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Technical Assistance and Co-operation Committee

Proposed Interregional Technical Cooperation Project on 'Strengthening Member State Capacities to Combat Banana Fusarium Wilt (TR4) through Early Detection, New Resistant Varieties, and Integrated Management'

Summary

- The Cavendish variety of banana, which makes up roughly 50% of global production and is important for domestic and export markets, is threatened by a new race (Tropical Race 4 – TR4) of the soil-borne pathogen, *Fusarium oxysporum, f. sp. cubense* (Foc), which causes Fusarium Wilt or Panama Wilt disease.
- This pathogen is affecting many countries around the world, and new outbreaks have been detected in Latin America and the Caribbean. The Andean Community has requested IAEA assistance to coordinate regional and interregional actions to combat and prevent the disease, which threatens the nutrition and food security of millions of people.
- The IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO), has a long and established track record in applying nuclear and nuclear-derived techniques and associated biotechnologies to improve crop plants, and develop resistance to diseases.
- Induced genetic resistance in Cavendish is possible by mutation induction and associated biotechnologies. Screening procedures are also available to determine whether TR4 resistance is prevalent in other varieties of banana and plantains.
- The proposed project will help countries to develop or strengthen capacities in the use of two techniques to manage the prevention and spread of the Fusarium Wilt TR4 in banana plantations. The first is the application of irradiation for the development of induced genetic resistance against

the disease. The second is the detection of the disease using the nuclear-derived technique of polymerase chain reaction or PCR and DNA sequencing.

- This project will support the development of novel genetic resistance to Fusarium Wilt in Cavendish and other banana varieties through mutation breeding, and will enable early detection of the disease and its containment.
- The project will be also a mechanism for sharing information, knowledge and experiences, and for the creation of networking and the promotion of South-South cooperation.

Recommended Action

It is recommended that the Board:

- Approve this proposed project as a new project in the Agency's proposed technical cooperation programme for 2022–2023;
- Approve the use of footnote-a/ funding for this project for a total amount of €5 028 900, which will be implemented as resources become available;
- Approve the possible participation of concerned non-Member States of the IAEA.

Proposed Interregional Technical Cooperation Project on 'Strengthening Member State Capacities to Combat Banana Fusarium Wilt (TR4) through Early Detection, New Resistant Varieties, and Integrated Management'

A. Background

1. A new race (Tropical race 4 – TR4) of the soil-borne pathogen, *Fusarium oxysporum*, *f. sp. cubense* (Foc), which causes the Fusarium Wilt or Panama Wilt disease, threatens the global banana crop. Banana is one of the world's top staple foods, with over 400 million people relying on bananas and plantains for food security and for income. The combined annual production of bananas and plantains across the globe is some 155 million metric tons, with about 84% of the banana crop produced by smallholder farmers and supplied to domestic markets. 16% of global banana production, accounting for some 25 million metric tons, is exported from tropical areas to countries in temperate zones.
2. The Cavendish variety of banana makes up roughly 50% of global production and is important both for domestic and export markets. Cavendish is grown under monoculture conditions in large plantations. The export banana market consists almost exclusively (99%) of this variety.
3. Fusarium Wilt, also called 'Panama disease', is regarded as the most important lethal disease of banana. Believed to have originated in Southeast Asia, it was first reported in Australia in 1876 and in Panama in 1890, damaging export plantations of the banana variety Gros Michel. The disease, caused by *Fusarium oxysporum f.sp. cubense* (Foc) Race 1, invaded banana growing countries in Central and South America, destroying plantations and wreaking havoc on the export industry. Following enormous socioeconomic and environmental costs, the banana industry turned to cultivation of the Cavendish variety, identified as resistant to Race 1, in the second half of the twentieth century. In the 1990s, however, Cavendish began to succumb to a new race of *Fusarium oxysporum f. sp. cubense*, Tropical race 4 (TR4), first in Southeast Asia and then Australia. TR4 has subsequently spread rapidly in banana production systems in Asia, Africa and the Middle East, and was reported for the first time in Latin America in Colombia in 2019, and in Peru in April 2021.
4. The Fusarium Wilt pathogen is soil-borne, and can survive for decades in the soil, making it difficult to control. Furthermore, TR4 has a wide host range and can target many cultivated bananas – the Cavendish monoculture plantations are particularly sensitive to TR4. Surveillance, early detection, quarantine and containment are highly critical to prevent the spread of TR4. Although cultural and

biological control options can slow down the development of epidemics, the only long-term option is to deploy new varieties with effective disease resistance.

5. Today, induced genetic resistance in Cavendish is possible by mutation induction and associated biotechnologies. This has been demonstrated by an IAEA coordinated research project, conducted in cooperation with the Food and Agriculture Organization of the United Nations (FAO).

6. Screening procedures are also available to determine whether TR4 resistance is prevalent in other varieties of banana and plantains. A screening procedure developed at the IAEA laboratories can determine resistance to the fungus under controlled conditions. In addition, an early study on resistance to TR4 in 34 banana and plantain cultivars under controlled conditions has reported resistance in two diploids and two polyploid groups.

7. Developing induced genetic resistance in Cavendish and, in parallel, finding productive, consumer-acceptable varieties with resistance to TR4 are central components in strategies to enhance the resilience of the export-oriented banana industry, as well as that of local and regional production systems aimed at domestic markets.

8. New outbreaks have been detected in Latin America and the Caribbean. In this context, the Andean Community has requested the urgent assistance of the IAEA to coordinate regional and interregional actions to combat and prevent the disease, which threatens worldwide banana production and, in turn, the nutrition and food security of millions of people.

B. Previous IAEA support to Member States

9. The IAEA, in partnership with the FAO, has a long and established track record in applying nuclear and nuclear-derived techniques and associated biotechnologies to improve crop plants, and develop resistance to diseases. Banana research in the IAEA laboratories and relevant capacity building in Member States goes back at least two decades and addresses key techniques that include cell and tissue culture, mutation induction, screening for disease and pest resistance, and related molecular and cytogenetics techniques.

10. Previous technical cooperation projects include support for the successful development of mutant wheat varieties resistant to wheat black stem rust, and cassava that is showing resistance to Cassava Brown Streak Mosaic disease and Cassava Mosaic Disease.

11. In addition, an IAEA coordinated research project in partnership with the FAO during 2015-2019 resulted in the development of a TR4-resistant mutant banana variety in China, and the identification of putative tolerant or resistant mutant lines in three other countries. Procedures for TR4 resistance screening under controlled conditions were also developed under the same coordinated research project.

C. Proposed IAEA interregional TC project

12. Through its technical cooperation programme, the Agency will contribute to ongoing efforts to address the global threat of Fusarium Wilt by helping countries to develop or strengthen national and regional capacities in the use of two distinct techniques to manage the prevention and spread of the Fusarium Wilt TR4 in banana plantations across the world. The first is the application of irradiation as

a physical mutagenic agent on plant material, either in tissue or cell culture, for the development of induced genetic resistance against the disease. The second is the detection of the disease using the nuclear-derived technique of polymerase chain reaction or PCR and DNA sequencing, complemented by effective integrated management.

13. The proposed interregional TC project will enable early detection of the disease and its containment, and most importantly, will support the development of novel genetic resistance to Fusarium Wilt in Cavendish and other farmer-preferred varieties through mutation breeding.

14. It is proposed that the project should be open to all Member States that are affected by Fusarium Wilt. The participation of non-Member States could be also considered in accordance with the Board's decisions on assistance to non-Member States contained in documents GOV/2810 and GOV/2818.

15. The proposal builds on previous assistance provided through the TC programme.

C.1. Project description

Title: Strengthening Member State Capacities to Combat Banana Fusarium Wilt (TR4) through Early Detection, New Resistant Varieties, and Integrated Management (INT5158).

Objective: To strengthen Member State capacities in the prevention and containment of Fusarium Wilt (TR4) disease in banana through surveillance, early detection, genetic resistance and integrated management.

Outcome: Enhanced technical and infrastructure capacities at the institutional level and within national, regional and global networks for the detection, surveillance, genetic resistance and management of banana Fusarium wilt (TR4).

Expected Outputs:

- National entities involved in Banana TR4 management identified and mapped and with full and up-to-date technical and infrastructure capacities for disease surveillance, detection and containment.
- Capacities strengthened for TR4 prevention, surveillance and reporting, containment and integrated management options.
- Native and mutant germplasm of banana and plantains with confirmed resistance to Fusarium TR4 developed.

Project duration: 5 years (2022–2026)

Project budget: €5 028 900

FOOTNOTE -a/ FINANCING

Year	Human resource component (€)					Procurement components (€)			Total
	Experts	Meetings	Training course	Fellowships & Scientific Visits	Subtotal	Procurement	Sub-contracts	Subtotal	
2022	214 800	148 700	382 500	116 000	862 000	800 000	12 000	812 000	1 674 000
2023	214 800	0	75 000	91 000	380 800	450 000	0	450 000	830 800
2024	237 800	77 400	382 500	116 000	813 700	275 000	0	275 000	1 088 700
2025	177 000	0	75 000	69 000	321 000	450 000	0	450 000	771 000
2026	227 000	77 400	285 000	75 000	664 400	0	0	0	664 400
Total	1 071 400	303 500	1 200 000	467 000	3 041 900	1 975 000	12 000	1 987 000	5 028 900