A historical overview of the appearance and spread of Musa pests and diseases on the African continent: highlighting the importance of clean Musa planting materials and quarantine measures.

Focus

- Chronological overview of first reported observations of a *Musa* pest or disease in Africa;

- Highlighting specific examples where a pest or disease was introduced with planting materials;

- Recent examples on how a pest or disease spread to a new region through infected planting materials.
East African Highland Bananas (AAA-EA) and Plantains

*Musa* spp., are not native to Africa. They evolved in tropical Asia, from Southwest India eastward to the island of New Guinea.

There is growing circumstantial evidence which suggests that the East African Highland banana and the tropical lowland plantain were cultivated on the African continent since before 1 AD.
It appears that the very early introductions of Highland banana and plantain arrived in Africa without many of the major pests and pathogens affecting them in Asia, at least those that cause conspicuous damage and for which recent records on the continent exist.
Arabian trade

It is likely that Arabian traders (from 600 AD) brought the ABB, AB and dessert AAB genome banana cultivars from India to the continent, and that these were slowly disseminated throughout East Africa.
Past 100 years - Botanical gardens and Research stations

The main centres of distribution for banana cultivars introduced in colonial times were botanical gardens, such as Zomba in Malawi, Entebbe in Uganda ('Sukari Ndizi', 'Gros Michel', 'Red', 'Dwarf Cavendish') and Amani in Tanzania.

Banana cultivars were also introduced through research centres e.g. the INEAC Yangambi station in central DR Congo.
A wide range of *Musa* pests and diseases are currently hampering banana/plantain cultivation across the African continent with severe implications for small-scale *Musa* farmers.

**Pests**

- Nematodes
- Banana Weevil

**Diseases**

- Sigatoka Leaf spots
- Banana Bunchy Top Disease (BBTD)
- Xanthomonas Wilt
- Fusarium Wilt
Nematodes

The important alien nematode species are:

- *Radopholus similis* (considered Australasian in origin)
- *Pratylenchus coffeae* (is considered a native of the Pacific and Pacific Rim)

Both *R. similis* and *P. coffeae* have presumably been introduced into Africa on *Musa* planting material.

A third species, *Pratylenchus goodeyi* is considered a native African species with an, at present, limited Afromontane distribution (e.g., in Uganda *P. goodeyi* predominates at altitudes over 1,200 masl).
Nematodes - *R. similis*

In Côte d’Ivoire, Cameroon and Guinea-Conakry, *R. similis*, as a pest of small-holder *Musa* production, is closely restricted to regions where large-scale Cavendish plantations occur/occurred. There appears to be little spread beyond these areas.
It has been suggested that *R. similis* was introduced to Uganda around 1960-1962 on introductions of plant material to one or more of the country’s research stations (Kawanda, Bukalasa or the Kabanyolo University Farm).

*Musa* planting material brought from Uganda to the Maruku Research Institute (Kagera, Tanzania), a centre for distribution of plant material to farmers and to other institutions across Tanzania, was recognised by authorities as the origin of *R. similis* in the Bukoba area.

Thirty, presumably *R. similis*-infected, *Musa* varieties from the Bukalasa banana collection in Uganda were taken to Maruku, Kagera, Tanzania in 1968.
Nematodes – *R. similis*

Multi-location variety trials conducted in the late 1960s by the Kawanda Research Station and the Kabanyolo University Farm in Uganda and the Maruku Research Institute in Tanzania may have significantly contributed to the spread of *R. similis* across the region.

Agricultural extension and planting material distribution efforts involving national research stations may also have contributed to the spread of the pathogen.
As early as 1969, the central region of Uganda was considered the most heavily infested with *R. similis* a region where the three main research facilities of the time were located. In 1969, after the discovery of *R. similis* at the Serere Experiment Station, the banana collection was uprooted.

Unfortunately, *R. similis* now appears to be widely distributed in ecologically suitable areas of East Africa including the islands of Zanzibar and Pemba, and in the coastal areas of Kenya and Tanzania.
Nematodes - *P. goodeyi*

Although of limited worldwide distribution, and as stated earlier considered native to the highlands of East and West Africa, the lesion nematode *P. goodeyi* has been found in Egypt and has also spread beyond the continent, being reported as a pest of banana in the Canary Islands, Crete, and New South Wales in Australia.

There is the suggested role that European botanic gardens may have had in this spread. Kew Gardens in the United Kingdom is in fact the taxonomic ‘type locality’ of *P. goodeyi* and in the 1970s *Musa* material originating from Kew being grown at Imperial College was found infested with *P. goodeyi*.

Archives at Kew Gardens record dispatches of *Musa* planting material to Tenerife in July 1892 and Gran Canaria in September 1894.
Banana Weevil

1903
1908
1913
1922
1924
1925
1927
1938
1945
1947
1957
1987
1988
1989
1990
1993
The banana weevil was most likely introduced in Uganda around 1908 with imported *Musa* plants, which had been established in the Botanic Gardens at Entebbe.

*C. sodidus* had in 1918 only been identified between 31°30' and 33°30' E longitude on the islands, or within 30 miles of Lake Victoria. Entebbe was approximately at the centre of this area.

*C. sordidus* was found to be well established at Amani in coastal Tanzania by A.H. Ritchie in 1922.
Banana Bunchy Top Virus
Banana Bunchy Top Virus (south Pacific group)

A large part of the movement of ‘South Pacific’ BBTV isolates has been linked to the movement of planting materials during the British colonial era.

The disease first appeared in New South Wales, Australia (Darnell-Smith, 1919; Darnell-Smith and Tryon, 1923) in 1913 and probably originated from the importation of diseased suckers from Fiji to start the new banana Industry.

Banana bunchy top disease was also reported in the Colombo district of Sri Lanka (Ceylon) in 1913 most likely with the importation of diseased planting materials from Fiji.
BBTD was identified in the *Musa* collection at the INEAC (currently called INERA) Yangambi station in today’s Democratic Republic of Congo in 1958.

The introduction of the disease at the INEAC Yangambi Research Station must have occurred somewhere in the late 1940s or early 1950s.

The new exotic planting material that arrived at Yangambi was first placed in quarantine and inspected while growing in the botanical garden of Eala and later on Bosa island in the Congo River.
Possible origin of BBTV at Yangambi

→ numerous *Musa* accessions obtained in Yangambi originated from *Trinidad*, where the British banana breeding program was located;

→ numerous plantain accessions were introduced from various regions in Congo, where no banana bunchy top had been noticed;

→ *Musa* collection at Bogor, formerly called Buitzenzorg, on Java, Dutch East Indies and sent to Yangambi well before World War II at a time when quarantine was rudimentary.

→ Yangmbi Km5....(Asia, Kilo Moto,...)
During 1956, symptoms of banana bunchy top were observed on plants of ‘Yangambi Km5’ (AAA genome) growing at the INEAC station of Lubarika, south of Bukavu, on the western side of the Rusizi valley, South Kivu, Democratic Republic of the Congo.

A small banana collection had been established at Lubarika and ‘Yangambi Km5’ plants had been introduced from the INEAC Yangambi station in the early 1950s.

No banana bunchy top symptoms were observed anywhere else around Lake Kivu during 1956. It can be assumed that Lubarika was the local source of BBTV.
**Mycosphaerella** leaf spot pathogens

*Mycosphaerella musicola* - Sigatoka leaf spot

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Source</th>
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<tbody>
<tr>
<td>Uganda</td>
<td>1938</td>
<td>Stover (1962)</td>
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<tr>
<td>Tanzania</td>
<td>1939</td>
<td>Stover (1962)</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1941</td>
<td>Stover (1962)</td>
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<tr>
<td>Etc...</td>
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Jones (2000) believed that the rapid global spread of *M. musicola* was most likely caused by the unrestricted movement of affected propagation material or leaves rather than by wind-blown spores.
Spread of *M. fijiensis* on the African continent is thought to have resulted from the initial movement of infected planting material and leaves from Asia followed by the subsequent dispersal of wind-blown ascospores.
Banana Xanthomonas wilt

Map showing the spread of Banana Xanthomonas wilt from 2001 to 2006 in various countries in Africa. The map includes a timeline from 1939-68.
Xanthomonas wilt was said to have been first observed in 2001 on a few plants by farmers at Bwere Hill, Bashali Mokoto village in the Masisi district, which is 72 km northwest of Goma in North Kivu Province, DR Congo.

The disease was first officially observed in June 2005 around Gisenyi in northern Rwanda. Farmer reports suggest the disease may have been present as early as 2002.

The disease may have spread from the DR Congo when Congolese people fled to Ruhengeri and Gisenyi provinces following the eruption of Mount Nyiragongo in January 2002. In addition, there is a regular interchange of people and goods across the Rwanda-DR Congo border and the first confirmed outbreak of the disease in the DR Congo was in Masisi region (Lacs Mokotos), which is close to Gisenyi.
Fusarium oxysporum f.sp. cubense (Foc)

The introduction and spread of Foc in Africa has not always been well documented. Several independent introductions of the pathogen may have occurred.
The first reports of Fusarium wilt in West Africa go back to 1924 in Sierra Leone, Nigeria and British Cameroon and were associated with the export production of ‘Gros Michel’ and mirror what happened with this disease in tropical America.

These outbreaks were probably related to subsequent first reports on ‘Gros Michel’ in Ghana (1937) and Guinea Conakry (1939).
Fusarium Wilt – Foc TR4

Foc ‘tropical’ race 4 (Foc TR4) has not been found on the African continent. To prevent its introduction, it is important to restrict the movement of banana plants (and soil) onto and within the continent, particularly those coming from Asia. Foc TR4 is currently only found in Asia, but its host range includes many important banana cultivars grown on the African continent.

The recent appearance of Foc TR4 in southern China is believed to have been due to movements of infected planting materials from Taiwan.

Similarly, the Foc TR4 outbreak in the Northern Territory of Australia in 1998 was believed to have resulted from movement of infected materials.

To date, the Foc TR4 pathogen has not spread to the major banana growing areas in North Queensland due to strict and effective quarantine policy implementation.

Similar efforts will be needed to keep Foc TR4 out of currently non-infested areas in the rest of the banana-growing world.
Need for strict quarantine measures

In conclusion, most pests and diseases arrived on the African continent over the past century.

→ Botanical gardens
→ Research stations (collections, multi-location evaluation, germplasm distribution)
→ Migration of people during times of natural disasters or social conflict
→ Planting materials moved by traders, private entrepreneurs
→ Planting material moved by farmers (farms, villages, cross-border)

Indigenous biotic constraints such as Xanthomonas wilt (Ethiopia) and the nematode Pratylenchus goodeyi (highlands of East and West Africa) are steadily spreading across borders.
Need for strict quarantine measures

Knowledge on geographical pest and disease spread is imperative for the strengthening or implementation of quarantine and phytosanitary measures to halt within-country or trans-border spread.

Rapid and healthy multiplication of banana planting material is key to a vigorous and healthy banana sector.

Technologies for clean seed production are available and include paring of corms, boiling water treatment, the use of macro-propagation and tissue culture plants.

Undoubtedly, clean planting materials and effective quarantine measures are key to the management of these important biotic constraints to production.
Acknowledgements

A special thanks to Leila Er Rachiq, Bioversity CfL assistant documentalist for tracing numerous Colonial era scientific publications.
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