Sterile Insect Technique (SIT):
Use of Radioactive Sources and Alternative Technologies

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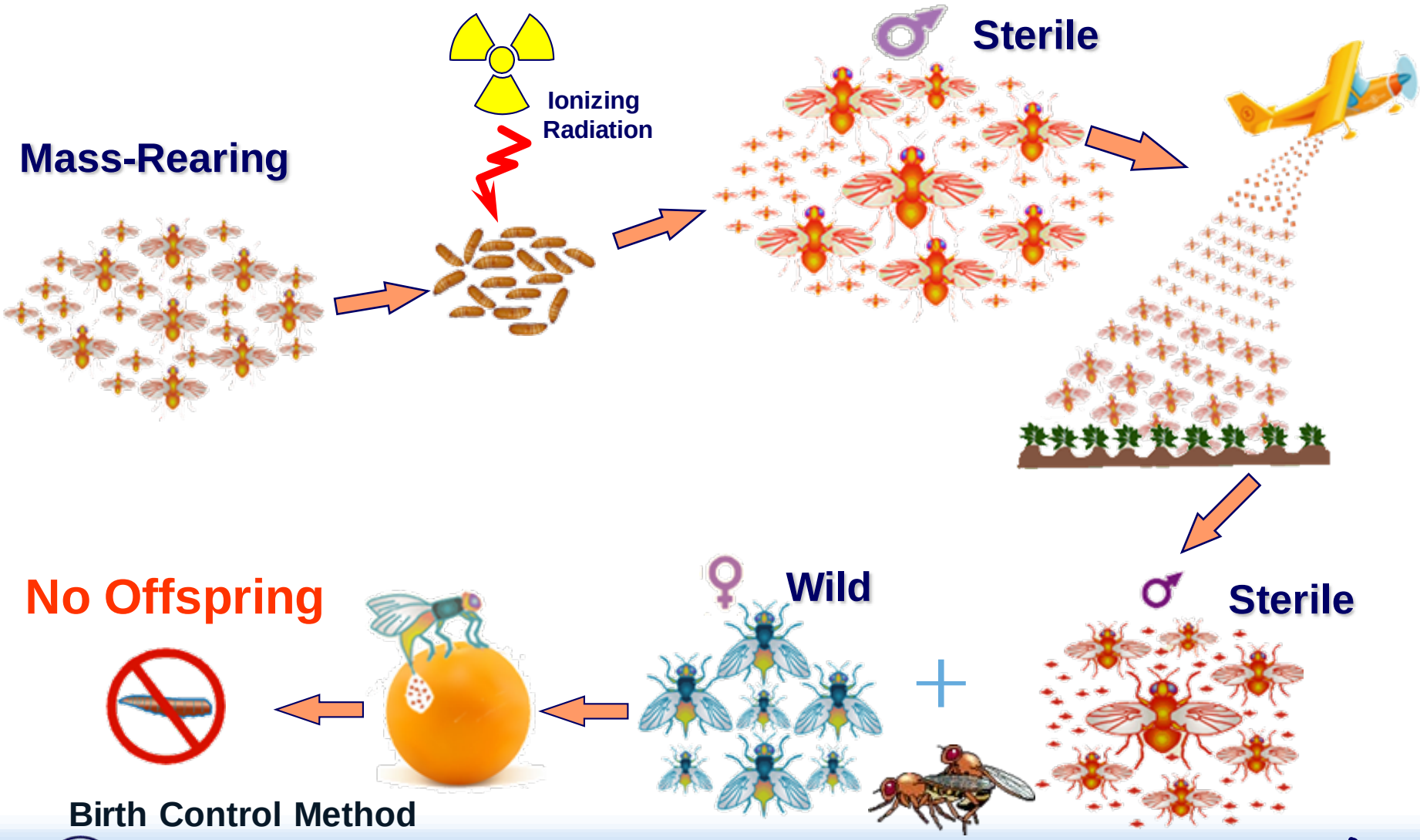
Outline

1. Sterile Insect Technique (SIT)
2. Ongoing operational programmes (and pilot projects)
3. Methods of irradiation
4. Biological evaluation (X vs γ irradiation)
5. Past and future trends
6. Data on SIT and accessibility

Insect pest control by the use of SIT



El Pino, Mediterranean Fruit Fly Facility Moscamed, Guatemala

Production capacity, 3 000 million pupae/week

Sterile Insect Technique (SIT)

1. Plant pests
    a. Fruit flies
    b. Moths

2. Pests of medical and veterinary importance
    a. Mosquitoes
    b. Screwworm
    c. Tsetse flies





Operational Programmes

1. **Fruit flies:**

   USA, Mexico, Guatemala, Dominican Republic**, Ecuador, Argentina, Chile, Peru, Spain, Croatia, Israel, Jordan, Mauritius, Morocco, South Africa, Thailand, Viet Nam, Australia**

2. **Moths:**

   Canada, Chile, South Africa, New Zealand

3. **Tsetse:**

   Senegal, Ethiopia, Chad

4. **Screwworm:**

   Panama, Uruguay, USA

5. **Mosquitoes (pilot projects):**

   China (operational project, SIT/IIT), Singapore, Spain, Italy, Germany, Mauritius, South Africa, Mexico, Brazil, Cuba, USA

Methods of irradiation

- **Standard irradiation for SIT programmes uses ^{60}Co sources (Gamma rays). Issues:**
  - **In case of ^{60}Co, Nordion discontinued production of irradiators**
  - **In addition, shipment of these sources has become difficult (delays and denials)**
  - **X ray are easy to ship with low shipment costs**
  - **Security and liability issues**
  - **Decay over time**
  - **Advantage: reliability**

Gammacell 220, Nordion

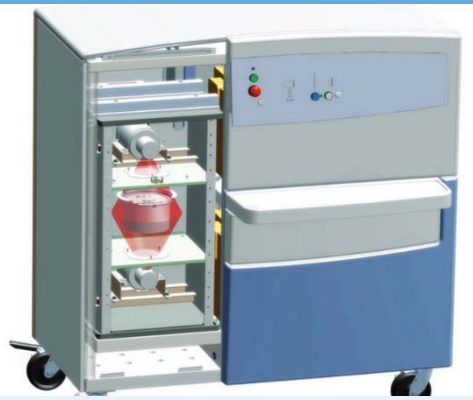
Methods of irradiation
(other than ^{60}Co)

E-beam (Spain)

RHODOTRON® TT200

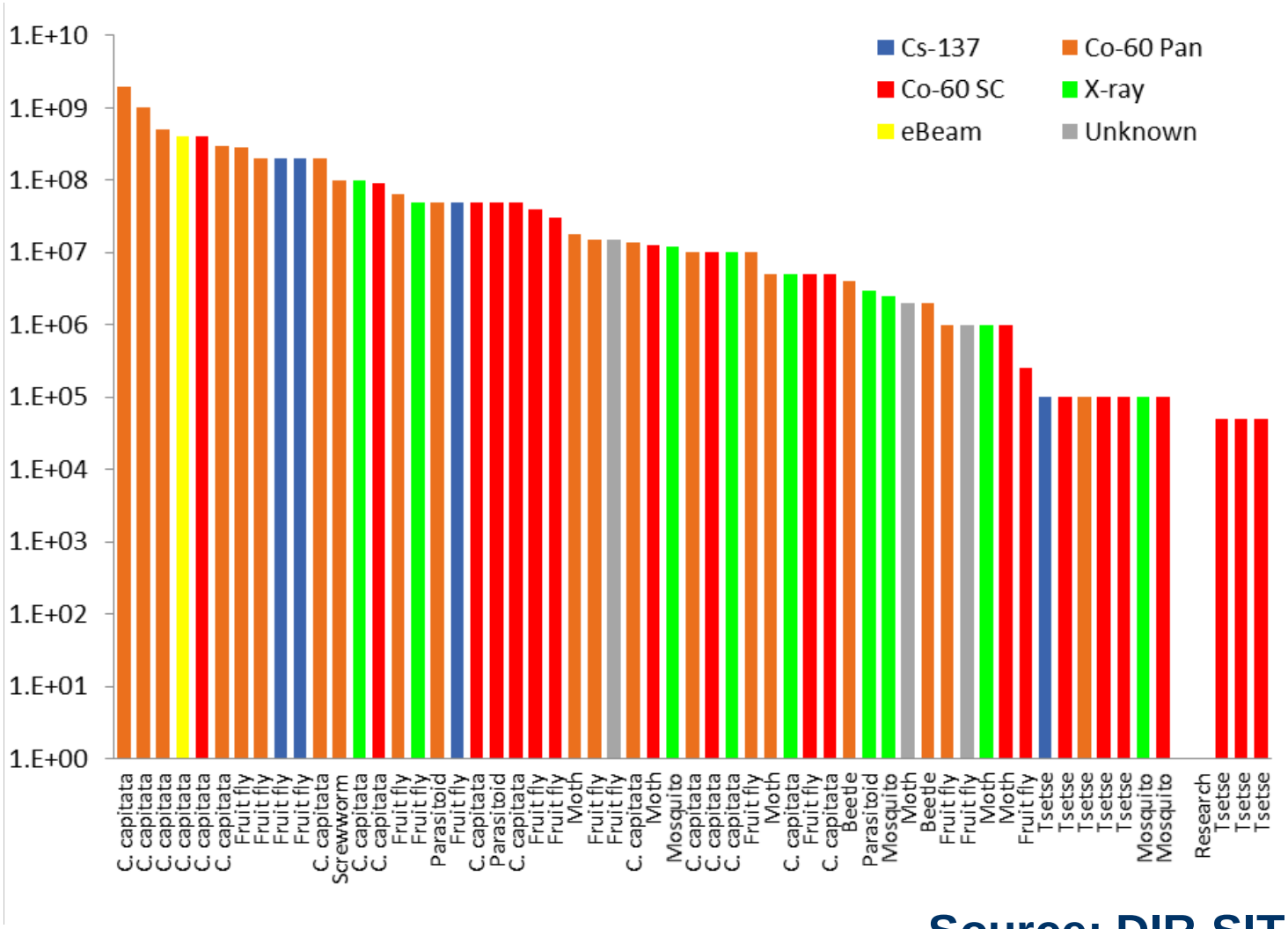
www.ionisos.com

X ray (recently)
Main issue: reliability



Raycell MK2
(Best Theratronics)

Methods of irradiation



Source: DIR-SIT

X ray vs ^{60}Co irradiation

- Early studies conducted with X rays in the early 1950s with screwworm demonstrated the feasibility of using X rays to sterilize insects for SIT proposes (Bushland, 1953)
- Also some recent studies on mosquitoes (Ndo et al. 2014; (*Anopheles*) and Yamada et al. 2014 (*Aedes*)
- Effect of both types of irradiation was assessed for *Ceratitis capitata and Anastrepha fraterculus and* no difference was found on male quality (Mastrangelo et al., 2010). Tests according to th FAO/IAEA/USDA Quality Control Manual
  - Sterility
  - Longevity under stress
  - Percent emergence and flight ability
  - Mating performance field cage tests


Ceratitis capitata

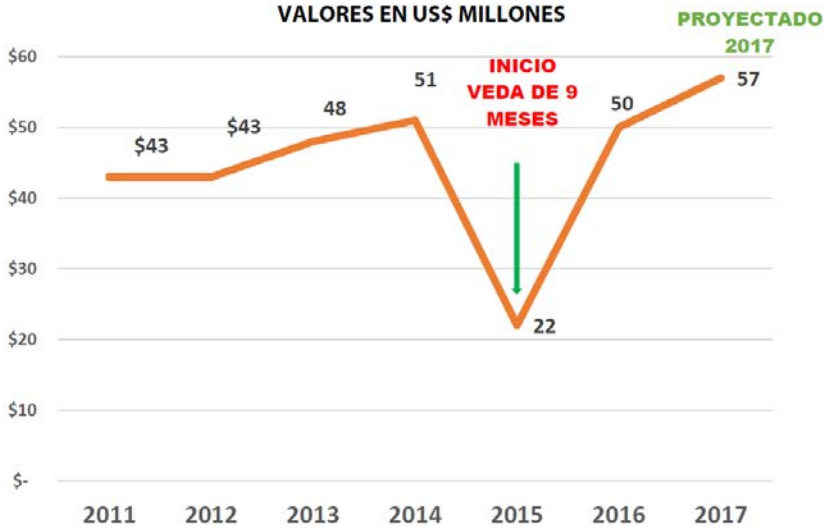

Anastrepha fraterculus

Past trends

- Shipment of ^{60}Co sources has become difficult (last 15 years)
- Evaluation of the X ray alternatives available (last 10 years)
  - Radio-biology: no difference were found between the two technologies
  - Reliability: so far main issues were found with the X ray tubes burning out and X ray tubes replacement
  - Need for stable power supply
- Developments on the SIT package for mosquitoes (last 10 years)
  - Transboundary shipments issues
  - Shipments more difficult due the shorter life cycle

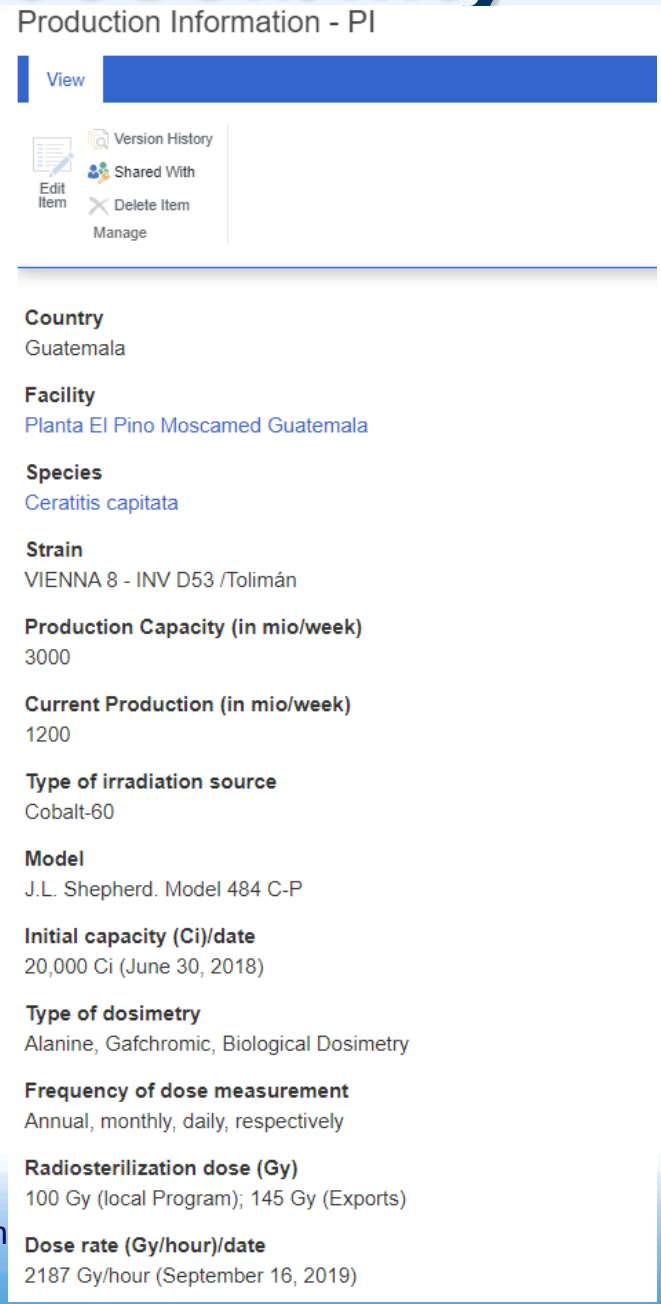
Future trends

- SIT needs a reliable alternative to the ^{60}Co
- Mosquito SIT demand will likely increase and since strains are difficult to ship, each project will need their own source
- Increase of insects invasions will likely increase the SIT demand (E.g. recently medfly invasion in Dominican Republic and Manzanilho, Mexico)



Data on SIT and its accessibility

- All our information is freely available. As example relevant for the topic of this presentation (2 out of our 4 databases):
- World-Wide Directory of SIT Facilities (DIR-SIT) (https://nucleus.iaea.org/sites/naipc/dirsit/SitePages/World-Wide%20Directory%20of%20SIT%20Facilities%20(DIR-SIT).aspx)
  - DIRSIT has been established with the objective of aiding the retrieval of information on facilities in the world mass rearing sterile insects
  - Contains information on: insect species and strain, production, contacts, website, etc



Data on SIT and its accessibility

International Database on Insect Disinfestation and Sterilization (IDIDAS) (https://nucleus.iaea.org/sites/naipc/ididas/SitePages/International%20Database%20on%20Insect%20Disinfestation%20and%20Sterilization%20(IDIDAS).aspx)

- the radiation doses used to induce sterility **(sterilization)** in target pests for the application of the sterile insect technique, inherited sterility and biological control as part of area-wide integrated pest management programmes;

- the phytosanitary irradiation **(disinfestation)** of fresh and durable commodities infested with specific pests.

- Facts: 365 species (321 insects & 34 arachnida); 5043 references

Data on SIT and its accessibility

- **Technical specification for an x-ray system for the irradiation of insects for the sterile insect technique and other related technologies (http://www-naweb.iaea.org/nafa/ipc/public/X-Ray-system-sit.pdf)**

- **Product Quality Control for Sterile Mass-Reared and Released Tephritid Fruit Flies (http://www-naweb.iaea.org/nafa/ipc/public/QCV7.pdf)**

- **Dose mapping by scanning Gafchromic film to measure the absorbed dose of insects during their sterilization (http://www-naweb.iaea.org/nafa/ipc/public/Dose-Mapping-Gafchromic-2020-11-02.pdf)**

Thank You