cochliomyia hominovorax*, Coquerel) eradicated from the United States, Mexico, Central America and Libya.
- **Tsetse fly** from Zanzibar.
- **Melon fly** (*Bactrocera cucurbitae*, Coquillett) from Japan.
- **Mexican fruit fly** (*Anastrepha ludens,* Loew) eradicated from most of northern Mexico.
- **RECENT ERADICATION OF Mediterranean fruit fly** (*Ceratitis capitata ,* Wied.) from the Dominican Republic.

**SIT - ENVIRONMENTALLY FRIENDLY PEST CONTROL TECHNOLOGY**

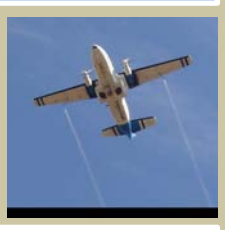
# ACTIVITIES - PART OF AN INTEGRATED PEST MANAGEMENT (IPM)

**DETECTION TRAPPING**

**DETECTION - SAMPLING**

**GROUND SPRAYS**

**AERIAL SPRAYS**



**MECHANICAL CONTROL**

**LEGAL CONTROL QUARANTINE STATIONS**

**AUTOCIDAL CONTROL**

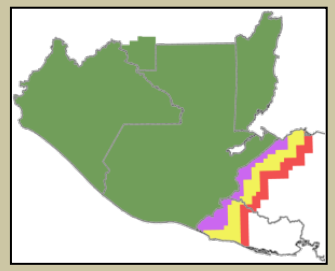
**COMMUNICATION**

**COMMUNITY WORK**

**APICULTURE**

PROGRAMA MOSCAMED
LOS FRUTOS DE UN ESFUERZO compartido
SAGARPA MAGA USDA

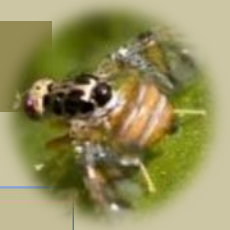
## RESULTS

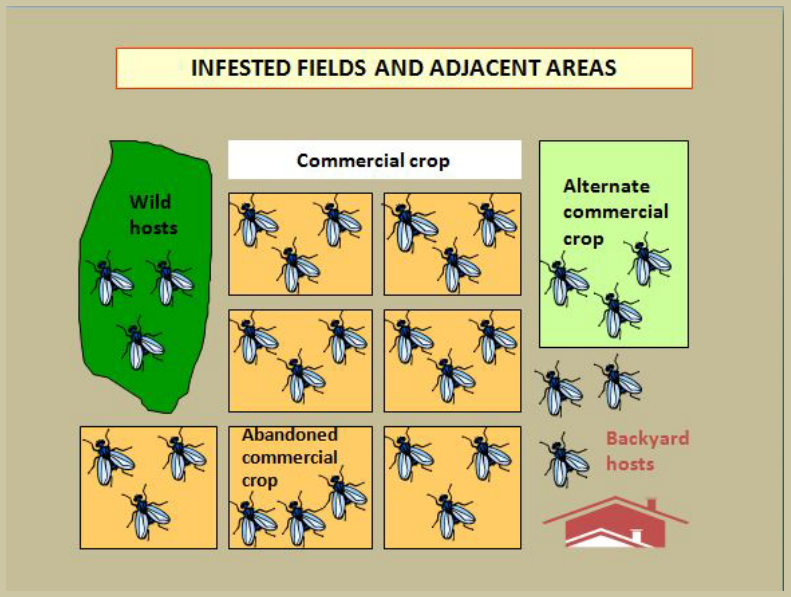


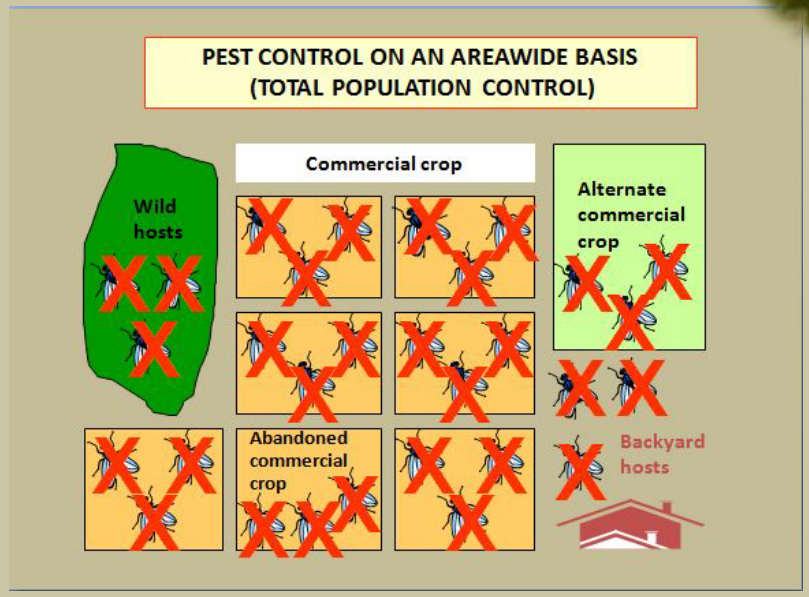
## DIGITAL PLATFORM

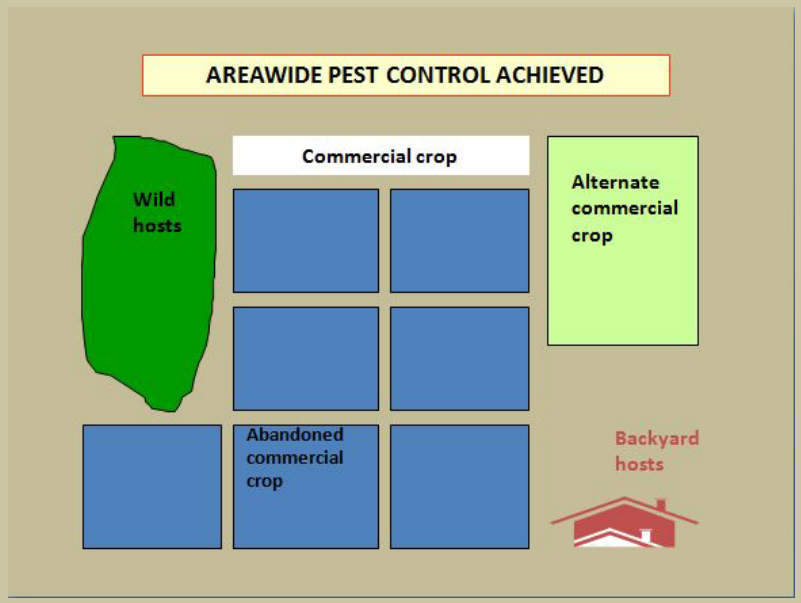
www.moscamed-guatemala.org.gt

# AREAWIDE PEST CONTROL (AW-PC) – IN CONTRAST TO FARM BY FARM



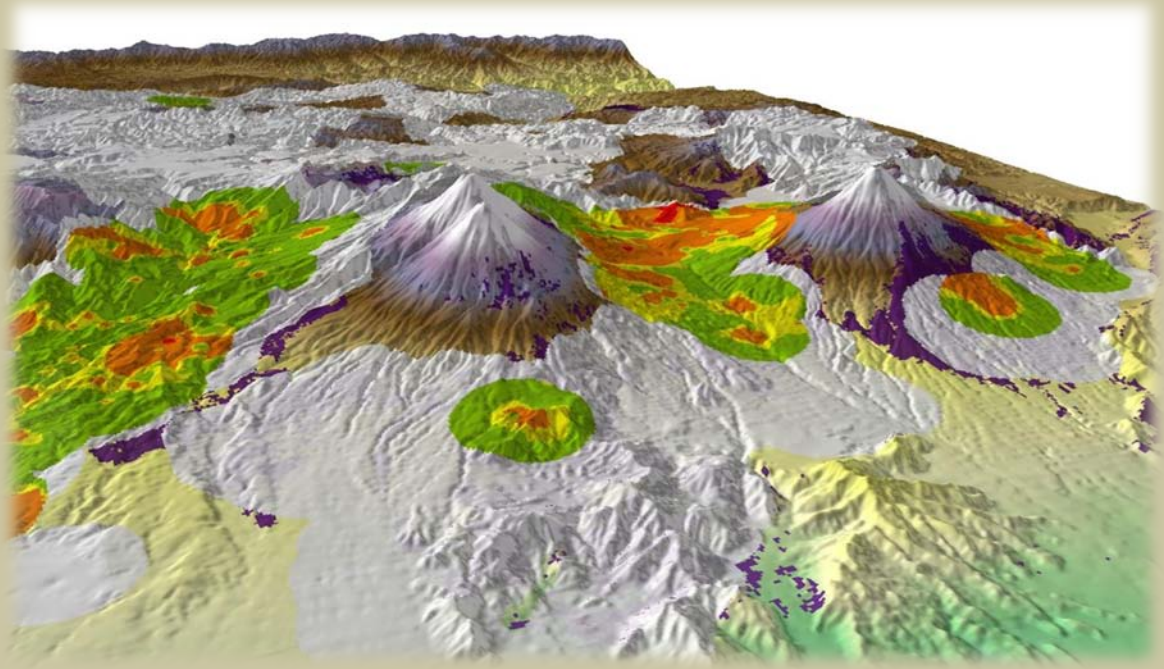



**MORE EFFECTIVE**
**REDUCES COSTS!**

# GEOGRAPHICAL INFORMATION SYSTEM (GIS)



**TRAPPING AND MAPPING OF PEST POPULATION LEVELS TO PROCEED WITH CONTROL ACTIVITIES.**

Flies per trap per day (FTD)

The flies per trap per day is a population index that estimates the average number of flies captured in one trap in one day that the trap is exposed in the field.

Its value is the result of dividing the total number of captured flies by the product obtained from multiplying the total number of serviced traps by the average number of days the traps were exposed. The formula is as follows:

$$F.T.D. = \frac{F}{T \times D}$$

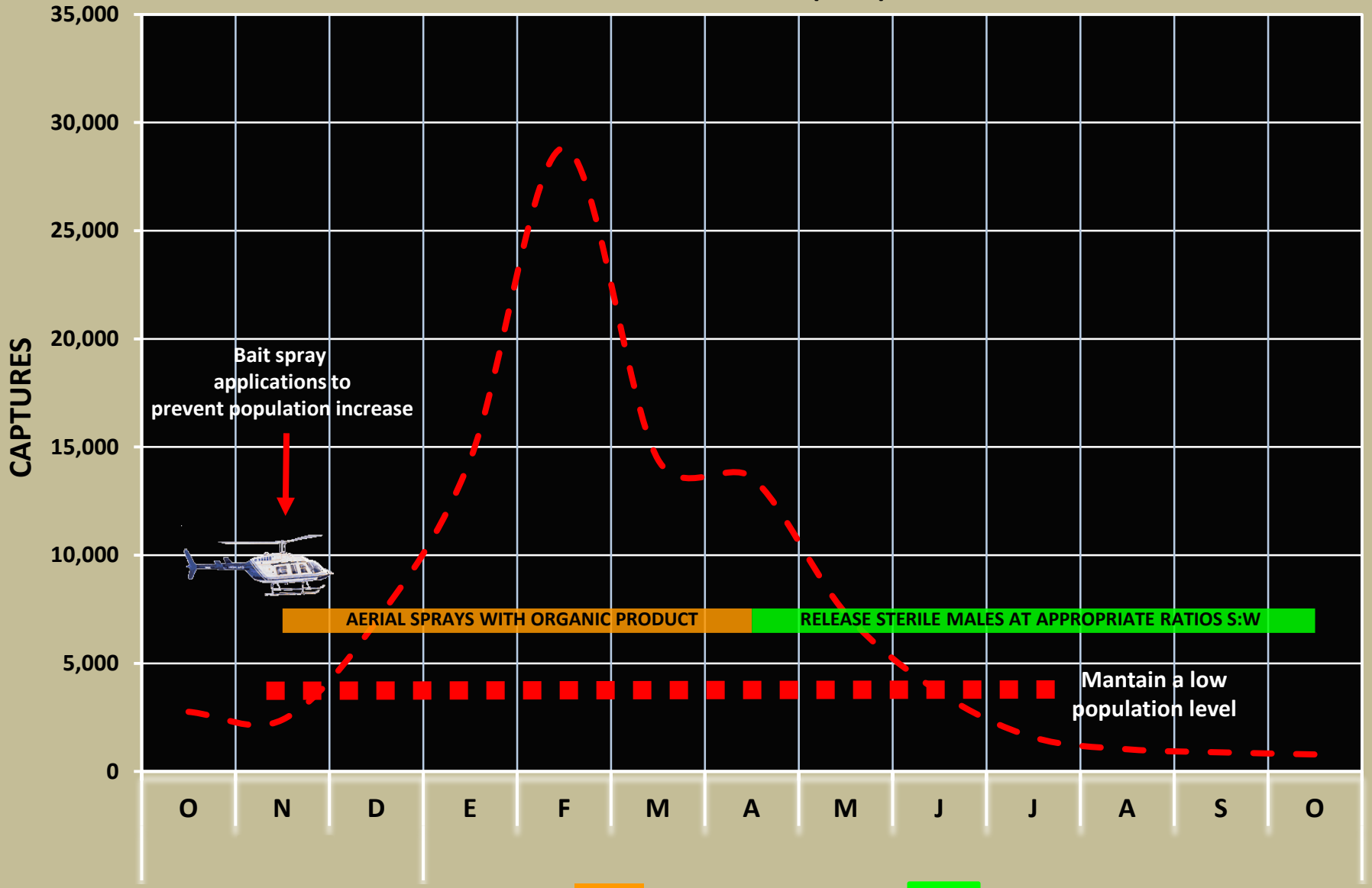
where,

F = Total number of flies
T= Number of serviced traps
D= Average number of days traps were exposed in the field

**FLIES/TRAP/DAY FTD**

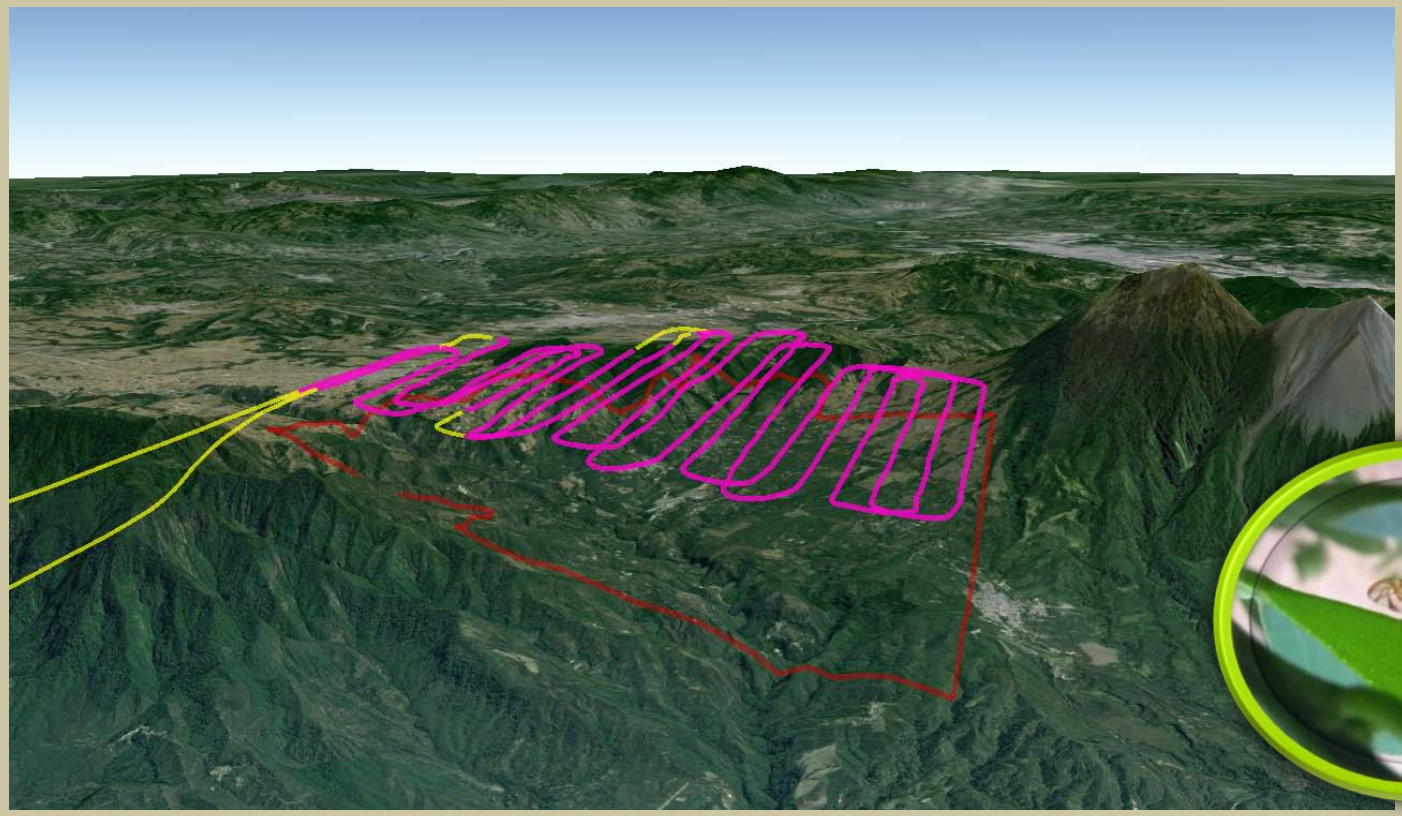
- 0
- (0 - 0.05]
- (0.05 - 0.1]
- (0.1 - 1]
- > 1.0

# HISTORICAL MEDFLY POPULATION GROWTH IN THE COFFEE BELT OF SOUTHWESTERN GUATEMALA. IMPLEMENTED SUPPRESSION STRATEGY AS PART OF THE GRADUAL ADVANCE PLAN (GAP)

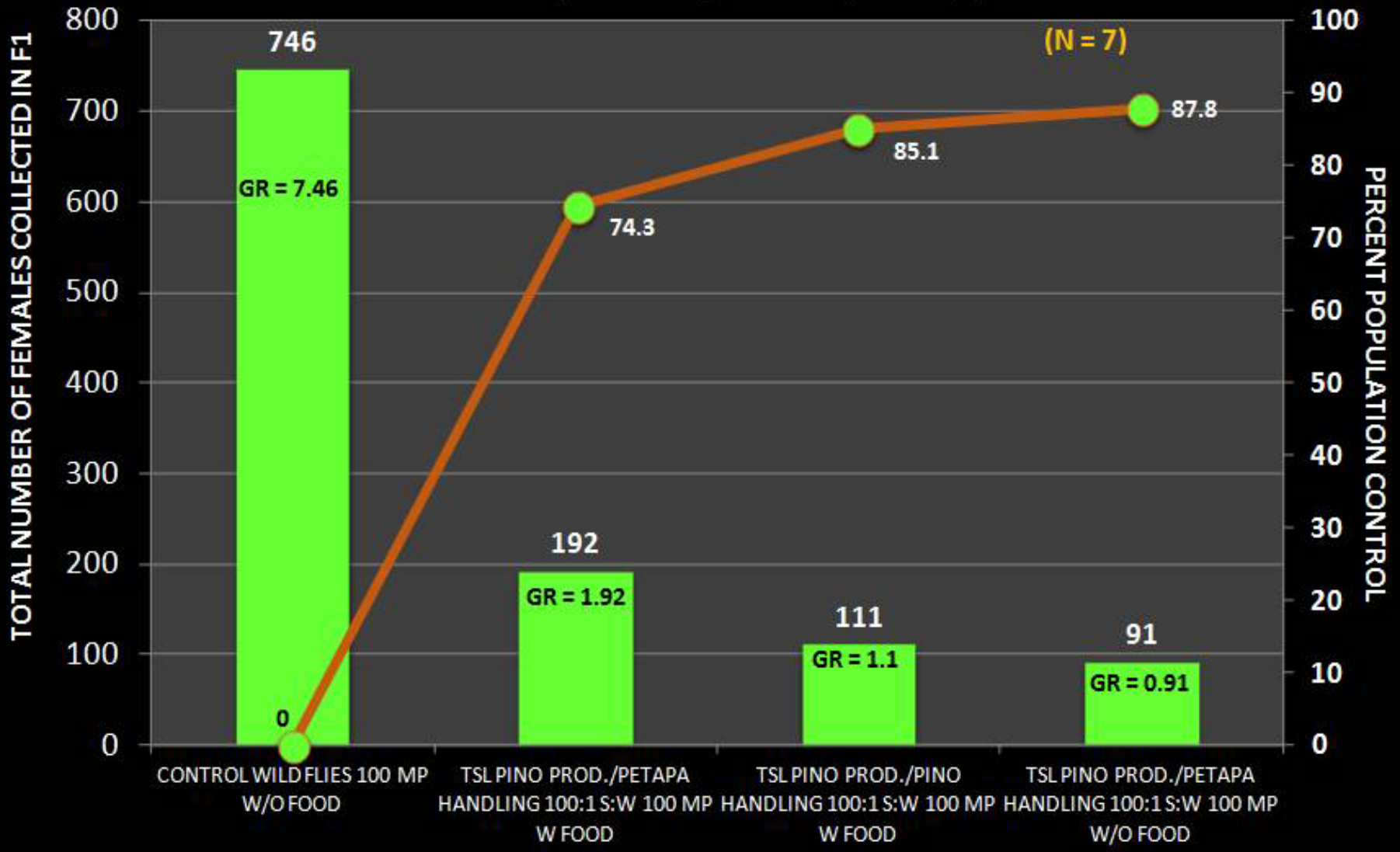


# AREA-WIDE FUIT FLY CONTROL – SPRAYS USING AN ORGANIC PRODUCT


# AERIAL RELEASE OF STERILE MALES

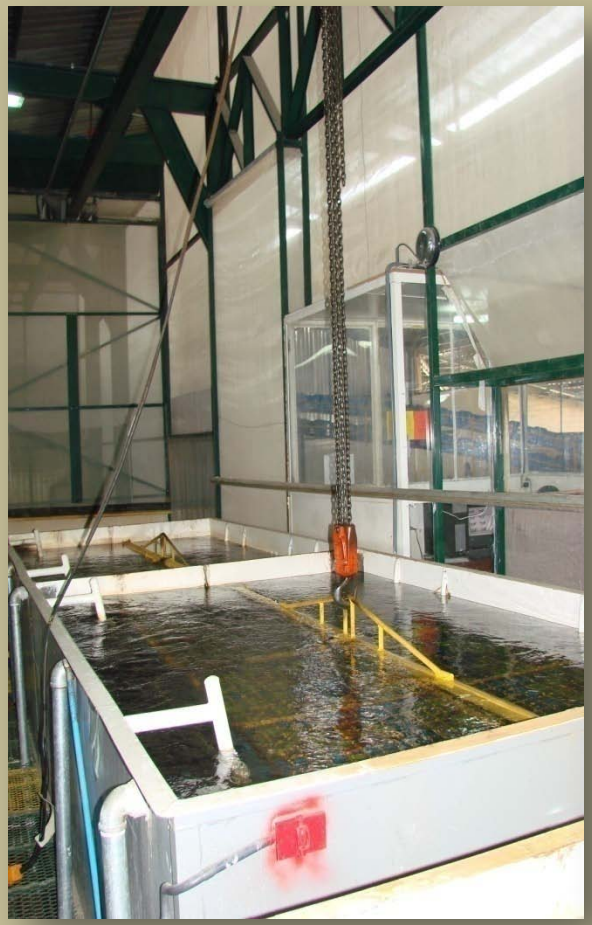
FIELD CAGE EVALUATION OF INDUCTION OF STERILITY OF THE TEMPERATURE SENSITIVE LETHAL TSL STRAIN PRODUCED AT EL PINO MASS REARING FACILITY. LARGE SCREENED CAGES SPLIT IN HALF CONTAINED ONE HUNDRED WILD MATING PAIRS IN EACH CAGE SECTION COMBINED WITH A RATIO OF 100 STERILE MALES PER WILD MALE. TREATMENTS REMAINED ONE WEEK WITHIN THE CAGES TO ALLOW FOR REMATING, PREDATION AND SO ON. GUAVAS WERE USED TO COLLECT FEMALE OVIPOSITIONS. AFTER REARING LARVAE, ADULT FEMALES WERE DETERMINED/TREATMENT TO CONDUCT CALCULATIONS SHOWN HERE. SAN AGUSTIN COFFEE FARM, VILLA NUEVA , GUATEMALA, March - April, 2018



# COST COMPARISON BETWEEN TECHNOLOGIES

| TREATMENT | COST/HA/WEEK IN U.S.$ |
|---|---|
| AERIAL SPRAYS | 17.48 |
| SIT | 1.78 |

# ECONOMIC GROWTH – JOB CREATION AND INCREASED AVAILABILITY OF FRUIT AND VEGETABLES.



# GUATEMALAN FRUIT EXPORTS UNDER PROTOCOLS AND FREE AREAS OF THE MEDITERRANEAN FRUIT FLY


Mango
*Manguifera indica*

Chile
*Cayena Capsicum*

Tomate
*Licopersicum esculentum I.*

Papaya
*Carica papaya*

Fuente: Estadísticas de Comercio General, Exportaciones por inciso arancelario, BANGUAT

# MASS PRODUCTION OF STERILE INSECTS
# EL PINO, GUATEMALA

ISO 9001:2015
CERTIFIED PLANT

CURRENT PRODUCTION
1,200 MILLION STERILE MALES/WK.

SENASICA, MEXICO, NEW METAPA PRODUCTION

MENDOZA, ARGENTINA FACILITY


LA MOLINA, LIMA, PERU.


ARICA, CHILE

# MASS PRODUCTION OF STERILE MALES OF THE MEDITERRANEAN FRUIT FLY

- Based on the production of the Temperature Sensitive Lethal (TSL) genetic sexing strain (GSS) Vienna 8 $^{-\text{ inv D53}}$ of the Mediterranean fruit fly "medfly" *Ceratitis capitata* (Wied).

- The production of the medfly TSL genetic sexing strain is based on a Filter rearing system, which produces mainly males (>99%) for field release.


**MALE PRODUCTION REARING PROCESS**

# MALE PRODUCTION REARING PROCESS
# MEDITERRANEAN FRUIT FLY

1. EGG COLLECTION

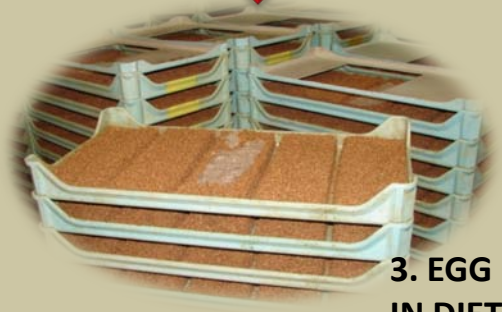
4. LARVAL DEVELOPMENT

7.MARKING AND BAGGING

2. EGG THERMAL TREATMENT

5. LARVAL COLLECTION

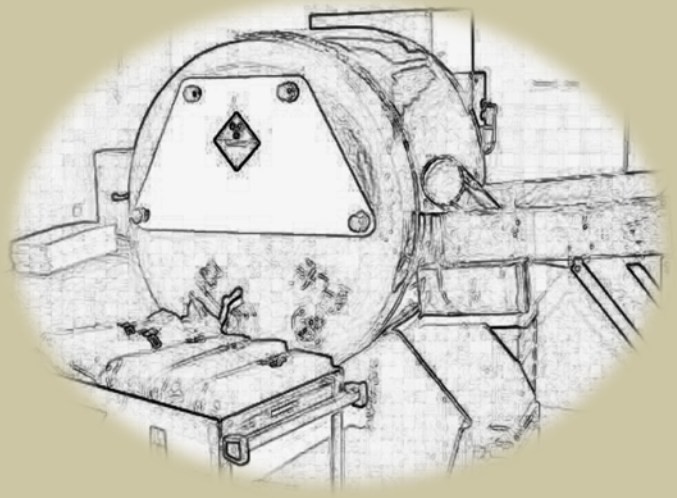
8.IRRADIATION



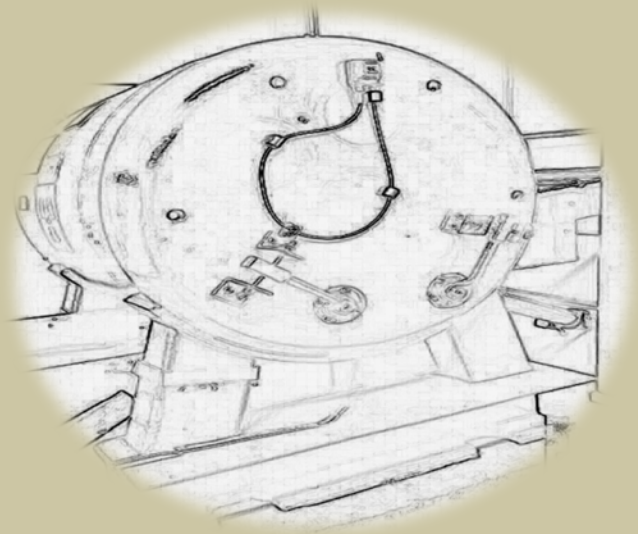
3. EGG SEEDING IN DIET TRAYS

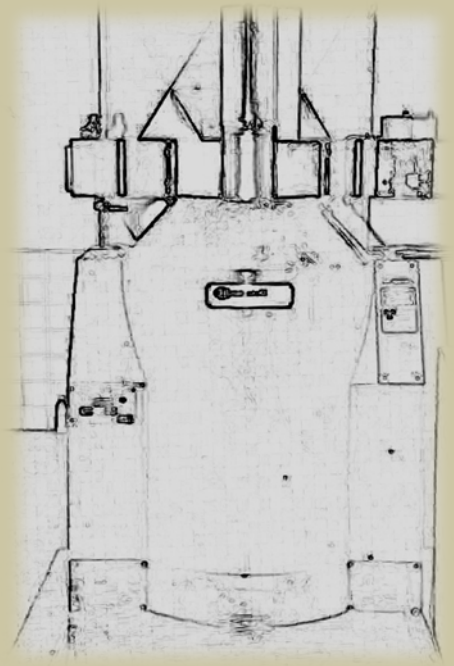
6. PUPATION AREA


9.IRRADIATED PUPAE



# IRRADIATION SOURCE DESIGN
# SELF CONTAINED UNITS





DIRECCION GENERAL DE ENERGIA
DEPARTAMENTO DE PROTECCIÓN Y SEGURIDAD RADIOLÓGICA

24 calle 21-12 zona 12. Tels. 2419-6363 Fax 2476-2007
e-mail proradpe@mem.gob.gt

Por cuanto el Departamento de Protección y Seguridad Radiológica, emitió el Dictamen Técnico No. **DPSR-AI-LT/005/2009**, de fecha: **12 de Mayo de 2009** de acuerdo a Decreto Ley 11-86 y el Reglamento de protección Y Seguridad Radiológica (acuerdo Gubernativo No. 055-2001).

**Otorga**

# LICENCIA DE TRANSPORTE IRRADIADORES AUTOBLINDADOS, TIPO II

**A**

**COMISIÓN MOSCAMED**
**Calle Real 3-69, Zona 9, San Miguel Petapa, Guatemala**
**Teléfono: 2320-2511**
**Ing. Pedro Emilio Velásquez Godínez**

**Lic. Edvin Ariel Gutierrez Martínez**
**Jefe**
**Depto. Protección y Seguridad Radiológica**

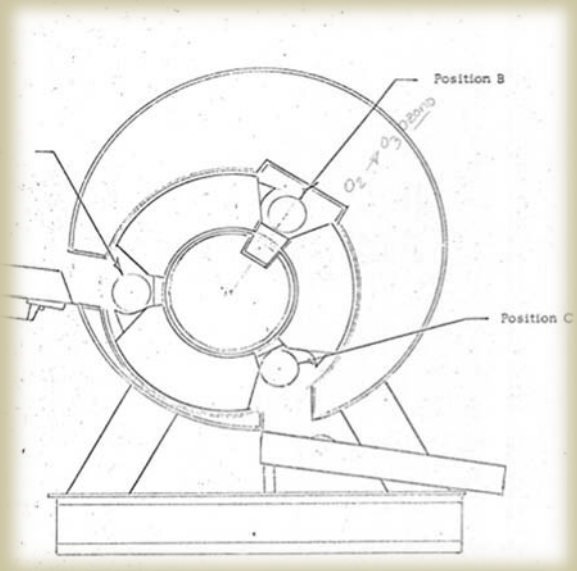
**Ing. Heriberto Arriaga Fion**
**DIRECTOR GENERAL DE ENERGIA**

*MANTENGASE EN LUGAR VISIBLE*

Fecha de Vencimiento: 19 MAYO 2010

# SELF CONTAINED GAMMA RADIATION UNITS AND THE LOCATION OF IRRADIATION CHAMBERS

# LOCATION OF IRRADIATION CHAMBERS

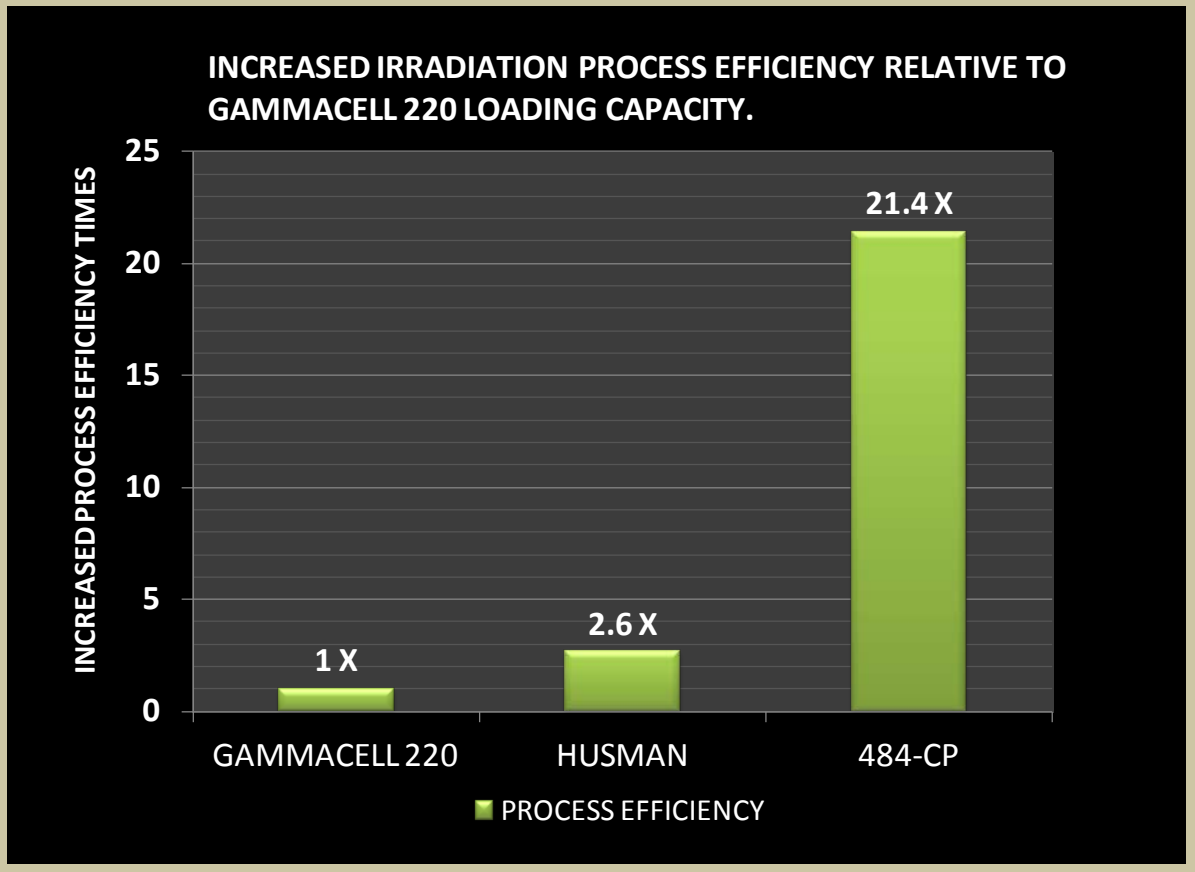



# IRRADIATION SOURCE SIZE AND PRODUCTION CAPACITY

| # | IRRADIATOR MODEL | MEDFLY PUPAE VOLUME IN IRRADIATION CHAMBER |
|---|---|---|
| 1 | GAMACELL 220 | 1.4 LITERS |
| 2 | HUSSMAN | 3.7 LITERS |
| 3 | 484 - CP | 15 LITERS X 2 = 30 LITERS |


OK


OK


INCREASED IRRADIATION PROCESS EFFICIENCY RELATIVE TO GAMMACELL 220 LOADING CAPACITY.
INCREASED PROCESS EFFICIENCY TIMES
25
20
15
10
5
0
1 X
2.6 X
21.4 X
GAMMACELL 220
HUSMAN
484-CP
PROCESS EFFICIENCY

# IRRADIATION SOURCES INITIAL LOADING ACTIVITY

| # | IRRADIATOR MODEL | ISOTOPE | INITIAL ACTIVITY |
|---|---|---|---|
| 1 | GAMACELL 220 | COBALT 60 | 11,500 CURIES |
| 2 | HUSSMAN | CESIUM - 137 | ~42,000 CURIES |
| 3 | 484 - CP | COBALT 60 | 20,000 CURIES |

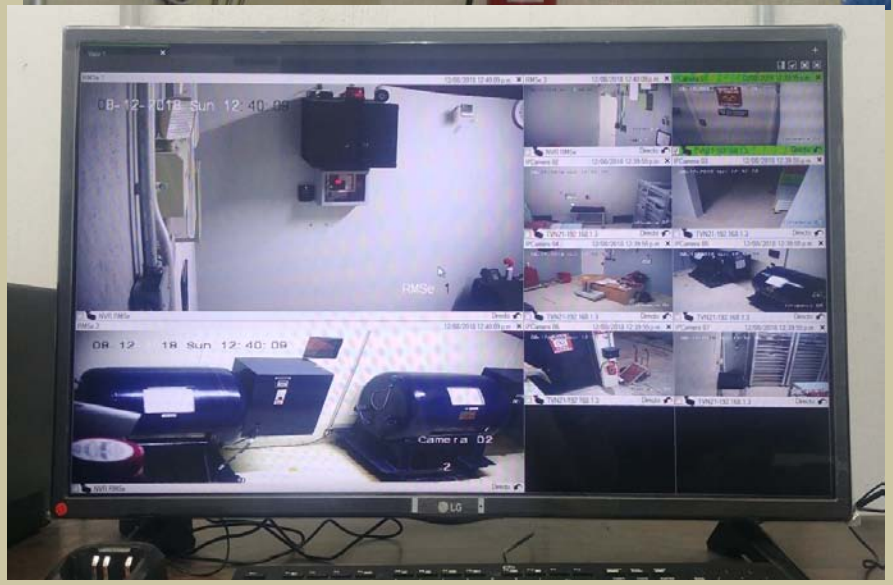
| INSECT SPECIES | REQUIRED IRRADIATION DOSE |
|---|---|
| MEXICAN FRUIT FLY | 80 Gy |
| MEDITERRANEAN FRUIT FLY | 120 – 145 Gy |
| SUGAR CANE BORER | 200 Gy |

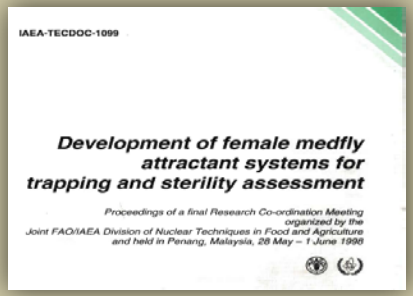
# SELF CONTAINED IRRADIATION SOURCES CHARACTERISTICS

| # | IRRADIATOR MODEL | SELF COINTAIN UNIT WEIGHT |
|---|---|---|
| 1 | GAMACELL 220 | 5K - Kg |
| 2 | HUSSMAN | 5K - Kg |
| 3 | 484 - CP | 8K-Kg |

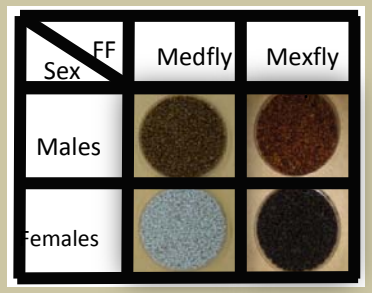
# IRRADIATION SOURCES PHYSICAL SECURITY

# IRRADIATION SOURCES PHYSICAL SECURITY




**Mass-Rearing & Irradiation**



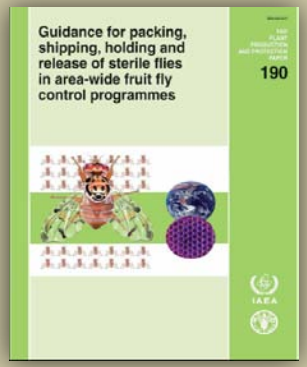


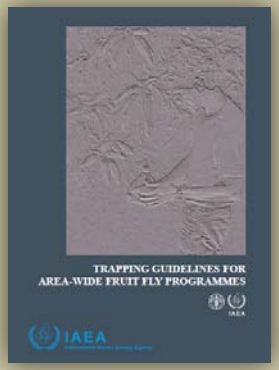

FAO FIAT PANIS

**Joint FAO/IAEA Division**
**of Nuclear Techniques in Food and Agriculture**

IAEA

**With Technology transfer contributions from the FAO/IAEA and Technical cooperation Department technologies relevant to the food security and sustainable development goals of the countries in the region.**



THANK YOU!

# REFERENCES

**1.) BRADSHAW CJA, LEROY B, BELLARD C**, et al. Massive yet grossly underestimated global costs of invasive insects. *Nature Communications*. 2016;7:12986. doi:10.1038/ncomms12986.

**2.) EDWARD F. KNIPLING**, 1909-2000. *A Biographical Memoir* by Perry Adkisson and James Tumlinson. 2003. The National Academies Press, Washington, D.C. Biographical Memoirs, Volume 83.