Banana Bunchy Top Virus (BBTV) Delimiting Survey in Tanzania:

Phase 1 Survey Summary Report



International Institute of Tropical Agriculture (IITA)
Tanzania Plant Health and Pesticides Authority (TPHPA)
Tanzania Agricultural Research Institute (TARI)
Tanzania Horticultural Association (TAHA)

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Background and summary of the findings

Bananas (and plantain, Musa spp.) are the most important crops contributing to food security and the income of millions of smallholder farmers in Tanzania. Banana bunchy top virus (BBTV, genus Babuvirus), an aphid-transmitted virus, was first reported in 2021 in the Buhingwe district in the Kigoma region of Tanzania (Mpoki et al., 2022). The disease caused by this virus infection is termed as banana bunchy top disease (BBTD). A reconnaissance trip in Tanzania from December 2020 to January 2021 revealed plants with typical BBTV symptoms (stunting, bunchy growth with shortened petioles with chlorotic streaks, and yellow leaf margins) in several banana fields in Muhinda and Mwayaya villages. A confirmatory survey conducted in April 2021 in Muhinda, Mnanila, Kibwiga (Buhigwe district), Kalinzi, Mkigo, and Nyarubanga (Kigoma DC) revealed that the disease was widespread. Following a surveillance and diagnostic workshop conducted in August and October 2022, including alerts to report fields with suspect BBTD symptoms, banana farms with symptoms of BBTV infection were reported from Dar es Salaam, Kilimanjaro, Mwanza, Pwani, and Rukwa regions. The BBTV has no effective solutions. Preventing the virus spread and eradication of infected matts is the best strategy.

With the support of funding from USAID and the CIGAR plant Health Initiative, an emergency delimitation survey was conducted in the major banana production regions where the crowdsourced information suggested the occurrence of BBTV symptomatic plants. This survey was conducted in five zones comprising regions already invaded and those at high risk of invasion. The delimitation survey summary, maps of BBTD distribution in Tanzania, and disease impact on banana production and livelihoods are provided in this preliminary report.

Delimitation survey preparatory activities:

The project has organized a preparatory workshop, “Containing the Banana Bunchy Top Virus (BBTV) Spread in Tanzania and Rehabilitating Banana Production in the Disease-Affected Areas: Inception and Planning Meeting,” on 24 and 25 March 2023, at IITA, Dar-es-Salaam, along with the project implementation partners, Tanzania Plant Health and Pesticide Authority (TPHPA), Tanzania Agricultural Research Institute (TARI) and Tanzania Horticultural Association (TAHA). The team discussed the delimitation survey plan, setting up teams, and training for survey teams in surveillance and sampling procedures. The surveyed regions were selected based on banana production area (Fig 1), proximity to areas known to have BBTV, and where the crowdsourcing information suggests the occurrence of BBTV symptomatic plants. A total of 15 regions were selected as a priority for the Phase-1 delimitation surveys, which were organized into five groups (Table 1). Five teams were set up to survey the target districts of each region. The primary survey team comprised 42 members drawn from IITA, TPHPA, TARI, and TAHA, and they were trained through two online workshops organized on 28 April

2023 and 2 May 2023, which covered the performing surveys using an Android app-based ODK tool specifically designed for the BBTV surveillance, which enables real-time data collection and reporting. The survey team was also taught to recognize disease and collect leaf samples for virus confirmatory testing in a laboratory. Each survey team further engaged secondary survey teams locally in the target districts and trained them in the survey procedures. The BBTV ODK application was loaded into the Android apps of the surveyors prior to the survey launch.

Table 1. Survey groups and regions

	Group 1	Group 2	Group 3	Group 4	Group 5
Regions	Arusha (6) Kilimanjaro (6) Manyara (3)	Tanga (8) Pwani (6) Dar (1) Morogoro (2)	Kagera (8) Kigoma (6)	Mbeya (8) Katavi (6) Rukwa (3)	Geita (6) Mwanza (8) Mara (6)
Number of districts to be covered in each region are indicated in the parenthesis					

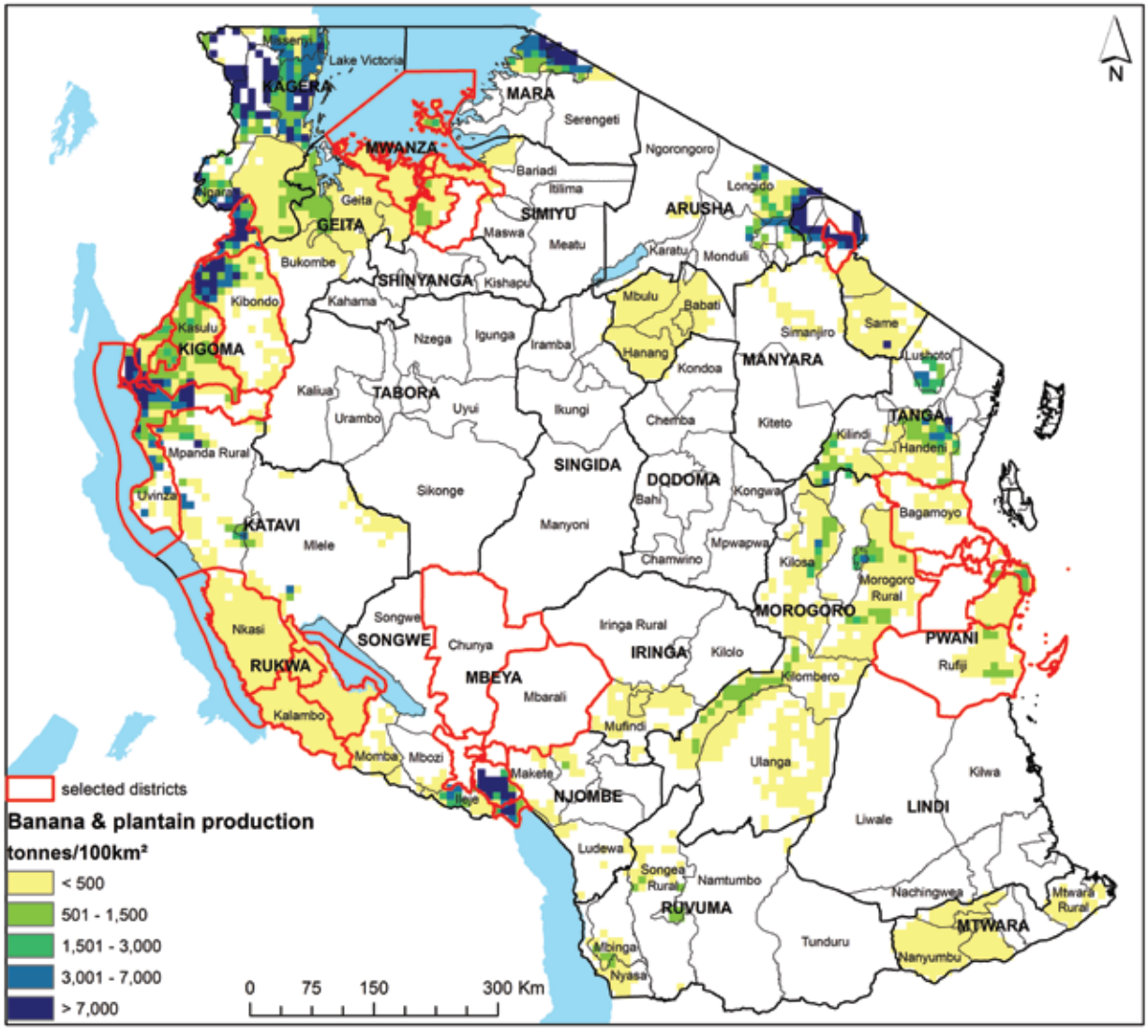


Fig 1. Tanzania map with banana production areas (ha/100 sq.km) and regions selected for delimitation surveys (indicated with red border).

Survey methodology:

Surveys were performed in a total of 15 of 31 regions of Tanzania. TPHPA wrote official letters to the regional, district, and ward-level extension offices informing them about the delimitation survey exercise and its relevance, seeking support for the survey team. On arrival to a district the survey team visited District Agricultural and Livestock Development Organization (DALDO), District Agriculture, Irrigation and Cooperative Officer (DAICO), and MAICO's office for courtesy and agreement on the work plan. The local officials provided approval and commissioned District Plant Protection Officers (DPPOs) to work with the survey team and oversee the survey activities in all sites in the respective districts. In the targeted villages, the survey team engaged with the Village Extension Officers (VEOs) who participated in conducting the surveys. These measures were taken to ensure that local authorities are part and parcel of the work being undertaken as well as to provide training on the disease and measures to take to manage the disease. From each visited banana field in the surveyed region, the teams collected leaf samples from suspected plants that could not be definitively diagnosed as BBTV using symptom expression alone. These samples were taken to the laboratory at the IITA in Dar-es-Salaam for confirmation using the rapid BBTV diagnostic kits based on recombinase polymerase amplification (RPA) and loop-mediated isothermal amplification (LAMP) devices.

Data was collected using a questionnaire in the ODK tool. The emphasis was on BBTV but also collected data on other important banana diseases and geographical and household information. During the survey, the enumerators visited BBTD-affected fields located at least 5 km apart and interviewed the head of the household based on the structured questions in the ODK tool uploaded on smartphones. Data in ODK forms were submitted when a reliable internet connection was secured. Virus testing data were collated in Excel sheets and matched to the corresponding field data downloaded from the BBTV ODK tool.

Key findings:

- Of the 15 surveyed regions BBTV was detected in 10 (Fig. 2). BBTV was not detected in Arusha, Kagera, Manyara, Mara, and Tanga regions (Table 1). Further monitoring of fields in these regions is ongoing using the BBTV crowdsourcing group.

- In the Kilimanjaro region, BBTV was detected in 2 districts, Moshi Municipal and Moshi Rural. The other districts (Hai, Mwanga, Rombo, and Siha) appear free from this disease. Measures to continue monitoring for the disease are in place using Crowdsourcing. Local authorities, including DPPOs and extension officers, were included in the crowdsourcing.

- BBTV was very severe in Moshi (Msaranga Ward), with farmers abandoning banana production for alternate crops like maize, cassava, etc. The virus wiped out entire banana fields. Initially, BBTV was seen in Moshi Municipal only in the previous surveys conducted in 2022, and now the virus has spread to the Rural Moshi district.

- In Dodoma, BBTV was detected in Dodoma Urban. This followed reports of a backyard garden that had BBTD symptoms. The garden had been established with planting material bought from a nursery in Morogoro. More districts in Dodoma should be surveyed to get the full extent of the disease in this region.

- In Morogoro, three districts were surveyed. BBTV was detected only in Morogoro Urban and in the Mzinga ward. This detection was made possible by a report of a farmer in Dodoma who observed BBTV symptomatic in the suckers purchased from a nursery near the Sokoine University of Agriculture in Morogoro. The survey team detected severe BBTD symptomatic suckers in the nursery. The nursery operator confirmed sourcing the planting material from the Mzinga ward in Morogoro Urban. The nursery has been selling banana seedlings to many farmers in Dodoma, Dar es Salaam, Mbeya, Shinyanga, and Mara. Farmers in Mzinga claim to have noticed BBTD symptoms starting in 2022 but were unaware of the source. Production losses in this ward are more than 90%. A follow-up of the banana sucker distribution from this nursery is needed.

- In Pwani, BBTD was detected only in Kisarawe District. No BBTD was detected in the other eight districts. Farmers were not aware of the disease. Because the plants were no longer producing, farmers abandoned the farms or cut at the base of pseudostems. The leftover stubbles and new sprouts serve as inoculum sources and perpetuate the disease.

- BBTD was widely distributed in the two districts (Kinondoni and Ubungo) that were targeted in Dar es Salaam Region. Most of the bananas are grown in backyard gardens. Most farmers bring planting material from their rural homes, which was the most likely source of the disease in Dar es Salaam. Farmers reported seeing the disease starting in 2021.

- Kigoma is the first place where the disease was noticed and reported. The disease is widespread in Buhigwe and Kigoma districts, with all fields visited having diseased plants. During this survey, BBTD was detected in Uvinza District, showing that the disease continues to spread southwards. Kasulu and Kibondo districts were free from the disease. However, a suspected plant was observed in one field in Kakonko District. Diagnostic tests of the samples taken from this field tested positive for BBTV. A repeat test will be organized for reconfirmation. Nonetheless, this result confirms a northward movement of BBTV. More fields in this area need to be surveyed to identify spread of BBTV to other fields in this area and implement eradication.

- In Katavi, BBTD was observed in the three districts that were surveyed, while in Mbeya, plants with BBTD symptoms were observed in four districts. It appears that BBTD is widespread in Katavi. Further surveys are needed, covering more districts to better understand disease distribution and severity, including Rukwa and Songwe regions, as these regions border with BBBTV-affected Mbeya to the south and Katavi to the north.

- In Nothern Tanzania, BBTD was detected in three of the eight districts in the Mwanza Region. The districts with BBTV are Nyamagana, Sengerema Town Council (TC), and Ukerewe Districts. Mild symptoms that looked like BBTD were observed on only one

plant/mat in one site in Misungwi on a Matoke variety reported to be sourced from Rombo District in Kilimanjaro. Confirmatory tests conducted in the laboratory was positive to BBTV.

- In Ukerewe District, BBTD is widely distributed, and all wards are affected. Disease incidence was 81%. A similar situation was observed in Nyamagana District. In Kagera, eight districts were surveyed, and all were free from BBTD symptoms and, no BBTV was detected in the leaf samples from these locations.

- In Geita, BBTD was detected in two districts, Geita TC and Geita Rural District. The Geita TC district is the most affected (80%), while the areas affected in Geita DC are those near Geita TC. It appears that the disease is spreading from urban to rural areas. Farmers reported that they had seen symptoms of BBTD in Geita TC since late 2019, and many have replaced their banana fields with sugarcane, vegetables, and other crops.

- Molecular diagnostics analysis of the collected samples confirmed the presence of BBTV in all areas where symptoms of BBTD were observed, including Kakonko and Misungwi districts where suspected cases were mild symptoms (Table 3).

Recommendations:

Immediate interventions are required to prevent further spread of BBTD in the country.

1. Top-level meetings should be organized to deliver awareness to the government/ministries to secure access to government resources in fighting against BBTD.

2. Awareness campaigns are needed among farmers and extension officials as their knowledge of BBTV and BBTD is critically limited. Consequently, the disease spread into new areas was not noticed until very late, which seems to have allowed the firm establishment of the disease in farms.

3. Movement of planting material might be the major factor contributing to the spread of BBTD. There is a need to reduce or restrict the movement of planting materials from one place to another. There is a need to establish a functional banana seed system to curb the spread of BBTD.

4. A strategy to strengthen the production and supply of clean planting material to farmers needs to be developed and operationalized. This should go hand in hand with educating famers to stop taking planting materials from neighbours or unverified sources.

5. The disease continues to spread. More surveys are needed, especially in the new areas, to delineate infected from uninfected areas and implement zoning to stop disease spread.

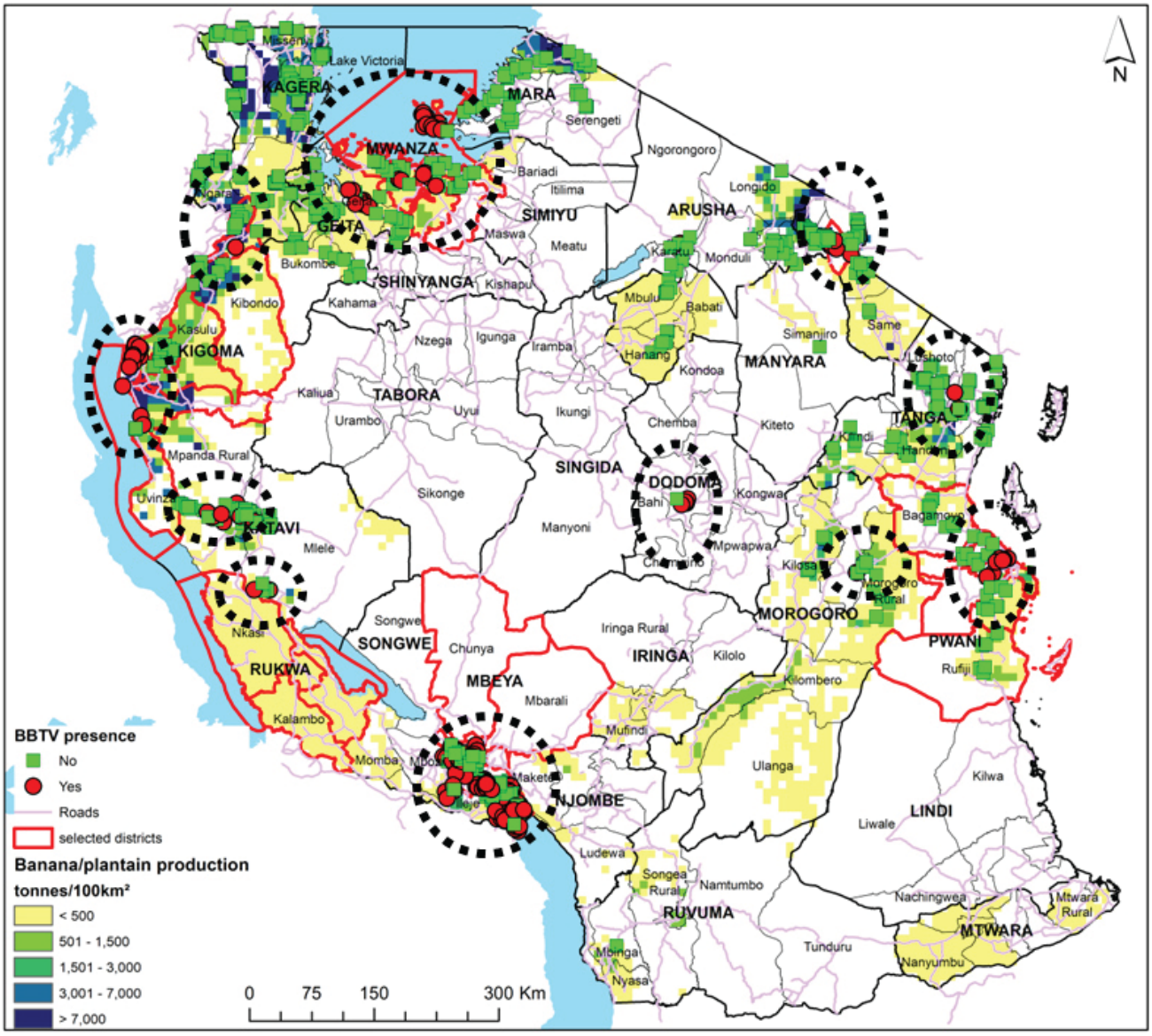


Fig 2. Locations of surveys conducted in Tanzania. Sites of BBTD occurrence is indicated in red solid circles.

Table 1. Regions and locations observed for banana bunchy top virus infection in the farmers' fields as part of the Phase-1 delimitation studies conducted in Tanzania.

Serial Number	Regions	Total Districts	Districts surveyed	Districts with BBTD
1	Tanga	11	11	0
2	Kagera	8	8	0
3	Pwani	9	9	1
4	Mara	7	7	0
5	Mwanza	8	8	4
6	Geita	6	6	2
7	Kigoma	7	6	4
8	Kilimanjaro	7	7	2
9	Arusha	7	6	0
10	Katavi	3	3	3
11	Manyara	6	3	0
12	Mbeya	6	6	4
13	Morogoro	7	3	1
14	Dar es Salaam	5	2	2
15	Dodoma	8	1	1
	Total	**104**	**85**	**22**

Note: Regions marked in red contain districts where BBTV has been detected.

Photos of BBTD-affected plants and testimonies



Figure 1. Plants with BBTD symptoms in a backyard garden in Mzinga ward in Morogoro. The nursery sources planting material from this ward and sell to other regions, including Dodoma, Dar es Salaam, Mbeya, Shinyanga, and Mara.



Figure 2. Infected abandoned mat by road side in Ukerewe.



Figure 3. Transportation of planting material (a sample collected from this carriage confirmed at least one of these suckers was infected by BBTV) from Ukerewe Island towards Bunda, where no BBTD symptoms have been reported before, nor were any symptoms spotted during the current survey. Uncontrolled/uncertified movement of planting material across administrative locations could be contributing to the rapid spread of BBTD, especially in urban locations.



Figure 4. BBTD-affected farms in Geita replanted with other crops. Farmers are replacing their banana plantations/farms with other crops (e.g., vegetables and sugarcane, maize, etc) as a coping mechanism.

Testimony from a few farmers on the impact of BBTV on their livelihoods

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Impact of BBTV

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"I used to harvest 150200 bunches of bananas per year and sell each at 15,000. This money was enough to pay for my Children's school fees and the remaining supplement family food. This year (2023), I have harvested only 10 bunches which are very small. I sold them at 2000 Tsh per bunch' Mr StewartKiwelu, Moshi June 24, 2023

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"I am a widow with 5 children When my husband passed on in 2019 he left 2 acres of bananas In 2020 I started observingstrange symptomson banana in my field Now my bananasare not producingbunches I used to harvest 300 banana bunche per year this year, I have harvested<10 bunches / uprooted part of the banana and planted maize so I can have food for my family. Next season/ will uproot the remaining bananas and plant maize But maize is not profitable compared to banana The govemment should assist us, so we go back to farming banana'

A widow farmer (Matyazo village in Buhigwe district)- Datel 6 May2023

Impact of BBTV



Photo 1: We planted new farm about two acres to support our student to eat fruits for nutrition purpose, sun fortunately the whole field is now infected with diseases . No farm, no banana for our student's Head teacher Mwakilima Secondary school. Photo May 12 /08/ 23

Kyela, Mbeya
Date 18th May,2023

Impact of BBTV



"I used to harvest 30 bunches per month in my 0.2h farm but after the disease came, I am luck if I can harvest bunches per month. I tried to use different method to combat the disease like to remove sick plant sand replanting, but the problem still persist said Maridhiana Nassibu, a farmer in Mzinga Morogoro



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