



GLOBAL G.A.P. + ADD-ON

INTEGRATED FARM ASSURANCE

TR4 Biosecurity Add-On for Bananas

CONTROL POINTS AND COMPLIANCE CRITERIA

ENGLISH VERSION 1.0

VALID FROM: 1 APRIL 2017

TABLE OF CONTENTS

RATIONALE.....	3
CONTROL POINTS AND CONTROL CRITERIA (CPCCS)	4
TR4 INFORMATIVE OVERVIEW: THE PATHOGEN <i>FUSARIUM OXISPORUM</i> F. SP. <i>CUBENSE</i> TROPICAL RACE 4	12
FURTHER LINKS OF INTEREST:	13
TR4 ANNEX 1: BASIC PRINCIPLES IN THE PREVENTION OF TR4	14
TR4 ANNEX 2: COMMUNICATION WITH NATIONAL/REGIONAL PLANT PROTECTION ORGANIZATIONS.....	19
TR4 ANNEX 3: BIO SANITARY DECLARATION TEMPLATE	20

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Rationale

Fusarium oxysporum f. sp. *cubense* is the causal agent of Fusarium wilt disease of bananas (often misleadingly referred to as “Panama disease”). As of now, one particular genetic lineage, the so-called Tropical Race 4, or Foc TR4, is the most imminent threat to the Cavendish-based banana industry and for livelihoods that depend on banana production and consumption for their subsistence, as Foc TR4 is also pathogenic to many local banana varieties. There is currently no known effective treatment to control Fusarium wilt and therefore no means of effective management of Foc TR4 affecting Cavendish cultivars. Therefore, preventive measures are currently the only viable option.

The GLOBALG.A.P. objective is to assure the implementation of good agricultural practices worldwide. In this context, the TR4 Add-On should be a tool to prevent the spreading of the pathogen within/from GLOBALG.A.P. certified farms and, most importantly, it should help raise awareness about the seriousness of the disease at a global scale. Thus, the Add-On should address this biosecurity issue and provide further support to the entire banana sector. Obviously, this is “one more tool in the tool box” and GLOBALG.A.P. is open for further partnership and participation in collective efforts.

Control Points and Control Criteria (CPCCs)

Note: Background information is offered in the annexes; therefore, please read them carefully before you start with the CPCCs.

Nº	Control Points	Compliance Criteria	Level
TR4	<i>(Fusarium oxysporum sp. cubense)</i> – Tropical Race 4		
TR4 - 1	UNDERSTANDING THE PATHOGEN (The Threat)		
TR4 - 1.1	Awareness about the pathogen and risk assessment plan		
TR4 - 1.1.1	Can the farm management show awareness about the pathogen and provide basic information about it?	The farm management shall be able to provide awareness and information of the pathogen's life cycle. This includes its presence in the soil, water, and plant tissue (including produced crops and other hosts, e.g. weeds). This also includes the national (if possible regional) efforts to contain/avoid this pathogen. Applicable documentation must be available (e.g. agricultural ministry plan for eradication and control of the pathogen).	Major Must
TR4 - 1.1.2	In case national legislation demands specific preventive measures at farm level (i.e. in case pathogen has been categorized as quarantine organism), are these being implemented on the farm?	Where national legislation specifies certain specific measures, these specifications shall be available and be properly implemented on the farm. This includes quarantine measures on the pathogen – if available – in the country.	Major Must
TR4 - 2	TRAINING AND AWARENESS-RAISING ACTIVITIES		
TR4 - 2.1	People present on farm		
TR4 - 2.1.1	Have all people present on the farm (including management, employees and relatives present or living on the farm) been made aware of the risk that TR4 brings to banana cultivation as well as the basic principles of prevention?	Farm management, employees and any other persons living or regularly present on the farm, or visiting other banana farms, needs to be made aware of the risk that TR4 presents for banana cultivation as well as the basic principles of preventive measures. See TR4 Annex 1 : Basic Principles in the Prevention of TR4	Major Must

N°	Control Points	Compliance Criteria	Level
TR4 - 2.1.2	Are all farm employees specifically trained to prevent the risk of receiving or spreading the pathogen according to their activities?	Each employee shall be trained to minimize the risk of receiving or spreading the pathogen according to their task. For example, field workers: through mud/soil dispersal and packing houses; workers: through contaminated water, etc. Training should be refreshed periodically according to the performed task. Smallholders shall be aware of minimal decontamination methods and apply them.	Major Must
TR4 - 2.1.3	Is all relevant training on this topic recorded?	Records of such training shall be recorded including their content, date, people being trained and their signatures.	Major Must
TR4 - 3.1	People transiting nearby and within the farm		
TR4 - 3.1.1	Are appropriate measures in place to inform any person transiting in the proximity of, and/or within the farm premises about the biosecurity measures in place?	Appropriate measures for all boundaries of the farm shall be in place. People using all common transit routes within, or close to, the farm must be aware of the biosecurity measures. There shall be a system in place to ensure measures are being respected.	Recom.

N°	Control Points	Compliance Criteria	Level
TR4 - 4	FARM SITE ACCESS POINTS		
	<p><i>Farm site access points are defined locations where people access the certified entity (farm). Within the farm, different measures of hygiene have to be implemented according to the activities performed, e.g.: farming or cropping zones require other measures than storage or packing zones. Each farm needs to identify these zones in order to address the risk of contamination accordingly.</i></p>		
TR4 - 4.1	Farm Site Risk Assessment		
TR4 - 4.1.1	Is there a risk assessment covering all access points to the farm site?	<p>Farm site access points shall be clearly identified in the farm site map. Additionally, the farm site risk assessment (see AF 1.2.1) shall, as a minimum, consider:</p> <ul style="list-style-type: none"> - Farm workers: <ul style="list-style-type: none"> - Daily routes to work (cross other fields?) - Main means of transport (walking/vehicles/bicycles/animals) - Visitors - Community members - Service providers (including energy, telephone, water/drainage, etc.) - Official agency workers (extension services, etc.) - Wild animals, which are vectors of contaminated soil (endogenous and migratory). <p>The risk assessment shall define risk areas for banana production and mark them accordingly.</p>	Major Must
TR4 - 4.1.2	Has a management plan been developed that establishes and implements strategies to minimize the risks identified in TR4 - 4.1.1?	<p>A management plan addresses the risks identified in TR4 - 4.1.1 and describes the biosecurity procedures implemented at every farm site access point and in every farm zone. The management plan includes necessary training schedules for staff in charge of the farm site access points and farm zone(s). Access protocols may apply based on farm zones.</p> <p>The management plan shall aim to reduce unnecessary entrance to the farm site.</p>	Major Must

N°	Control Points	Compliance Criteria	Level
TR4 - 4.1.3	Are clear signs and protocols in place to ensure an effective implementation of the biosecurity measures?	<p>Protocols and signs shall be in place to ensure that all necessary biosecurity measures are implemented at all farm site access points and in all zones of the farm. Justification for the measures in place (or lack of) shall be available. Documentation shall include all relevant actors as specified in TR4 - 4.1.1.</p> <p>This is complementary to the visual identification and/or farm map in AF 1.1.1.</p>	Major Must
TR4 - 4.1.4	Are farm site access points for people and vehicles properly controlled?	<p>As a minimum, farm site access points shall include the necessary measures to avoid introduction (or further spreading) of the pathogen. This includes contaminated soil, water and plant tissues.</p> <p>There shall be a register of all people and machinery entering the farm (e.g.: See TR4 Annex 3: Biosanitary declaration template)</p> <p>Depending on the situation and risk level, effective foot bath and vehicle decontamination methods should be implemented, which enable sufficient exposure time between agent and infested surfaces.</p> <p>Any contaminated water shall be disposed of in a manner which avoids further spreading of the pathogen and with consideration to the environment. Levels of disinfectant agents shall be monitored regularly and records kept.</p>	Major Must
TR4 - 4.1.5	Are farm access points properly equipped according to the management plan and protocols in place (TR4 - 4.1.2)?	<p>The necessary equipment (e.g.: disinfection agents, boots, etc.) and resources (e.g. staff) shall be available to enable the successful implementation of the management plan (TR4 - 4.1.2).</p>	Recom.
TR4 - 4.1.6	Is there a map of the farm including its surroundings and any risk relevant environments, structures, objects, etc.?	<p>A map of the surroundings of the farm shall identify sources of risk (e.g.: roads, towns, flooding of a river or basin, forest nearby, etc.) and justify the actions included in the management plan. This is complementary to the visual identification and/or farm map in AF 1.1.1.</p>	Major Must
TR4 - 4.1.7	Are there foot bath and disinfection stations for people at each farm site access point?	<p>Each access point shall have effective foot baths, where a new pair of boots is provided for every person entering the banana production site. Decontamination protocols for people shall ensure effective exclusion (further spreading) of the pathogen.</p> <p>Water decontamination agents and staff compliance shall be constantly monitored. Records shall be available.</p>	Recom.

N°	Control Points	Compliance Criteria	Level
TR4 - 4.1.8	Are all vehicles and farm machinery properly decontaminated before accessing and/or exiting the farm (farming zone)?	<p>Any vehicle that needs to enter the farm shall be properly decontaminated from all soil/dust/mud and plant tissues. Farm machinery changing working zones should also be decontaminated before changing zones.</p> <p>Vehicle movement should be minimized to the very minimum. Visitor parking areas should be defined and properly marked.</p> <p>In case public roads are nearby, extra measures shall be in place to avoid contamination from the road (green fences, ditches, etc.).</p> <p>Decontamination protocols for vehicles and farm machinery shall ensure effective exclusion (further spreading) of the pathogen.</p> <p>Water decontamination agents and staff compliance shall be constantly monitored. Records shall be available.</p>	Recom.
TR4 - 4.1.9	Is there a monitoring and management plan for local fauna?	<p>Local fauna (e.g.: wild pigs, migration birds, etc.) should be identified and preventive measures be taken in accordance with the findings taking into consideration endangered wildlife species.</p> <p>Any animal moving soil (or plant tissue) should be considered.</p>	Recom.
TR4 - 5	AGRONOMIC MEASURES		
TR4 - 5.1	Planting material		
TR4 - 5.1.1	Is all planting material sourced from accredited laboratories or nationally approved diseased-free nurseries?	<p>Planting material and substrates shall be pathogen-free and be acquired at nationally approved nurseries. Planting material shall be free of soil and/or substrates. Documentation shall be available to prove the source of the planting material, its properties and the status of the supplying nursery.</p> <p>On farm nurseries shall have hygiene measures in place to avoid pathogen propagation.</p>	Major Must

N°	Control Points	Compliance Criteria	Level
TR4 - 5.2	Soil management		
TR4 - 5.2.1	Are soil management strategies planned in order to avoid movement of soil?	Soil movement shall be managed strategically to prevent unnecessary movement, especially from/to farming zones. Prevention measures shall include, but are not limited to: <ul style="list-style-type: none"> - Reducing soil erosion - Preventing soil movement within the farm - Minimizing soil movement in water, air, etc. - Ensuring machinery and tools are soil free prior to movement between different farming zones - Disinfecting machinery prior to movement between different farming zones 	Major Must
TR4 - 5.3	Water management		
TR4 - 5.3.1	Is a risk assessment available that covers the presence of the pathogen in all water sources used on farm and waterbodies nearby?	The risk assessment for pathogen presence shall include all water sources used on the farm and also those water bodies that might unintentionally enter the farm (e.g.: flooding of rivers, drainages, ditches, etc.).	Major Must
TR4 - 5.3.2	Has a water management plan been developed?	The water management plan shall aim to provide pathogen-free water. If necessary, water testing shall be done regularly. Any water used at disposal sites (e.g.: washing pits) shall be disposed of in an appropriate manner in order to avoid further pathogen propagation and/or negative environmental effects. Waste water (either contaminated or water with decontamination agents) shall be treated accordingly before final disposal. Natural water bodies on the farm shall be properly managed in order to avoid introduction of the pathogen or further spreading thereof. This is complementary to the requirement for a water management plan as required in CB 5.2.2.	Major Must

N°	Control Points	Compliance Criteria	Level
TR4 - 5.4	Monitoring and identification of affected plants		
TR4 - 5.4.1	Is there a monitoring plan of the pathogen on the farm?	The farm shall be monitored for presence of the pathogen by capable staff, who can show evidence of knowledge. The monitoring frequency shall be established according to the regional/farm risk.	Major Must
TR4 - 5.4.2	Has an identification protocol for affected plants been developed / identified and is this being followed by all farm workers?	Farm workers shall be aware of the protocol and actions specified during the audit.	Major Must
TR4 - 5.4.3	Has a pathogen suppression plan been developed?	<p>A pathogen suppression plan shall be available. The plan shall include all measures necessary to minimize the movement of the pathogen and its suppression. At a minimum, it shall include protocols to ensure the following:</p> <ul style="list-style-type: none"> - Location on the farm (GIS coordinates of infested area) - Measures to minimize soil disturbance - Sample taking specifications - Identification and (isolation) cordoning off of infested areas [i.e.: establishing a safety perimeter] - Evaluation of other viable banana varieties (e.g.: less susceptible ones such as soma clonal varieties) and resistance inductors on healthy plants if available - Pathogen suppression actions (crop rotation, intercropping, strategies, etc.) - Stop of harvesting and (re-)planting activities from infected plants - Communication strategy with all relevant actors - Records of all the above measures <p>Plan of next actions shall include, as a minimum, detailed procedures that lead to:</p> <ul style="list-style-type: none"> - Positive identification of pathogen - Destruction measures - Communication strategy with all actors 	Major Must

N°	Control Points	Compliance Criteria	Level
TR4 - 6	PATHOGEN SUPPRESSION (N/A IF NO PATHOGEN IN FARM)		
TR4 - 6.1	Is the pathogen suppression plan (TR4 - 5.4.3) being implemented?	The pathogen suppression plan (TR4 - 5.4.3) shall be implemented in a timely and efficient manner.	Major Must
TR4 - 6.2	Are pathogen suppression efforts being coordinated with local authorities (regional efforts)?	Pathogen suppression strategies shall be made in cooperation with local authorities and aim to minimize the dispersal of the pathogen. Records of the strategy and efforts are available. See TR4 Annex 2: Communication with National/Regional Plant Protection Organizations for further guidance.	Major Must
TR4 - 6.3	Where feasible, are soil and water movement controlled by ditches, physical and vegetative barriers?	The suppression strategy may include physical barriers such as ditches, roads, channels, etc. in order to fulfill its purpose.	Recom.
TR4 - 6.4	Is the pathogen presence reported to international organizations?	The farm management shall report the pathogen according to national legislation or regional guidelines. See TR4 Annex 2 : Communication with National/Regional Plant Protection Organizations for further guidance.	Major Must

TR4 Informative Overview: The Pathogen *Fusarium oxisporum* f. sp. *ubense* Tropical Race 4

Fusarium oxisporum f. sp. *ubense* Tropical Race 4 is one variety of the *Fusarium oxisporum* pathogenic strains. The main difference between this and other widely spread varieties is the strong pathogenic effect, not only on the hosts affected by the races 1 and 2 but also its additional pathogenic effect on the subgroup of Cavendish cultivars, which constitute the most commercially used banana variety in the world. Therefore, the wider spread of TR4 throughout the world would affect millions of farmers that rely on banana cultivation for their subsistence. The pathogenicity of TR4 also raises food security concerns in the parts of the world that rely on bananas as a staple crop.

Furthermore, the *Fusarium spp.* family is very complex, since it presents a wide range of hosts, pathogenic forms and different *Fusarium spp.* strains that can have very different effects. However, TR4 is the most serious threat for bananas and therefore given priority in this Add-On.

The dispersal of the pathogen is mainly through the soil or through contaminated plant propagation material (asymptomatic plants). The commonly infected parts of the plants are roots, rhizomes, pseudo-stem and the petioles. There are no known cases of TR4 dispersal (or presence of) in the banana fruit. TR4 can grow in temperatures between 9 and 38°C, with an optimal growth at approx. 25°C. Tropical (warm and humid) climates are therefore beneficial for its development.

TR4 can also survive and sporulate on dead plant tissue and thus continue its dispersal once the host has been eliminated. Additionally, the dispersal can be through other hosts apart from banana cultivars. However, a very important feature is that TR4 produces long-lasting chlamydiospores, which are a special form of hibernation bodies. These chlamydiospores can survive in the soil for more than 30 years and, with the presence of banana root exudates, can germinate to contaminate the banana plant and continue with the normal life cycle. This makes the eradication of TR4 very challenging.

At the time of the preparation of this Add-On, the worldwide confirmed dispersal of TR4 extends to the following countries (by order of identification):

- Taiwan
- Malaysia
- Indonesia
- Philippines
- China
- Australia
- Mozambique
- Jordan
- Pakistan
- Lebanon
- Any neighboring country to the ones listed above, shall be considered at high risk of contamination.

The last 4 countries have been confirmed in the last 3 years. Considering the big geographic distances between these countries, it is evident that a sector-wide effort is required to contain this pathogen.

TR4 has a long incubation time. This means that the pathogen takes a long time to cause “disease symptoms” to the hosting banana plants. This is due to the long time it takes the fungi to colonize the roots of the banana, enter the rhizome, continue to the pseudo-stem, create the mycelium through the vascular system and reach the xylem. Once the xylem has been reached, TR4 produces microspores that are transported through the tap and which continue colonizing the upper parts of the pseudo-stem. Finally, after a long time, the banana starts showing wilt symptoms, which in some cases may not be identified as TR4 - For example, they might be thought to be nutritional (K) deficiencies, water shortage (e.g.: dry season) or other diseases such as Moko, which is a bacterial disease caused by *Ralstonia/Pseudomonas solanecearum*.

Here are the main distinctions between TR4 and Moko symptoms: 1) TR4 is manifested first on the old leaves, then on the new leaves; while Moko starts in new leaves and then manifests in old leaves. 2) Moko-affected plantlets/chupons are directly visibly affected; while TR4-infected plants might show no immediate symptoms. 3) Moko-contaminated plant tissues show the “typical gum” exudate when cut; while TR4 causes no gum exudates. 4) Moko visibly affects the fruits, while TR4 does not show any symptoms on fruits.

Further links of interest:

FAO/ World Banana Forum

http://www.fao.org/wbf/en/#.V-okjOT_qUk

for TR4 task force page visit: http://www.fao.org/economic/worldbananaforum/fusarium-tr4/en/#.V-omcuT_qUI

Biosecurity Service of the Government of Queensland, Australia

<https://www.daf.qld.gov.au/plants/health-pests-diseases/a-z-significant/panama-disease2>

Government of Queensland, Australia: Growers Kit on TR4

<https://publications.qld.gov.au/dataset/panama-disease-tropical-race-4-grower-kit>

International Plant Protection Convention (IPPC)

<https://www.ippc.int/en/>

Page of the Regional Plant Protection Organization (RPPO) OIRSA

<https://www.oirsa.org/>

CIRAD (French research center)

<http://www.cirad.fr/nos-recherches/filieres-tropicales/banane-et-plantain/contexte-et-enjeux>

TR4 PROMUSA (scientific community banana research)

<http://www.promusa.org/Tropical+race+4+-+TR4>

Wageningen University and Research Centre (Prof. Dr. Gert Kema)

<http://panamadisease.org/>

TR4 Annex 1: Basic Principles in the Prevention of TR4

This annex presents a brief summary of principles that should be implemented to prevent the TR4 pathogen at farm level. The principles described here summarize mainly the biosecurity standards and guidelines issued by the Department of Agriculture and Fisheries of Queensland, Australia [\[available under this link\]](#) and the applicable sections of the “Contingency plan in the case of a Foc 4 outbreak” issued by the Organismo Internacional de Sanidad Agropecuaria (OIRSA) [\[available under this link\]](#). We strongly recommend reviewing these documents for a more detailed description. For specific references, please consult these publications.

“Prevention is the best option”

There are no commercially viable (proven) eradication measures, thus prevention is the best option. Therefore, preventing pathogen contamination in the first place (and/or spreading it any further) has top priority. For this aim, the creation of physical barriers around and within the property or banana cultivation areas is recommended. These barriers should limit unnecessary movement (access) of people, machines and equipment – and ideally animals – to the property to reduce the risk of infection (or dispersal) of the pathogen (TR4). At the same time, reducing the movement – into the farm or within defined risk zones – reduces the time and cost associated with decontamination measures.

“Define risk zones”

There should be clearly established risk zones within the production area (farm). Risk zones should:

- Be differentiated by the processes that take place in that zone (e.g.: banana farming, packing houses, storage/warehouse, habitational, recreational, etc.).
- Define different risk levels according to the processes that take place within them and their position on the farm (e.g. near a road, river, etc.).

According to the risk levels, preventive measures shall be in place, which achieve the objective of preventing the entry and/or further dispersal of the pathogen.

In general, within the established zones, the following should be true:

- There should be minimum movement of staff, tools and/or machinery and equipment
- Protective equipment (e.g.: boots and overalls) and working equipment and machinery/equipment (e.g.: knives, wheelbarrows, machetes, tractors and trucks) shall be provided to the staff in each risk zone
- Materials and/or equipment should not leave the zone

When movement to a different risk zone is necessary, proper decontamination measures should be performed within the current farming zone (clean entry to new zone). This applies to people, equipment, machines, etc. moving within risk zones.

“Implement – minimal – measures that achieve the intended objective”

The complete isolation of an entire farm from its neighborhood is of course not possible. And achieving the objective of an intervention does not necessary mean that a big investment is required.

Wash-down facilities:

In general,

- Use only pathogen-free water sources (“clean water” sources could be rain water from a clean roof; bore hole water, town/drinking water).
- Be aware of indirect contamination foci by adhering to the following:
 - Avoid recycling of irrigation equipment (contaminated pumps).
 - Avoid use of second hand (or borrowed) irrigation machinery.
 - Decontaminate any machinery and/or equipment before use (e.g.: water pipelines, irrigation installation, etc.).
- Use biodegradable detergent for soil and plant material removal; followed by suitable disinfecting agents (proper concentrations and exposure times).

- While using a disinfecting agent, such as any quaternary ammonia formulation, keep in mind that:
 - The presence of soil and organic matter inactivates the efficiency of these disinfecting compounds.
 - The amount of soil and organic matter accumulated shall be constantly controlled and surpluses shall be disposed.
 - Disinfectant agents shall be likewise monitored and concentrations adjusted to the recommended optimum.
 - Apply caution of external dilutants (such as rain water in the absence of a roof).

An efficient decontamination is only achieved when the exposure time of the surface (e.g.: boots) to the disinfectant solution is appropriate. Therefore, the following should be adhered to:

- Monitor the time of exposure of any procedure on the farm (e.g.: foot bath or wheel bath).
- Make sure there is sufficient contact (depending on the concentration of the solution and the exposure time).
- Ensure that the targeted surface (e.g. boots) has no possibility to avoid sufficient contact with the disinfectant solution.

“Wash-down facilities” for machines and vehicles:

- Monitor that all parts of the machine/vehicle that may retain soil are dismantled and cleaned properly within the process (i.e.: no use in cleaning only the outermost part of the wheels or parts, if the internal parts are full of soil).

Effluents shall be properly disposed.

- Decontamination pits should have solid floors and catch all dirty water (effluents).
- Effluents shall be properly treated prior to disposal.
 - Disinfectant agents shall be degraded and pathogens eliminated before water is released into the environment.

Every wash-down facility shall implement a “Controlled Drainage Area (CDA)” for efficient effluent disposal. CDAs should:

- Capture and hold all water coming from wash-down facilities.
- Be physically delimited and avoid entry of a contamination source or spill off to clean water bodies or zones.
- Store water as long as necessary to treat the water (agent degradation).
- Allow water to evaporate or percolate within the property or exit without contaminating.

Failure to achieve the objective of the intervention with poor practices is a waste of time and resources.

“Major measures: roads and ditches”

Consider the cost and time necessary for implementing measures with current infrastructure versus the benefits of investing in new infrastructure when viable.

When constructing new roads and/or ditches, make sure of the following:

- Materials shall be sourced from pathogen-free sources.
- Construction shall take place with clean or decontaminated equipment.
- Subcontractors shall be made aware of the risks, the pathogen and prevention measures.

Also consider upgrading available infrastructure (if possible) by:

- Defining roads for delivery pick up to packing houses.
- Introducing “dirty” roads for packing houses supplied from the field.
- Creating new ditches for heavy-rain events that could spread the pathogen, etc.

“Keep an eye on your daily agronomic practices”

Planting material:

- Never use material coming from contaminated or suspicious sources.
- Always demand a certificate of proof that the material you are using is pathogen-free.
- Make sure that no soil is being transported with the planting material.
- Select resistant varieties if available.

When establishing a new plantation and/or when removing previous crops:

- Consider the creation of ditches and/or roads while creating (or removing) a plantation.
- Use cover crops or any other items that help ensure soil movement is minimized.

Soil movement

- The pathogen can be transported through the soil. Therefore:
 - Soil movement shall be reduced to an absolute minimum.
 - Do not transport soil from one plot to another (e.g. through planting material, equipment and/or machines).
 - Consider erosion as a natural (or induced) soil movement.

Irrigation of crops:

- Assess water quality before use.
- Dam water can be contaminated by overland flow or external agents (wild animals).
- Ideally, use machinery/vehicles that do not leave the property to avoid decontamination measures.

Fertilizing and application of plant protection products:

- Avoid introducing or spreading the pathogen further while carrying out any application.
- Use clean water.
- Machine/vehicle/equipment use shall be pathogen-free.
- Subcontractors shall be aware of risk and contamination agents.

Weeds. Certain weeds can host the TR4 pathogen. They therefore require special attention. Here is a list of currently known weeds that may host TR4:

- *Chloris inflata* (Syn. *C. barbata*)
- *Commelina diffusa*
- *Cyanthillium cinereum*
- *Ensete ventricosum*
- *Euphorbia heterophylla*
 - **Heliconia spp.**
 - *H. caribea*; *H. psittacorum*; *H. mariae*
- *Ixophorus unisetus*
- **Musa spp.**
- *M. textilis*; *M. acuminata*; *M. balbisiana*,
- *Panicum purpurascens* (syn. *Urochloa mutica*)

- *Tridax procumbens*

Suppressing the *Fusarium spp.* in soil requires a broad range of tools:

- Less N reduces the *Fusarium spp.* incidence; whereby NO₃ tends to reduce and NH₄ increases the presence of *Fusarium spp.* Symptoms.
- Ca suppresses chlamydiospores germination.
- Less Fe availability increases the *Fusarium spp.* suppressing quality of the soil.
- Adjusting soil pH to above 5.6 (ideally around 6) usually leads to less *Fusarium spp.*

Waste management:

- Avoid moving waste, such as plant tissue/debris, from the plot.
- In case of contaminated material, this should be disposed of according to national legislation.
- If national legislation does not specify anything, contaminated materials should be incinerated and any remains deep-buried.
- In case a sub-contracted agency is used, detailed records should be available to track debris.
- In case of service provision by a sub-contractor, proof should be available.
- Water contamination, especially underwater (flooding) contamination, should be ensured.

Harvesting

- Do not harvest from contaminated plants or suspect plants/blocks.
- Use only decontaminated tools and if possible use one set of tools for contaminated plots.
- Leave bunches that have been in contact with the soil or contaminated material in the field.
- Transport to the packhouse should be only through “dirty” roads.
- Within the **packhouses**, there should be clearly established clean and dirty zones.
 - Deliver bunches only to the “dirty” side of the packhouse.
 - Zones should implement appropriate decontamination protocols.
 - Ensure there is a one-way flow of product.
 - Avoid moving fruit across zones.
- Do not re-use plastic bunch bags and dispose them accordingly.
- Manage water category/quality (clean vs. contaminated) according to the zone within the packhouse.
- Dispose all waste (incl. contaminated water).
- Prevent cartons from touching contaminated soil.
- Carton/pellet storage shall be in a clean zone. Cartons shall be easily identifiable and a good traceability system in place.
- Evacuation of product shall be carried out through clean roads.
- Ensure that drivers and trucks for evacuation of product respect decontamination protocols of the packhouses (incl. registers).
- Manage vermin and birds according to the risk (soil and contaminated waste movement).

Training of all the necessary staff or people transiting in the farm as well as the refreshing of the necessary knowledge (risks) shall be repeated constantly. This shall be tailor-made for the type of work and/or for the risk zone they operate in. Decontamination protocols shall be known and followed by all actors. This is the only way to ensure that the objectives are internalized and applied on a daily basis.

Record keeping is an important part of the integrity of any system and shall be done thoroughly. Proper records shall enable the identification of poor practices and allow the proposition of corrective actions and thus improvement (operational and financial).

Sampling and soil testing for TR4 identification: Since *Fusarium spp.* are omnipresent, it is important to follow specific sampling and identification protocols to ensure positive identification of the TR4 pathogen. To this end, please contact a competent organization for support. Usually national plant protection organizations or extension service agencies can provide assistance.

TR4 Annex 2: Communication with National/Regional Plant Protection Organizations

This annex aims to provide producers with a minimal level of guidance on the communication with the national plant protection organizations (NPPOs). This is important, since the TR4 pathogen may be classified by banana-producing countries as a quarantine pathogen and special legal requirements may therefore apply. For example, a national strategy to suppress and/or avoid this pathogen may be coordinated by the government. Not complying with such national efforts might be regarded as a law infringement. Furthermore, this pathogen is a sector-wide concern, meaning that a joint effort is required. This can only be achieved if all parties communicate openly.

Please note that in the case of a quarantine pest or pathogen, NPPO are usually – at a minimum – legally empowered (obliged) to enter any private property to sample, isolate, eliminate infested plants and, if needed, to implement measures to ensure that the pest or pathogen is contained. Any obstruction of these efforts can lead to legal prosecution, which is why it is imperative that producers cooperate with NPPOs. However, the details of national legislation vary considerably from country to country, which also applies to the respective law enforcement. Any suspicious incidence of the pathogen in a country may activate quarantine measures in that particular country, which is why it should be taken seriously.

First steps

- identify the contact person responsible for bananas within your NPPO.
- Actively request all available information about the TR4 pathogen at this agency as well as the national contingency plans or support programs.
- Request a written proof in case there is no national program or support material available in your country or region.
- Look for advice from a farm assurer, consultant or certification body regarding this issue.
- In case no person can assist you in your region, contact an international organization (see links below).

It is important to take seriously any suspicious (or possible) incidence of Fusarium wilt.

- Any sample taken in the frame of a suspected case shall be treated with all applicable biosecurity measures (sampling, transport of sample, analysis, etc.) in order to avoid spreading the pathogen in case confirmation of the pathogen is made after analysis.
- Positive results shall be reported to the National Plant Protection Organization (NPPO).
- Suspected cases include not only the Cavendish cultivars but any other *Musaceae spp.* or any possible host organisms (e.g.: weeds).
 - The report shall include all necessary information to identify the host (plants), area infested (incl. GIS coordinates) and the contact person (e.g.: producer, extension officers, consultants, etc.).
- Taking a sample for official identification of TR4 as well as its analysis and identification are highly complex processes. Producers should therefore request assistance from NPPOs or any other appointed organization to do so. Please always contact your NPPO for assistance.

TR4 Annex 3: Bio sanitary Declaration Template

ON FARM BIOSECURITY VISITOR AND AUDITOR STATEMENT

(1) LAST NAME _____ (2) NAME _____

(3) PASSPORT NO. _____ (4) COUNTRY: _____

(5) COMPANY: _____ (6) TELEPHONE _____

(7) EMAIL _____

(8) POSITION: _____

(9) HAVE YOU BEEN IN A BANANA PLANTATION BEFORE?

YES: ___ WHERE: _____ NO _____

(10) HAVE YOU VISITED ANY COUNTRY IN SOUTH ASIA IN THE LAST 6 MONTHS?

(11) YES: ___ WHERE: _____ (12) NO _____

(13) CHECK ALL THE COUNTRIES FROM THIS LIST, THAT YOU HAVE VISITED IN THE LAST 6 MONTHS

- Taiwan,
- Malaysia (including Sarawak on the island of Borneo),
- Indonesia (Java, Sumatra, Sulawesi, Halmahera, Kalimantan, and Papua, New Guinea),
- Mainland China (Guangdong, Hainan, Guangxi, Fujian and Yunnan)
- Philippines – the island of Mindanao
- Australia (Northern Territory)
- Jordan
- Mozambique
- Lebanon
- Pakistan
- Queensland in Australia
- Oman
- Others, specify: _____

With my signature, I hereby certify that all this information is true

Signature: _____

Date: _____

Passport No.: _____