IAEA FACTSHEET

Food and Agriculture

Controlling Insect Pests with the Sterile Insect Technique

What should I know?

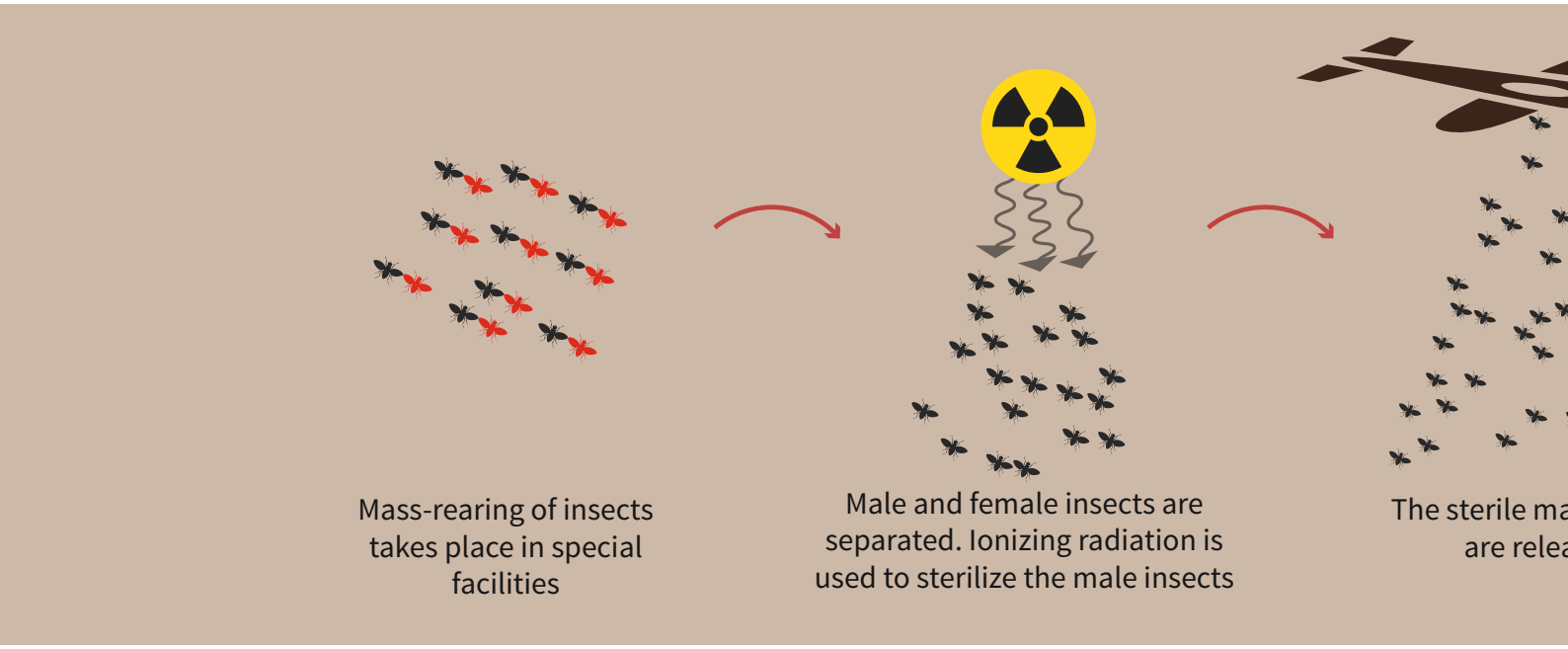
Despite the increased use of pesticides, insects account for most of the world's pre- and post-harvest food losses, which can run as high as 40%, and impact agricultural production and food security. In addition, millions of people and animals suffer from vector-borne diseases as a result of insect pests such as the tsetse fly and mosquitoes. Crucial to increasing agricultural productivity and sustainable global food security and safety is the investment in environment-friendly pest management practices that sustain the natural ecosystem and reduce reliance on chemical pesticides.

The sterile insect technique (SIT) is a form of pest control that uses ionizing radiation to sterilize mass-produced insects of the same type as the target pest. The sterile insects, produced in special rearing facilities, are released systematically from the ground or air over the infested areas, where they mate with wild females, but do not produce offspring. The species-specific SIT is applied on an area-wide basis, covering areas with commercial crop production as well as surrounding marginal land where the pest may also occur.

This differs from conventional chemical control methods, where pesticides are applied on a field-by-field basis to the commercial crop only, resulting in a less sustainable effect. The SIT can therefore diminish and, in some cases, eventually eradicate insect populations such as tsetse flies, fruit flies, mosquitoes and moths. The SIT is among the most environment-friendly control techniques available. While it is usually applied in combination with other control methods as the final component of integrated campaigns to suppress or eradicate insect pest populations, it is also increasingly being applied prophylactically to prevent the establishment of new invasive pests.

In the Dominican Republic, SIT has been used to fight the Mediterranean fruit fly infestation. MOSCAMED-RD staff fill each box with 45 000 pupae, divided into three sections of 15 000 pupae each. (Photo: L. Gil/IAEA)

The rapid growth in global trade has led to an increase in insect pest incursions. Climate change and pesticide resistance also play a major role in the rise and geographical expansion of agricultural pests. The IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO) through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (Joint Division), spearheads global research in the development and application of the SIT.



The SIT — uses ionizing radiation for insect steriliz

The method is developed and refined at the Insect Pest Control Laboratory (IPCL) run by the Joint FAO/IAEA Division in Seibersdorf, (Austria). The insect pest control subprogramme currently provides support to over 70 countries through the IAEA's technical cooperation programme.

Benefits of the SIT

Interest in the SIT — a technique that has been around for 50 years — is growing. It has several comparative advantages over conventional chemical pest control. Firstly, sterilized insects carry no potential to adversely affect the ecosystem, whereas pesticides can seriously harm both workers and the environment. Secondly, sterile insects neither establish themselves in the environment nor does the SIT kill beneficial non-target organisms; the techniques therefore integrate well with other biocontrol methods. Thirdly, the SIT can contain or eradicate invasive pest outbreaks sustainably, because it also reaches that last pest insect that pesticides cannot reach.

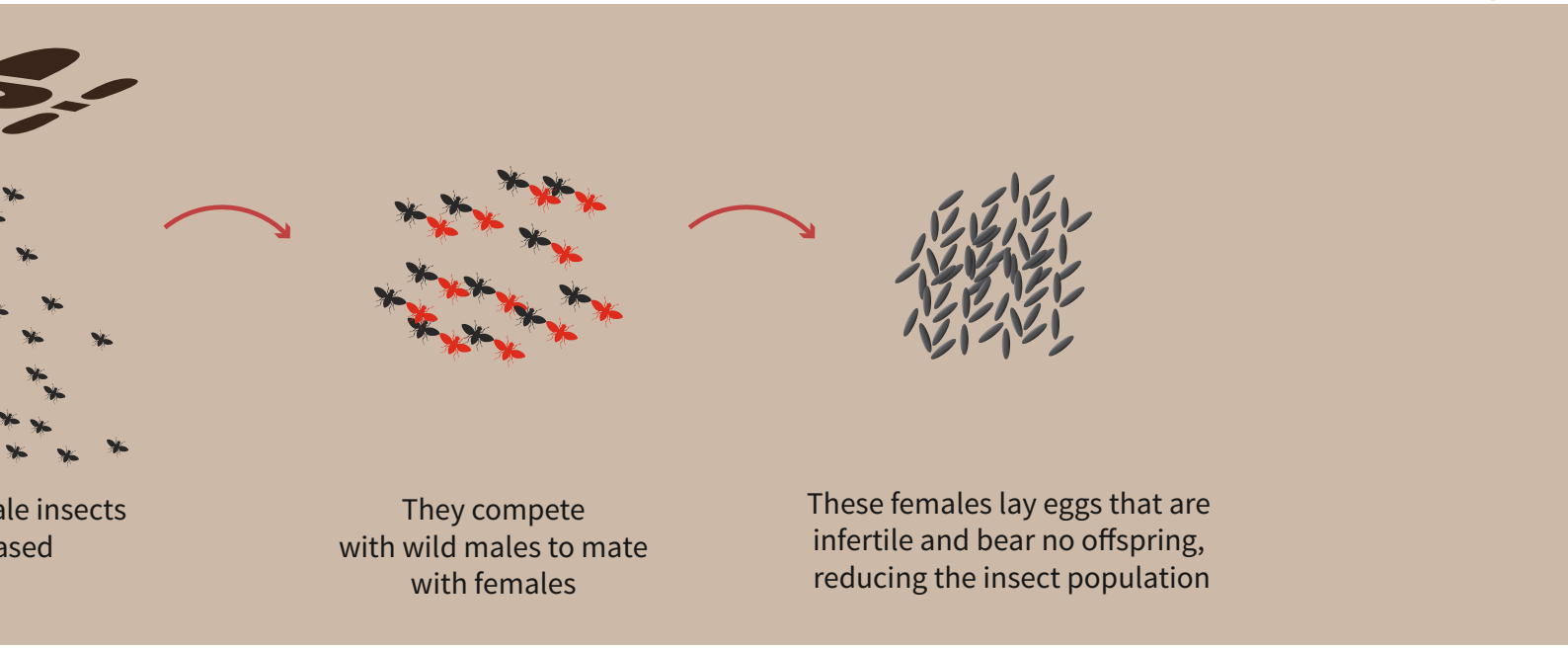
Many Member States facing pest control problems are considering the incorporation of the SIT into their integrated pest management programmes. However, the development and implementation of the SIT is an incremental and complex process that requires long-term commitment, supporting infrastructure and trained staff.

How does it work?

Facilities in countries need appropriate set-ups and trained staff to mass-rear, sterilize, handling and release the sterilized insects to effectively implement the SIT.

At the designated 'emergence and release facilities', all preparations need to be made to ensure that the mass-reared and sterilized insects are received and prepared for adult emergence and release in good time. This includes quality testing the received insects and placing them in containers in holding rooms for a period during which the sterilized pupae emerge and are fed, and are then collected for adult release.

In the case of fruit flies, the process involves preparation of a liquid food mixture of agar, water and sugar that is carefully poured into fibreglass trays to solidify. Once the agar is solid, it is cut and placed in the insect containers as feed for the soon-to-emerge sterile adult flies. The containers are then sealed and placed in the holding room to await the emergence of sterilized flies.



zation — to control insect pests. (Infograph: R.Kenn/IAEA)

Once ready for release, sterile adult flies are dispersed by ground release, or released by air, to interact with wild female flies. Monitoring is conducted with the help of fruit fly traps placed on trees with weekly checks of how many are caught and whether they are wild or sterile.

How does the IAEA help?

The IAEA supports SIT capacity building and training in Member States. In order to facilitate the application of the SIT worldwide, the Joint FAO/IAEA Division carries out its mandate through strategic and applied research, technology transfer, capacity building, policy advice and information management, which includes:

1. Performing R&D at its own dedicated facilities at the FAO/IAEA Agriculture & Biotechnology Laboratories in Seibersdorf that focus on improving the cost-effectiveness of all aspects of the SIT application and related technologies, including the development of male-only strains; insect diets; genetic and behavioural studies; the irradiation of mass-reared insects to ensure sterility; and quality control.
2. Assisting Member States through more than 35 national and regional technical cooperation projects.
3. Providing policy advice to national and provincial governments on the application of the SIT.
4. Supporting Member States to declare pest-free areas and areas of low pest prevalence.
5. Providing access and assistance for stakeholders to use its International Database on Insect Disinfestation and Sterilization and its World-Wide Directory of SIT Facilities.
6. Educating around 140 trainees annually, both at its own laboratories at Seibersdorf and through workshops and training courses on location in Member States.

Snapshot of achievements

There are numerous examples of the successful implementation of the SIT as part of area-wide integrated pest management approaches. These include the eradication of the Mediterranean fruit fly from Mexico, that was first detected in the country in 1977. By 1982 the Moscamed Programme had successfully eradicated the invasive Mediterranean fruit fly from the areas that it had invaded. Significant investments by the Governments of Mexico, Guatemala and the United States of America in this programme for over 40 years have been highly cost-effective and have facilitated a multibillion dollar horticultural industry.

Ahmad Abu Siam, a laboratory technician releases the sterilized male medflies, produced at the Sterile Insect Technique Emergence Facility in the Jordan Valley.
(Photo: D. Calma/IAEA)

In Africa, tsetse-borne trypanosomiasis is one of the main constraints on agricultural production and development. The SIT was used to successfully eradicate tsetse flies from Unguja Island (Zanzibar) in 1997 and no tsetse flies have subsequently been detected. Socioeconomic studies have demonstrated significant improvements attributable to the elimination of trypanosomiasis: within three years of its eradication, the proportion of small farmers rearing indigenous cattle increased from 31% to 94%; sales of milk from indigenous cattle increased from 11% to 62%; and the percentage of farmers with improved cattle breeds increased from 2% to 24%.

Senegal has also successfully integrated the SIT into its tsetse fly management project in the Niayes area. The disease that tsetse flies transmit can kill livestock or make them sick. These flies can lower quality of life and lead to a loss of milk and meat provided by livestock, which significantly impacts farmers' livelihoods and stifles local development. The SIT was introduced as part of the area-wide pest management programme in the Niayes area. By 2017, it was nearly 99% tsetse free. The overall number of trypanosomiasis cases in the region has fallen to close to zero, paving the way for local farmers to replace lost native herds with more productive cattle breeds offering higher yields.

In early 2015, the IAEA and FAO provided assistance to the Dominican Republic to use the SIT to eradicate an outbreak of the Mediterranean fruit fly — one of the most damaging agricultural pests in the world, which attacks many types of fruit and vegetable. Through assistance from the IAEA and FAO, as well as the United States Department of Agriculture and other stakeholders, including the Moscamed Programme in Guatemala, the International Regional Organization for Plant and Animal Health and the Inter-American Institute for Cooperation on Agriculture, the Dominican Republic was able to eradicate the fly within two years, and to regain access to export markets worth over US $50 million a year.

More information

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

www.iaea.org/about/insect-pest-control-section

www.iaea.org/about/organizational-structure/department-of-nuclear-sciences-and-applications/joint-fao/iaea-division-of-nuclear-techniques-in-food-and-agriculture

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