



**COLEAD**

# COMPETENCY FRAMEWORK

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FOR THE DEVELOPMENT OF  
**TRAINING ON TR4**



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## INTRODUCTION

*Fusarium oxysporum* f. sp. *Cubense* race 4 (TR4) (recently re-classified as *Fusarium odoratissimum*) is a soil-borne pathogen that attacks the roots of banana plants, causing Banana Fusarium Wilt disease by clogging its vascular system. The fungus spreads through infected plant material and contaminated soil particles attached to items such as farm tools, shoes, clothes, animals and vehicles. Irrigation and drainage water also play a critical role in its spread. Typhoons and storms can carry the TR4 fungus to new plantations. The survival form of the fungus, spores with a thick wall called chlamydospores, can remain dormant in the soil or on several host plants for decades.

The fungus affects many varieties including Cavendish bananas, which provide around half of global banana supply and almost all of the bananas exported. Once established in a field, TR4 can cause complete yield loss. After the first detection in Asia in the 1970s of what would later become known as Tropical race 4 and its subsequent spread to Africa in 2013, TR4 arrived in Latin America in 2019, where around two thirds of the global banana trade originates. TR4 is one of the most aggressive and destructive fungi in the history of agriculture and the world's greatest threat to banana production. Bananas and plantains are critical to the food security and livelihoods of around 400 million people. The continued spread of TR4 would be devastating for those who rely on banana for their food and livelihoods, but also for those who simply enjoy eating them.

The aim of this document is to provide a framework that can be used worldwide to develop awareness raising, information materials and training courses on the management of TR4. It will ensure that awareness raising and training worldwide deliver the same clear and consistent messages to those involved in banana production and trade on how to contain, manage, and prevent the further spread of the disease. The competencies were developed by the TR4 Task Force of the World Banana Forum (WBF), and coordinated by COLEAD.

## TRAINING COMPETENCIES

Competencies provide the basis on which to design training courses. They specify what key stakeholders need to know and be able to do by the time they complete the training. The competencies needed to tackle TR4 vary according to target group. The knowledge and skills needed by a transporter, for example, are different to those needed by a plantation manager.

Competencies outline the key messages that need to be understood and addressed to tackle TR4. They are important to orientate awareness raising (short messages) and capacity building (deepening knowledge and skills).

This training competency framework acts as a resource that can be used by any organisation worldwide to develop and deliver training on TR4. Training courses are best developed locally so that they are customised according to the local context and language, ensuring that they are appropriate, easily understood, and thus more likely to be adopted. Nevertheless, training needs to be based on a competency framework that ensures the training is consistent and covers all the knowledge and skills needed.

This competency framework targets key stakeholders who have a role to play in the prevention and management of TR4. These include:

- Government (ministry and policy level)
- National Plant Protection Organisations (NPPOs)
- Individual small-scale farmers and farmer organisations
- Large farms / plantations
- Workers on large farms and plantations
- Traders, retailers and transporters
- Technical support services (consultants, extension officers, training organisations, NGO)
- General public

The training in a given context will need to be adapted according to whether TR4 is present (where the focus should be on containment) or where TR4 is absent, but at risk (where the focus should be on prevention).

## **GOVERNMENT (MINISTERIAL AND POLICY LEVEL)**

*What the persons responsible for the national oversight of TR4 prevention and containment need to know and be able to do.*

### **Understanding the pathogen**

- Be aware of TR4 and the threat it poses to the banana sector
- Have concrete information and data on the potential impact of the spread of TR4 in the country and in particular regions: economic (direct, linkages with other sectors), social (including direct and indirect employment), food security, others
- Know where TR4 is present – geographical distribution
- Understand how it spreads
- Be able to identify the main risks of introducing TR4 into the country (e.g., via trade and movement of goods and services from infected areas)
- Have a knowledge of the role of international organisations (to initiate dialogue on potential support in developing a national prevention strategy)

### **Identification and Surveillance**

- Map the distribution of bananas and plantains in the country, including production for export and domestic markets, from small-scale farms to large-scale plantations
- Become acquainted of the policy and legal framework that needs to be in place for a quarantine pest
- Understand the policy and infrastructure needed for national surveillance programmes and diagnostic facilities
- Be able to assess the human and financial resources needed to implement a national TR4 surveillance programme, sufficient staff with the necessary skills and operational resources
- Be able to assess the human and financial resources needed to implement border controls
- Have a knowledge of the TR4 diagnostic facilities required with appropriate equipment, skills, and methods, and where these can be accessed at national, regional, or international laboratories
- Be able to bring together key stakeholders to implement a TR4 pest risk assessment and impact assessment, including (but not limited to) public-private alliances and support mechanisms for smallholder farmers

### **Biosecurity**

- Be able to ensure that the necessary regulatory framework is in place and is implemented to prevent the introduction or spread of TR4 as a notifiable pest according to the relevant IPPC guidelines. This framework must include provision for the development of a response plan, surveillance strategy, compliance strategy, tracing methodology, sampling strategy, and risk assessments. Understand and put in place the infrastructure and resources (human and financial) needed to enforce regulations and implement official controls to prevent the introduction or spread of TR4 (including the NPPO, diagnostic services, extension services, disinfection points, others)

- Understand the importance of having a national TR4 focal point within the NPPO that responds to the International Plant Protection Convention (IPPC) and FAO
- Understand the need to conduct a national inventory of the main producers, buyers, traders, and retailers of banana
- Be able to bring together key stakeholders to develop a national biosecurity action plan
- Be able to assess the infrastructure and resources needed (financial and human) to support implementation of a national TR4 action plan, including awareness raising and communication

### **Agronomic methods of prevention**

- Be able to understand the importance of clean planting material; promote or facilitate access to clean planting material (especially for small producers)

## **NATIONAL PLANT PROTECTION ORGANISATIONS**

### **NPPO Executive level**

*What the persons responsible for overseeing national TR4 strategies within the NPPO need to know and be able to do*

### **Understanding the pathogen**

- Be aware of TR4 and the threat it poses to the banana sector, especially:
  - its distribution at international and national levels.
  - The threat it represents for the national banana sector (based on a knowledge of the national sector including products, operators involved, production methods, etc.)
  - The potential economic impact of the disease
- Know the biology of the pathogen, including:
  - how it reproduces and develops (cycle and epidemiology)
  - how it affects the host plant, internal and external symptoms in leaves and stems
  - susceptibility of commercial banana varieties and other hosts; susceptibility of varieties for domestic markets, local consumption, and food security
  - persistence in the soil and wild hosts
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting materials
  - over short distances by root-to-root contact, and from parent plant to suckers
  - by alternative hosts, including weeds
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by domestic animals, wildlife (e.g., rats, bandicoots, feral pigs, wading birds) and potentially by insects (e.g., banana weevil borer)
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods

- Have a knowledge of the management options, including:
  - that no effective control method is currently available
  - that potentially resistant banana varieties are under development
  - the different options of disinfectants and other supplies to be used as part of biosecurity systems, and be able to recommend users on the doses, periodicity, and availability
  - that the only management options available are biosecurity (to prevent spread), and agronomic practices (to reduce impact)
  - methods to put a part of the plantation infected by TR4 under quarantine
- Have a knowledge of how TR4 is identified including:
  - Have basic understanding on *Fusarium* taxonomy and symptoms
  - Know that identification of the TR4 pathogen cannot be done in the field; it requires a specialized laboratory that can conduct PCR analysis (Polymerase Chain Reaction) among other specialized for the topic
  - that the laboratories conducting analysis need specialised skills, equipment, and materials (including assessment, references, and primers)
- Links to further information

### Identification and Surveillance

- Based on mapping of plantations, be able to implement a national TR4 surveillance programme in line with risk assessment plans, taking soil samples on a regular basis in the banana producing zones
- Identify what host species need to be included in the surveillance programme
- Be able to establish and implement a procedure for further investigation and management of reports of suspected TR4 cases
- Be able to train field officers (NPPO and extension services) on the symptoms of TR4
- Be able to train field officers to take and handle soil and tissue samples for diagnostic purposes
- Be able to oversee a TR4 diagnostic service in-country (or access to regional/international analytical facilities)
- Develop capacities within extensionists and farmers to address all aspects of TR4, this through workshops, distribution of TR4 Global Network materials of the World Banana Forum, as well as others pertinent for the situation
- Maintain effective contact channels with extensionists and farmers, encouraging the support in case of emergency, avoid panic messages knowing that we are in this together

### Biosecurity

- Implement effective communication channels with the International Plant Protection Convention (IPPC) and FAO
- Have a detailed knowledge of biosecurity measures needed at farm, area and country level
- Be able to implement official controls, including inspection and border controls as well as on-farm compliance, according to national regulations (with a particular focus on imports of plant products) including:
  - cooperation and communication with relevant competent authorities
  - establishment of procedures for TR4 inspection at border inspection posts according to the relevant import control system
  - Be able to implement procedures if infected plant confirmation is received (including procedures for rapid destruction; setting up of security perimeters)

- Be able to establish and oversee implementation of procedures for disinfection of vehicles and equipment at border entry points and between zones in countries where the disease is present
- Be able to implement simulation exercises both as a preventive measure, and in the event of a suspected TR4 outbreak
- Be able to establish and oversee implementation of procedures for the containment and destruction of infected material
- Be able to certify and oversee the laboratories involved at national level and ensure their compliance with international protocols and support
- Be able to establish and oversee implementation of a TR4 advisory service for banana producers, transporters and traders on biosecurity measures, with biosecurity guidelines
- Be able to establish and oversee an approval scheme for TR4-free planting material
- Be able to facilitate the establishment and implementation of a national TR4 action plan, including awareness raising and communication
- Know what disinfectants are effective and available on the market, and their recommended use (conventional and organic production systems); be able to communicate this information to producers

### **Agronomic methods of prevention**

- Be able to understand the importance of clean planting material
- Be aware of available tools and information sources

### **NPPO Technical level**

What the persons responsible for implementing national TR4 strategies within the NPPO need to know and be able to do

### **Understanding the pathogen**

- Be aware of TR4 and the threat it poses to the national banana sector
- Know the biology of the pathogen, including:
  - how it reproduces and develops
  - how it affects the host plant, internal and external symptoms in leaves and stems
  - susceptibility of commercial banana varieties and other hosts; susceptibility of varieties for domestic markets, local consumption, and food security
  - persistence in the soil and wild hosts
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting material
  - over short distances by root-to-root contact, and from parent plant to suckers
  - by alternative hosts including weeds
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by domestic animals, wildlife (e.g., rats, bandicoots, feral pigs, wading birds) and potentially by insects (e.g., banana weevil borer)
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods

- Have a knowledge of the management options, including:
  - that no effective control method is currently available
  - that potentially resistant banana varieties are under development
  - the different options of disinfectants and other supplies to be used as part of biosecurity systems, and be able to recommend users on the doses, periodicity, and availability
  - that the only effective and available management option is biosecurity (to prevent spread), and agronomic practices (to reduce impact)
  - methods to put a part of the plantation infected by TR4 under quarantine
- Have a knowledge of how TR4 is identified including:
  - have basic understanding of taxonomy
  - be able to describe the sign and symptoms of the disease on banana (external and internal) and important alternative hosts)
  - know that identification of the TR4 pathogen cannot be done in the field; it requires a specialized laboratory that can conduct the analysis using appropriate techniques (for example Polymerase Chain Reaction (PCR)
  - that the laboratories conducting analysis need specialised skills, equipment, and materials (including assessment, references, and primers)
- Where to access relevant information and support

## Identification and Surveillance

- Based on mapping of plantations, be able to oversee the implementation a national TR4 surveillance programme in line with risk assessment plans
- Be able to develop and apply appropriate protocols covering the entry and exit of properties during surveillance activities, ensuring that regulatory personnel do not themselves become disease vectors.
- Identify what host species need to be included in the surveillance programme
- Be able to design a national TR4 surveillance system including:
  - Identification of TR4 surveillance targets
  - Selection of relevant areas (based on biology, spread methods, entry points, distribution
  - Definition of the host species
  - Definition of the sample category (banana plant, soil, water)
  - Definition of the population units to be surveyed
- Be able to establish and implement a procedure for investigation and management of reports of suspected TR4 outbreaks considering:
  - Sampling methods (and materials, equipment needed)
  - Sample storage and transport
- Be able to report and define potential outbreaks according to internal NPPO procedures
- Be able to oversee a TR4 diagnostic service in-country (or access to regional/international analytical facilities)
- Be able to monitor the effects of measures taken on suspect or infected farms and assess the effectiveness of biosecurity measures
- Be able to train field officers (NPPO and extension services) on the symptoms of TR4, surveillance system and survey protocols
- Be able to train field officers to take and handle soil, water, and tissue samples for diagnostic purposes

- Be able to train diagnostic laboratory staff on TR4 diagnosis protocols
- Develop capacities within extensionists and farmers to address all aspects of TR4 through workshops and distribution of relevant information and resources
- Maintain effective communication routes with extensionists and farmers
- Be able to provide relevant information on pest-free areas, if appropriate

## Biosecurity

- Be able to implement effective communication channels with the International Plant Protection Convention (IPPC) and FAO
- Have a detailed knowledge of biosecurity measures needed at farm level and country level
- Be able to support farmers in the assessment of TR4-linked risks (entry points, identification, tools, and equipment management, soil, and water management, etc.) at farm and/or packhouse level.
- Be able to oversee implementation official controls, including inspection and border controls, according to national regulations (with a special focus on the import of plant products) including:
  - cooperation and communication with relevant competent authorities
  - procedures at border inspection posts for TR4-related inspections
  - import control systems (country approvals, approval of organisation, etc.) and certification rules (phytosanitary certificates and other administrative documents)
- Be able to establish and oversee implementation of procedures for disinfection of people, vehicles and equipment moving on and off farms, at border entry points, and between zones in countries where the disease is present
- Be able to implement simulation exercises both as preventive measure and in the case of a suspected TR4 outbreak
- Be able to establish and oversee agreed procedures if potentially infected plant material is received:
  - for rapid destruction
  - for the establishment of secure zones around the point of outbreak
  - establish movement restrictions
- Be able to certify and oversee the laboratories involved at national level and ensure their compliance with international protocols
- Be able to establish and oversee implementation of a TR4 advisory service for banana producers, transporters, and traders on biosecurity measures, with biosecurity guidelines
- Be able to establish and oversee an approval scheme for TR4-free planting material
- Be able to facilitate the establishment and implementation of a national TR4 action plan, including awareness raising and communication, and incorporating triggers for the review of the action plan and development of alternatives
- Be able to train and give technical assistance to stakeholders in above mentioned themes

## Agronomic methods of prevention

- Be able to understand the importance of clean planting material
- Supervise certification of planting material
- Be aware of and able to access relevant information and resource materials

## SMALL-SCALE FARMERS

*What individual farmers need to know and be able to do (including growers specialising in banana, as well as those who may have a small number of plants just for local or home consumption)*

## Understanding the pathogen

- Be aware of TR4 and the threat it poses to the banana sector, and their farms in particular
- Know the biology of the pathogen, including:
  - how it reproduces and develops
  - how it affects the host plant, internal and external symptoms in leaves and stems
  - susceptibility of commercial banana varieties and other hosts
  - persistence in the soil and wild hosts
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting material
  - over short distances by root-to-root contact, and from parent plant to suckers
  - by alternative hosts, including weeds
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by domestic animals, wildlife (e.g., rats, feral pigs, wading birds) and potentially by insects (e.g., banana weevil borer)
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods
- Understand that the only management options available are biosecurity (to prevent spread), and agronomic practices (to reduce impact)
- Have a knowledge of how TR4 is identified including:
  - Be able to describe the sign and symptoms of TR4 (internal, external) in banana and alternative hosts
  - Know that identification of the TR4 pathogen cannot be done in the field; it requires a specialized laboratory (specialised skills, equipment, and materials)

## Identification and Surveillance

- Be acquainted with the NPPO plan and support its implementation, according to their guidelines
- Be able to monitor for the presence of TR4 (frequency, distribution)
- Know how to report suspicious plants to the NPPO
- **Know what not to do:** infected plants should not be cut or removed without the support of the competent authorities; this results in the further spread of the fungus

## Biosecurity

- Be able to implement communicate with the NPPO
- Be able to identify the high-risk factors on the farm (visitors, workers and equipment, domestic and wild animals, irrigation water, flood water, others)
- Be able to identify which biosecurity measures can be used to reduce the risk of introducing TR4 onto the farm, and be able to apply them
  - Movement:
    - As far as possible, restrict the movement of people and animals on and off the property by having a boundary fence and, if necessary, internal zoning
    - Be able to construct and maintain a border fence
    - Record all visitors
    - Provide visitors (neighbours, service providers, etc.) with information about TR4. Identify what information to include, and where to locate TR4 warning and information signs for visitors and neighbours
    - Ensure all visitors follow the farm biosecurity measures
    - Limit the entry and movement of visitors and vehicles, especially those that are high risk because they move between farms/areas that grow bananas (e.g., vehicles for delivery or collection, agronomists, others).
    - Keep high-risk visitors and vehicles to a restricted area at the farm entrance
    - Have a plan to limit the movement of farm animals
  - Cleaning/ disinfection:
    - Be able to manage effective disinfection of footwear using water and footbaths
    - Be able to disinfect tools used for cultural practices on a regular basis
    - Be able to clean, wash down, and disinfect vehicles, machinery, and equipment
    - Know what disinfectants are locally available and how to use them
    - Be able to make sure that vehicles, equipment, machinery, and footwear are washed and disinfected before they enter the farm
    - Be aware of the importance of using clean water for washing and disinfection, and how to maintain a restricted area for dirty washing water
  - Know the importance of using clean planting material, and the meaning of certified planting material. Be able to identify certified planting material
  - Have proper communication tools, such as posters and billboards, with TR4 information including preventive procedures and biosecurity measures
- Be able to make sure that all family and farm workers know about TR4 and understand the importance of maintaining the farm TR4-free. Ensure they are aware of and follow the farm biosecurity measures
- Understand the importance of having a designated person who is responsible for ensuring that farm biosecurity measures are always followed as far as is practically possible

## Agronomic methods of prevention

- Know where to obtain clean planting material from approved tissue culture nurseries or how to use suckers from the farm nursery
- Be able to minimize risks of spreading by irrigation; preferably using water for irrigation sourced from boreholes (not a river, channel, water reservoir)
- Know how to manage water run-off from exclusion and separation zones on their farm
- Implement measures to reduce soil erosion, to minimize soil and water movements
- Manage soil movement through in-coming and out-going drainage channels, building sediment traps

- Make sure that waste plant materials are dumped in areas that are not subject to overland waterflow
- Avoid soil movement from one part of the farm to another
- Make sure that solid waste (bunch bags, strings) is separated and disposed of safely
- Construct fences to avoid the movement of livestock or hinder the movement of wildlife
- Check the origin of organic based soil amendments (compost, compost teas based on microorganisms); this must be sourced from areas or prime materials not associated with banana production
- Be prepared for natural phenomena that could have effect on the risk of spreading of TR4 (flooding, storms)
- Not use banana leaves for protection of bunches on trailers

## **LARGE-SCALE FARMERS/PLANTATION MANAGERS.**

*What the person responsible for TR4 in the plantation needs to know and be able to do*

### **Understanding the pathogen**

- Be aware of TR4 and the threat it poses to the banana sector, and understand the importance of maintaining the farm free of TR4. Once present, it is difficult to control and will be present for many years, meaning that bananas can no longer be cultivated)
- Know the biology of the pathogen, including:
  - how it reproduces and develops
  - how it affects the host plant, internal and external symptoms in leaves and stems
  - susceptibility of commercial banana varieties and other hosts; susceptibility of varieties for domestic markets, local consumption, and food security
  - persistence in the soil and wild hosts
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting materials
  - over short distances by root-to-root contact, and from parent plant to suckers
  - by alternate hosts including weeds
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by domestic animals, wildlife (e.g., rats, feral pigs, wading birds) and potentially by insects (e.g., banana weevil borer)
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods
- Have a knowledge of the management options, including:
  - that no effective control method is currently available
  - that potentially resistant banana varieties are under development
  - the different options of disinfectants and other supplies to be used as part of biosecurity systems, and be able to recommend users on the doses, frequency, and availability
  - that the only management options available are biosecurity (to prevent spread), and agronomic practices (to reduce impact)
  - methods to put a part of the plantation infected by TR4 under quarantine

- Have a knowledge of how TR4 is identified including:
  - Be able to describe the sign and symptoms of TR4 in banana and other hosts (internal and external)
  - Understand the need to take samples for analysis where any internal symptoms are present
  - Distinguish its symptoms from nutritional disorders, drought, and/or waterlogging
  - Distinguish it from other diseases (Erwinia, Yellow sigatoka ...) or pests (banana weevil borer, etc.) with similar symptoms
  - Know that identification of the TR4 pathogen cannot be done in the field; it requires a specialized laboratory (specialised skills, equipment, and materials)
- Know where to go for further information or help

## Identification and Surveillance

- Be acquainted with the NPPO plan and support its implementation, according to their guidelines
- Be able to monitor for the presence of TR4 (frequency, distribution) relying on the company's trained staff
- Be able to develop and implement a monitoring plan for banana and alternate hosts. This needs to be done on a regular basis, on each plot, and according to prescribed sampling methods
- Be able to continuously train field staff to identify suspicious plants
- Know what to do if they find a suspect plant, and be able to report to the NPPO
- **Know what not to do:** infected plants should not be cut or removed as this causes the production of spores and further dissemination of the fungus – when feasible

## Biosecurity

- Be able to implement effective communication with NPPO
- Be able to identify the main ways in which TR4 could enter the farm (dirty vehicles, equipment, machinery, tools, clothing, shoes, infected planting material, irrigation water, others)
- Be able to identify high risk factors, and select appropriate biosecurity measures to manage them
- Be able to apply biosecurity measures and implement them according to risk:
  - Movement:
    - As far as possible, restrict the movement of people and animals onto the farm by constructing and maintaining a secure boundary fence or natural barriers
    - Where appropriate, establish a zoning plan, and adjust practices to implement effective zoning on the farm.
    - Maintain dedicated access roads with hard-surfaces
    - Maintain a record-keeping system for all visitors.
    - Ensure that visitors, family, and farm workers know about TR4 and understand the importance of maintaining the farm TR4-free
    - Provide visitors and neighbours with information about TR4. Identify what information to include, and where to locate TR4 warning and information signs for visitors and neighbours.
    - Limit and manage the entry and movement of visitors and vehicles, especially those that are high risk because they move between farms/areas that grow bananas (e.g. vehicles for delivery or collection, agronomists, contractors, international visitors...).

- Ensure all visitors follow the farm biosecurity measures
- Keep high-risk visitors and vehicles to a restricted area at the farm entrance
- Where possible, use animal proof fencing to exclude farm and wild animals from the farming zone
- Cleaning/ disinfection:
  - Have procedures in place and implemented for wash-down and disinfection considering:
    - effective disinfection of footwear using water and footbaths
    - disinfection of tools used for cultural practices on a regular basis
    - cleaning, washing down, and disinfecting vehicles, machinery, and equipment
    - cleaning planting equipment
    - equipment and disinfectants are locally available and can be used
    - disinfection of vehicles, equipment, machinery, and footwear before they enter the farm
    - the appropriate number and location of decontamination stations
  - Maintain a supply of clean water for washing and disinfection.
  - Construct and maintain cleaning and disinfection facilities, with a restricted area for dirty washing water
  - Ensure thorough washing and disinfection of all machinery and equipment, especially items loaned or purchased second-hand
- Be able to establish and maintain farm zoning (exclusion, separation, and farming zones)
- Implement appropriate biosecurity measures in each farm zone
- Ensure that risks are managed where the farm is next to or crossed by public roads with signage to alert the public that entry is prohibited without permission
- Construct drainage to divert water-run off from adjacent farms and public roads away from the farm
- Know the importance of using clean planting material, and the meaning of certified planting material. Be able to identify certified planting material
- Have proper communication tools, such as toolbox talks, posters and billboards, with TR4 information including preventive procedures and biosecurity measures
- Be able to give training on an ongoing basis to farm workers so that they are aware of and follow the farm biosecurity measures
- Understand the importance of having a designated person who is responsible for ensuring that farm biosecurity measures are followed at all times as far as is practically possible

### **Agronomic methods of prevention**

- Know where or how to get clean planting material from approved tissue culture nurseries, or sourced from own farms (from within contiguous land parcels).
- Be able to minimize risks of spreading by irrigation; preferably using water for irrigation sourced from boreholes (not a river, channel, water reservoir)
- Be able to manage water run-off from exclusion and separation zones on their farm
- Implement measures to reduce soil erosion, to minimize soil and water movements
- Manage soil movement through in-coming and out-going drainage channels, building sediment traps
- Make sure that waste plant materials are dumped in areas that do not drain to other parts of the farming zone
- Avoid soil movement from one part of the farm to another
- Make sure that solid waste (bunch bags, strings) is separated and safely disposed of

- Construct fences to avoid the movement of livestock or hinder the movement of wildlife
- Check the origin of organic based soil amendments (compost, compost teas based on microorganisms); this must be sourced from areas or prime materials not associated with banana production
- Be prepared for natural phenomena that could have effect on the risk of spreading of TR4 (flooding, storms)
- Not use banana leaves for protection of bunches on trailers

## PLANTATION/FARM WORKERS

*What plantation workers need to know and be able to do*

### Understanding the pathogen

- Be aware of TR4 and the threat it poses to the banana sector
- Understand the importance of maintaining the farm free of TR4 (Once present, it cannot be controlled, and will be present for many years, meaning that bananas can no longer be cultivated)
- Have a knowledge the biology of the pathogen
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting materials
  - over short distances by root-to-root contact, and from parent plant to suckers
  - by alternate hosts including weeds
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by domestic animals, wildlife (e.g. rats, feral pigs, wading birds) and potentially by insects (e.g., banana weevil borer)
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods
- Have a knowledge of the management options, including:
  - that no effective control method is currently available
  - that the only management options available are biosecurity (to prevent spread), and agronomic practices (to reduce impact)
  - quarantine restrictions that could be implemented by the national authorities
- Have a knowledge of how to identify TR4 in banana and alternate hosts

### Identification and Surveillance

- Be able to report to a manager in the event that they identify a potential outbreak
- **Know what not to do:** infected plants should not be cut or removed as this causes the production of spores and further dissemination of the fungus – when feasible

## Biosecurity

- Be able to follow and apply the biosecurity measures implemented on the plantation including:
  - Movement:
    - understand the importance of restricting the movement of people and animals
    - the need to record all visitors, and to ensure that they adhere to all biosecurity measures in place
    - the need to limit and manage the entry and movement of visitors and vehicles, especially those that are high risk
  - Cleaning/disinfection:
    - Be able to manage effective disinfection of footwear using water and footbaths
    - Be able to disinfect tools used for cultural practices on a regular basis
    - Be able to clean, wash down, and disinfect vehicles, machinery, and equipment
    - Be able to clean planting material
    - Know what equipment and disinfectants are locally available and can be used
    - Be able to make sure that vehicles, equipment, machinery, and footwear are washed and disinfected before they enter the farm
    - Be aware of the importance of using clean water for washing and disinfection, and how to maintain a restricted area for dirty washing water
  - Not use banana leaves for protection of bunches on trailers

## TRADERS, RETAILERS AND TRANSPORTERS

*What the persons responsible for managing TR4 in the organisation need to know and be able to do*

### Understanding the pathogen

- Be aware of TR4, the threat it poses to the national banana sector and its potential economic impact
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting materials
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods
- Understand the need to support the farmers in meeting the costs of the prevention and containment measures

## Biosecurity

- Understand the need to contribute to monitoring plans and systems in banana producing countries (including financially)
- Be able to identify the main ways in which TR4 can be transported between farms and between countries (dirty containers, pallets, vehicles, equipment, clothing, shoes, infected planting material)
- Understand that traders and transporters play a key role in preventing the spread of TR4. People, vehicles, and equipment (e.g., containers) that move from farm to farm, between districts, and between countries where bananas are grown are very high risk

- Know the biosecurity measures that traders should follow and be able to implement them:
  - Be able to ensure thorough washing and disinfection of all vehicles and equipment purchased second-hand
  - Be able to put procedures in place and implement them for wash-down and disinfection of vehicles and equipment (e.g., containers, pallets)
  - Be able to follow all biosecurity measures required by public authorities and the farms visited
- Keep all the required documents to ensure traceability
- Be able to give training on an ongoing basis to ensure that all employees are aware of TR4, and the need to follow biosecurity measures at all times
- Understand the importance of communicating with contractors to ensure that they have a training and information programme in place to ensure that their employees are aware of TR4, and the need to follow biosecurity measures at all times

### Agronomic methods of prevention

- Be able to make use of disinfection facilities (footbaths, disinfection facilities) in an effective manner.
- know that the use of banana leaves to protect bunches on trailers should be refused.

## TECHNICAL SUPPORT SERVICES (consultants/extension officers/trainers/NGO)

*What the persons responsible for providing TR4 technical support need to know and be able to do*

### Understanding the pathogen

- Be aware of TR4, the threat it poses to the national banana sector and its potential economic impact
- Maintain constant communication with the NPPO to know disease status and appropriate management strategies to be applied
- Know the biology of the pathogen, including:
  - how it reproduces and develops
  - how it affects the host plant, internal and external symptoms in leaves and stems
  - susceptibility of commercial banana varieties and other hosts; susceptibility of varieties for domestic markets, local consumption, and food security
  - persistence in the soil and wild hosts
- Be able to describe how TR4 spreads, including:
  - by infected banana plants, plant material and planting materials
  - over short distances by root-to-root contact, and from parent plant to suckers
  - by alternate hosts including weeds
  - by people, through the movement of dirty vehicles, footwear, machinery, tools, etc.
  - by domestic animals, wildlife (e.g., rats, feral pigs, wading birds) and potentially by insects (e.g., banana weevil borer)
  - by contaminated soil and water
  - by natural processes such as heavy rainfall and floods

- Have a knowledge of the management options, including:
  - that no effective control method is currently available
  - that potentially resistant banana varieties are under development
  - that the only management options available are biosecurity (to prevent spread), and agronomic practices (to reduce impact)
  - methods to put a part of the plantation infected by TR4 under quarantine
- Have a knowledge of how TR4 is identified including:
  - Be able to describe the signs and symptoms of TR4 in banana and alternative hosts (internal and external)
  - Distinguish its symptoms from nutritional disorders, drought, and/or waterlogging
  - Distinguish it from other diseases (Erwinia, Yellow sigatoka ...) or pests (banana weevil borer, etc.) with similar symptoms
  - Know that identification of the TR4 pathogen cannot be done in the field; it requires a specialized laboratory (specialised skills, equipment, and materials)
- Know where to get further information and support

### Identification and Surveillance

- Be acquainted with the NPPO contact information and guidelines
- Be aware of national TR4 surveillance programmes and reporting mechanisms
- Be able to train farmers/plantation managers on symptoms of TR4 and how to develop and implement surveillance plans (covering frequency, distribution, host species, others)
- Be able to guide farm managers to avoid improper activities and on when to contact the NPPO in case of a suspicious TR4 case

### Biosecurity

- Implement effective communication channels with the NPPO
- Have a thorough knowledge of the national regulations and official controls, as well as detailed knowledge of the full range of biosecurity measures available
- Be able to help farmers develop a package of biosecurity measure appropriate to their circumstances
- Know that agronomists/service providers play a key role in preventing the spread of TR4 both as sources of advice, as well as potential vectors. People, vehicles, and equipment (e.g., containers) that move from farm to farm, between districts, and between countries where bananas are grown, are very high risk.
- Understand the need to follow all biosecurity measures required by public authorities and the farms visited
- Be able to provide ongoing training and information to ensure that all employees are aware of TR4, and the need to follow biosecurity measures at all times
- Be able to communicate the importance of “arriving clean, leaving clean” to a variety of target audiences

## Agronomic methods of prevention

- Be able to make use of disinfection facilities (footbaths, disinfection facilities) in an effective manner.
- Know how to give technical assistance and training covering all knowledge and practices mentioned above for small- and large-scale farmers and traders.

## GENERAL PUBLIC

### What the public need to know and be able to do

- Be aware of TR4 and the threat it poses to the national banana sector, farmers, consumers and the economy
- Be able to describe how TR4 spreads
- Know what TR4 looks like, and what to do if they find a potential outbreak
- Understand the main ways in which TR4 can be transported between farms and districts (dirty vehicles, clothing, shoes)
- Understand that transporting bananas and items made from banana leaves between countries is very high risk and must be avoided.
- Know that if they visit banana producing areas or farms, they must follow the required biosecurity measures such as disinfecting footwear and vehicles
- As responsible consumers, identify and implement the best way to support farmers through responsible value chain mechanisms



# GROWING PEOPLE

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