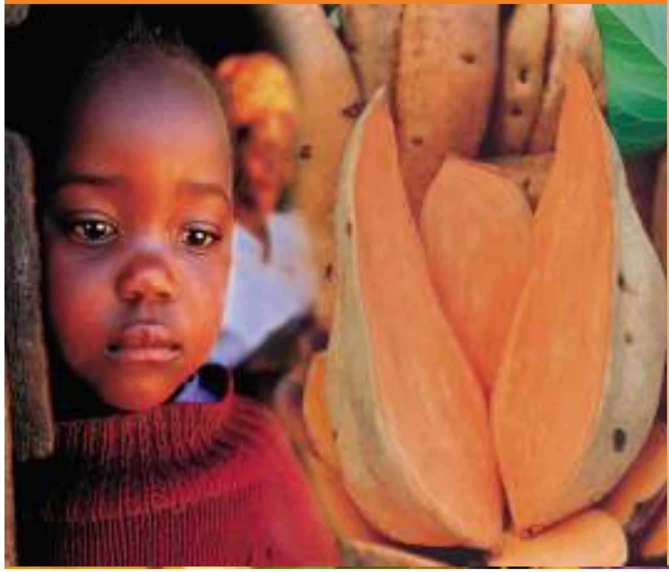


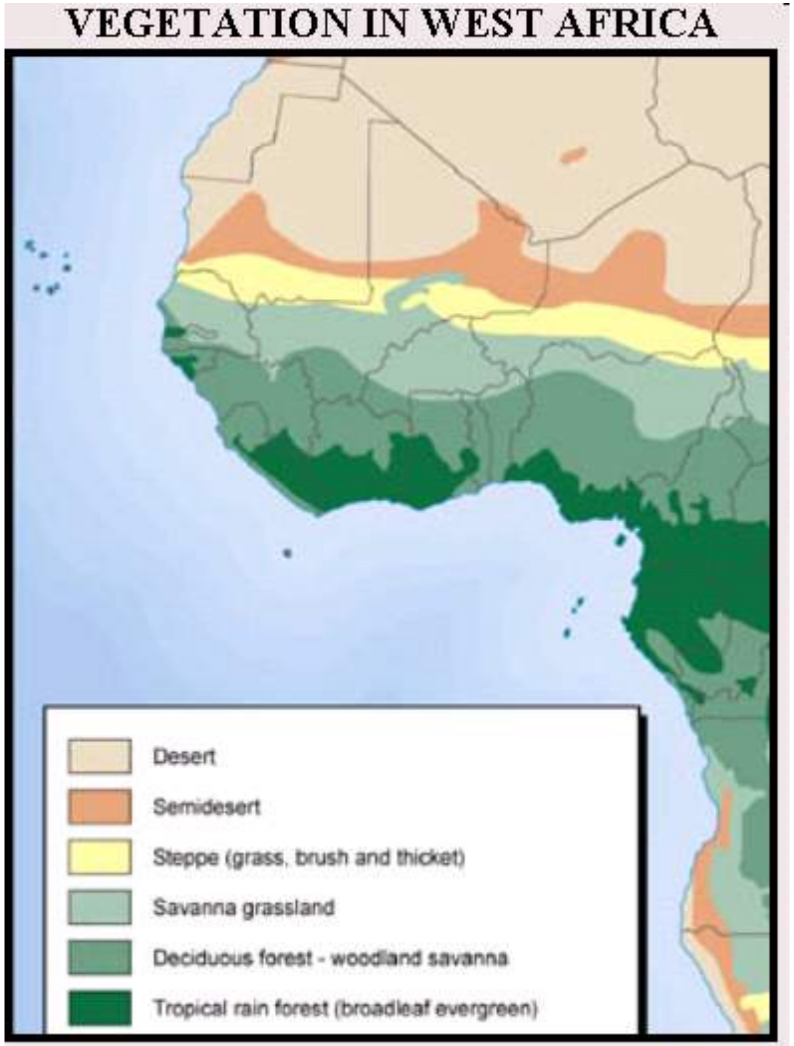
SASHA and the Sweetpotato Support Platform: Breeding and Seed Systems for West Africa

Ted Carey

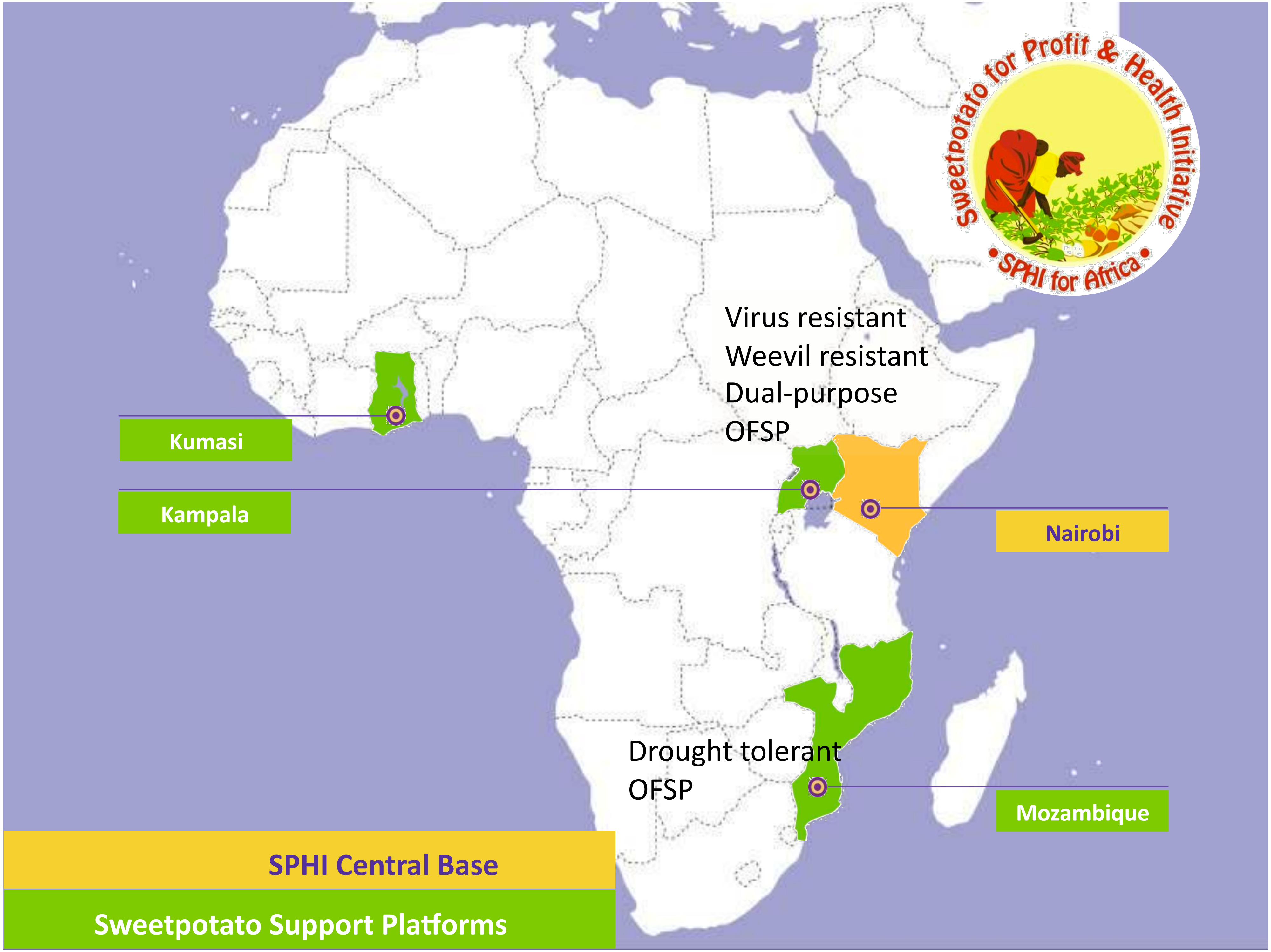
6 July 2010

Sweetpotato Support Platform West Africa

- Non-sweet Pre-breeding (unsweetpotato = USP)
  - Drawing on global capacity
  - NIRS
- Breeding Backstopping/ partnership (AGRA and others)
  - Ghana
  - Nigeria
  - Burkina Faso
  - Others
- Germplasm Exchange Seed System Support



Even though it’s not sweet the vehicle has to be orange!


Sweetpotato for Profit & Health Initiative
SPHI for Africa
Virus resistant
Weevil resistant
Dual-purpose
OFSP
Kumasi
Kampala
Nairobi
Drought tolerant
OFSP
Mozambique
SPHI Central Base
Sweetpotato Support Platforms

Breeding Unsweetpotato

- Understanding USP
  - Sweetness
    - Population target (<12% total sugar, <9% sucrose)
  - Taste (sweetness, texture, appearance, etc)
  - Utilization – Participatory approach (producers, processors, consumers)
  - Adaptation (Major AEZs – Forest to Savanna)
  - Students – WACCI (Vivian Oduro; Ernest Baafi) and others

USP potential uncertain
Low dm absorbs too much oil

Understanding USP Germplasm sources

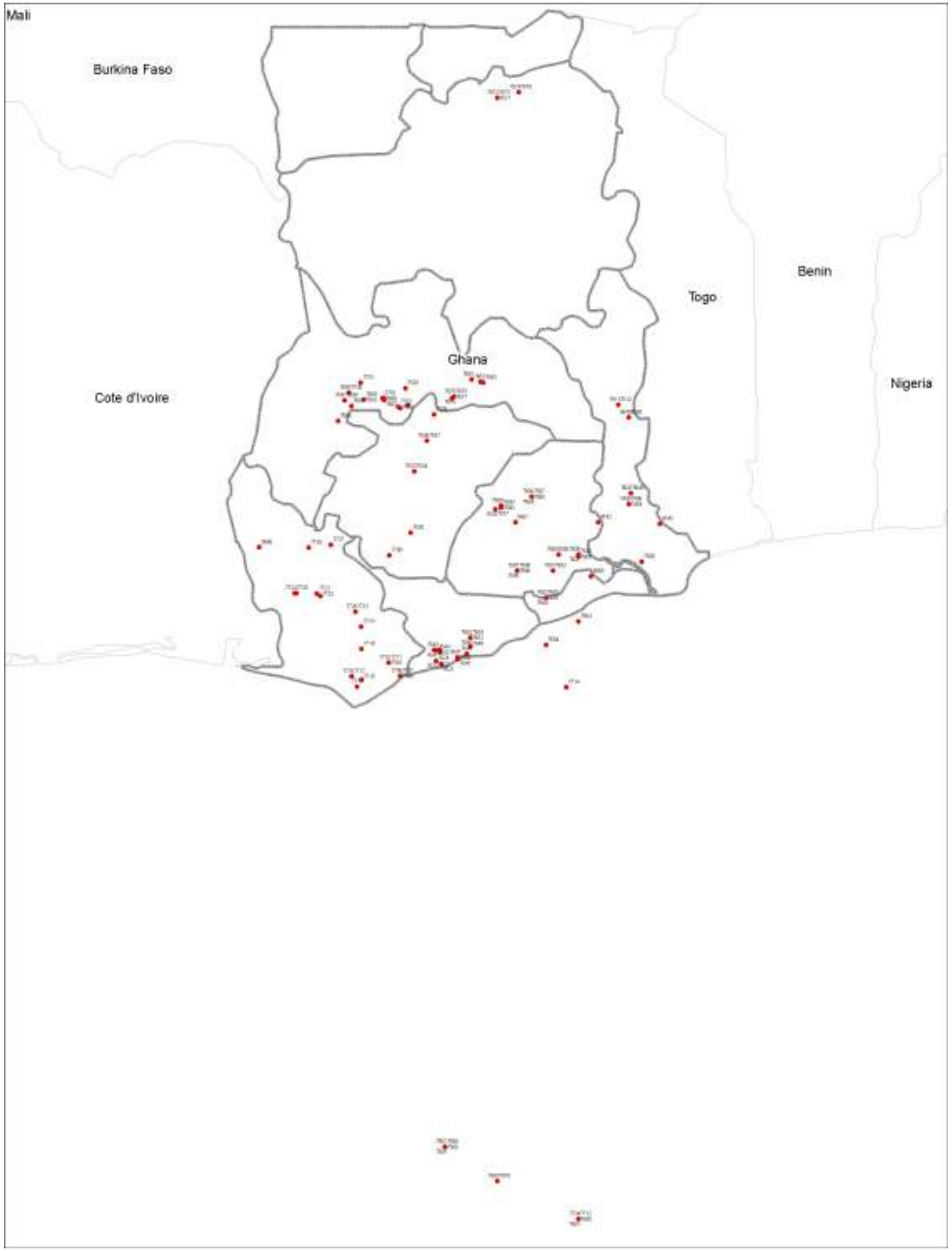
- West African Germplasm
  - Farmers varieties?
  - IITA materials
- Global genetic resources
  - CIP (Population B)
  - USDA (Stan Kays)
    - Kyukei 97 ~7% (bake) ~7% (raw), v. low amylase
    - CN1280-3 ~20% (bake) 9% (raw), v. low amylase

Germplasm

First map showing distribution of sweetpotato germplasm collection in Ghana

Next steps are clear

Vivian Oduro



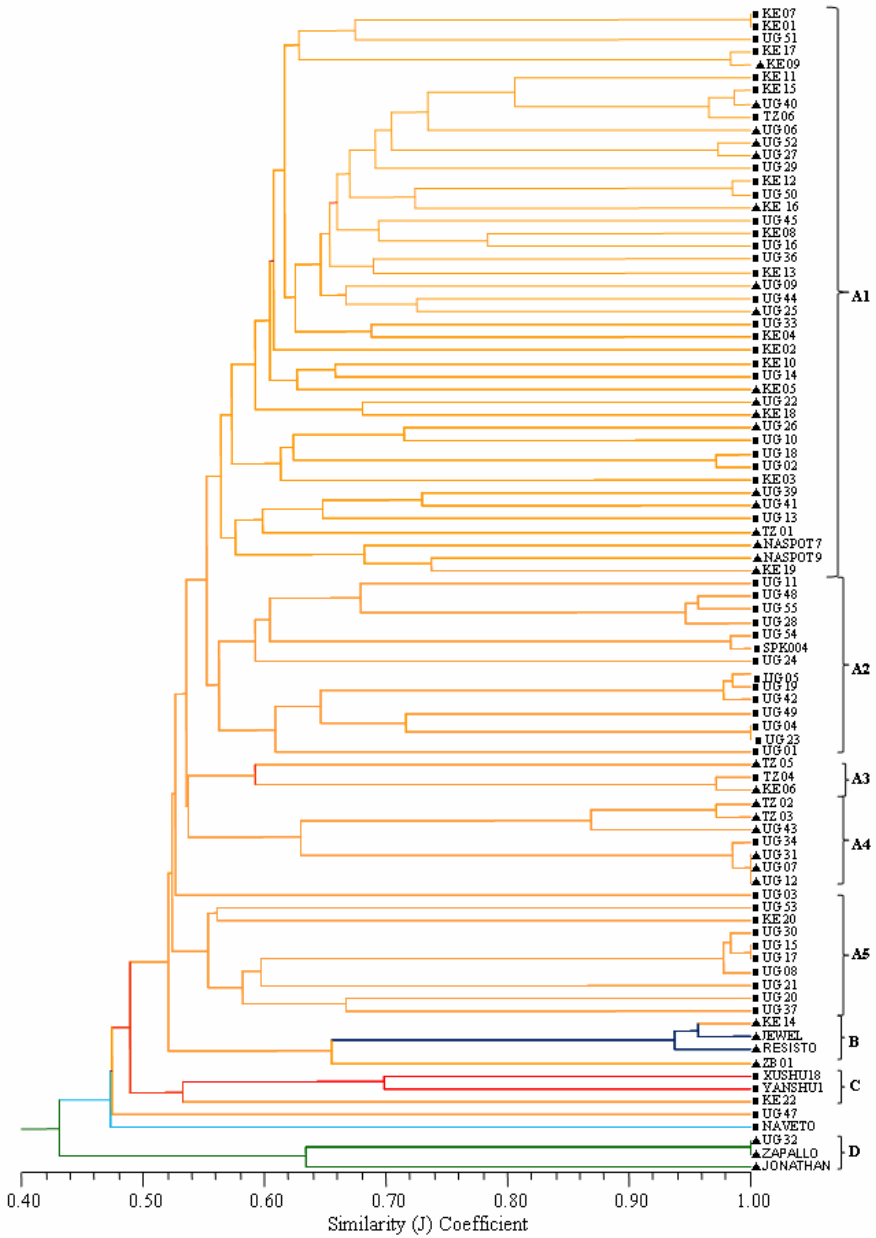
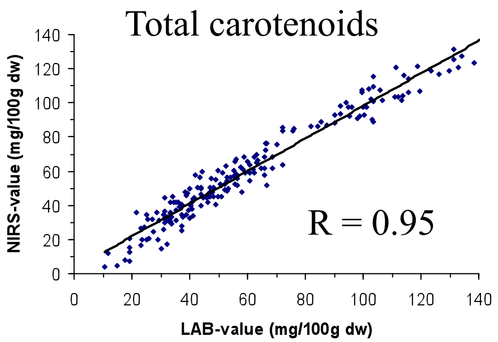
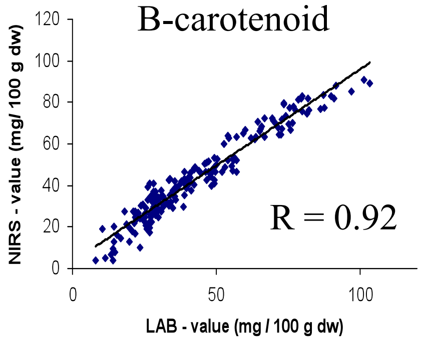


Fig. 2 Dendrogam of the UPGMA cluster analysis of 92 sweetpotato cultivars (85 cultivar of African origin) on the basis of Jaccard's SSR based genetic similarities

(origin of clones: orange = Africa, green lines = South American germplasm, light blue = Pacific, deep blue = North America, and red = China; origin of East Africa farmer varieties: UG = Ugandan, cultivars, KE = Kenya, TZ = Tanzania, ZB = Zambia; ☐ = White fleshed clones, Δ = Orange-fleshed clones)

(VII) NIRS (Near Infrared Reflectance Spectroscopy)





<u>Sweetpotato dried roots:</u>

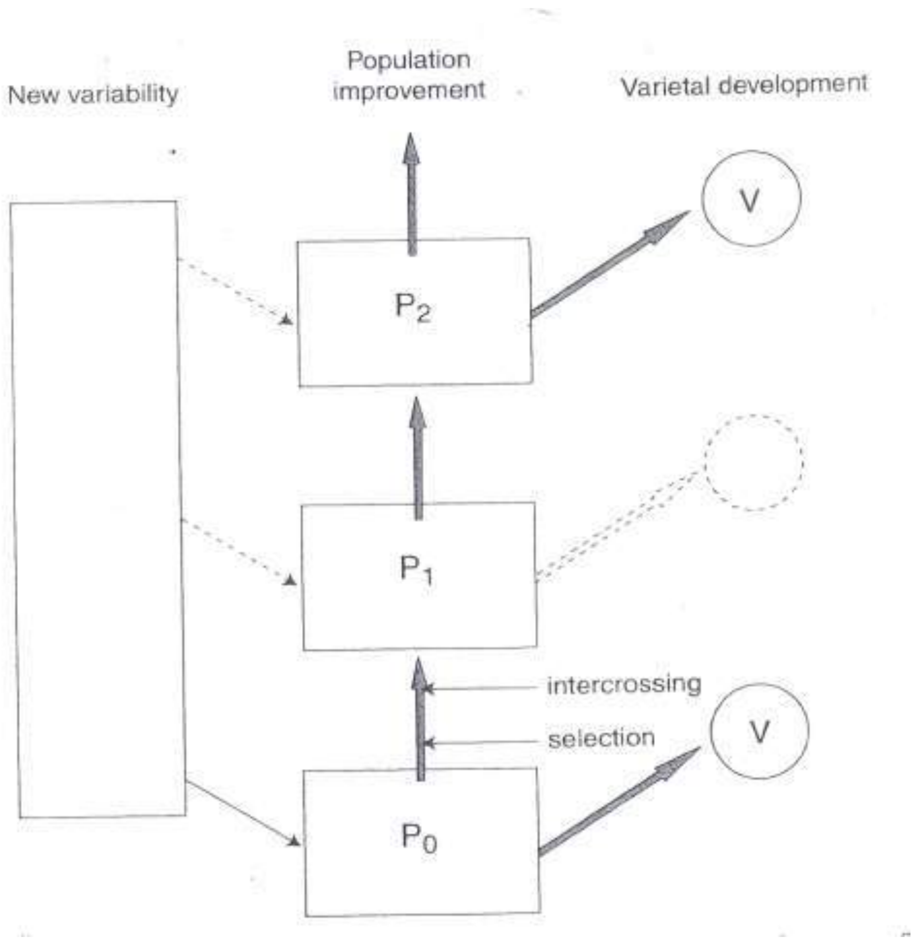
Protein, starch, sucrose, fructose, glucose, total carotenoids, b-carotene, Fe, Zn, Mg, Ca, Mg

<u>Sweetpotato fresh roots:</u>

Protein, starch, sucrose, fructose, glucose, total carotenoids, b-carotene, Fe, Zn, Mg, Ca, Mg

CIP is conducts the NIRS calibration development for Harvest Plus across all HP crops

Sweetpotato Support Platform (SSP) Breeding Activities



- Population (P) improvement by SSP – long term (SASHA)- use distinct populations to lead to major improvements (heterosis) in e.g. yield, disease resistance
- Variety (V) improvement by sweetpotato National programs – short term (AGRA or other support)

Seedling nursery and Crossing Block

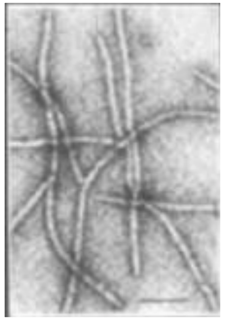
Multiplication for trials with SARI

Kumasi is a virus hot spot

Apomuden - Resistant **Jewel - Susceptible**

Markers and Sweetpotato virus disease (SPVD)

Aphids



SPFMV and / or other viruses + SPCSV Crinivirus →

Whiteflies

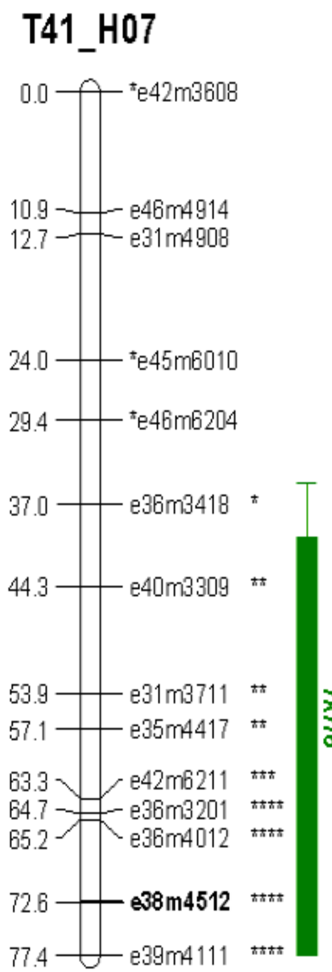
Apparently healthy SPFMV and / or other viruses

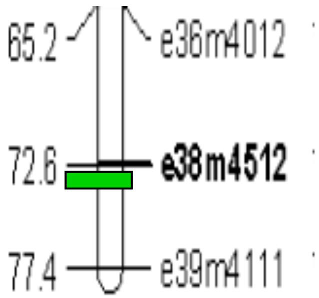
SPVD
SPCSV + SPFMV and / or Other viruses

In experiments:
Yield reduction up to 90%

In practice:
Yield reduction up to 75%

Identify Gene/Marker and Verify Marker





Sequence

Compare to known sequences

Specific Primers (rkn1f, rkn1r))

Testing in other Progeny or clones

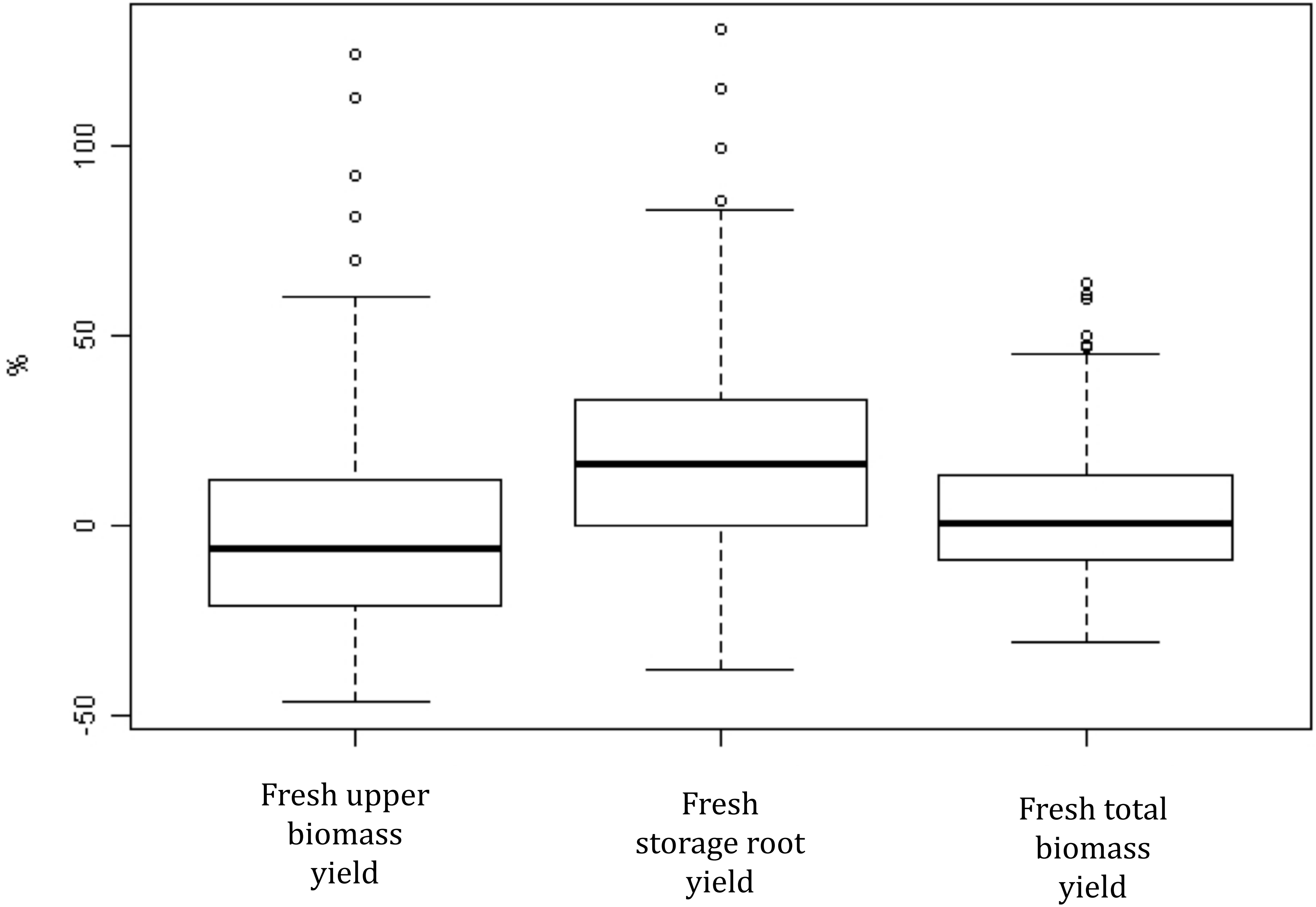
Confirm QTL

Use marker for selecting resistant clones (MAS)

Planting early selection stages of sweetpotato for the accelerated breeding scheme in San Ramon (one of 3 locations)

Plot size: 1m row plot

Mid-parent – progeny distributions 231 families



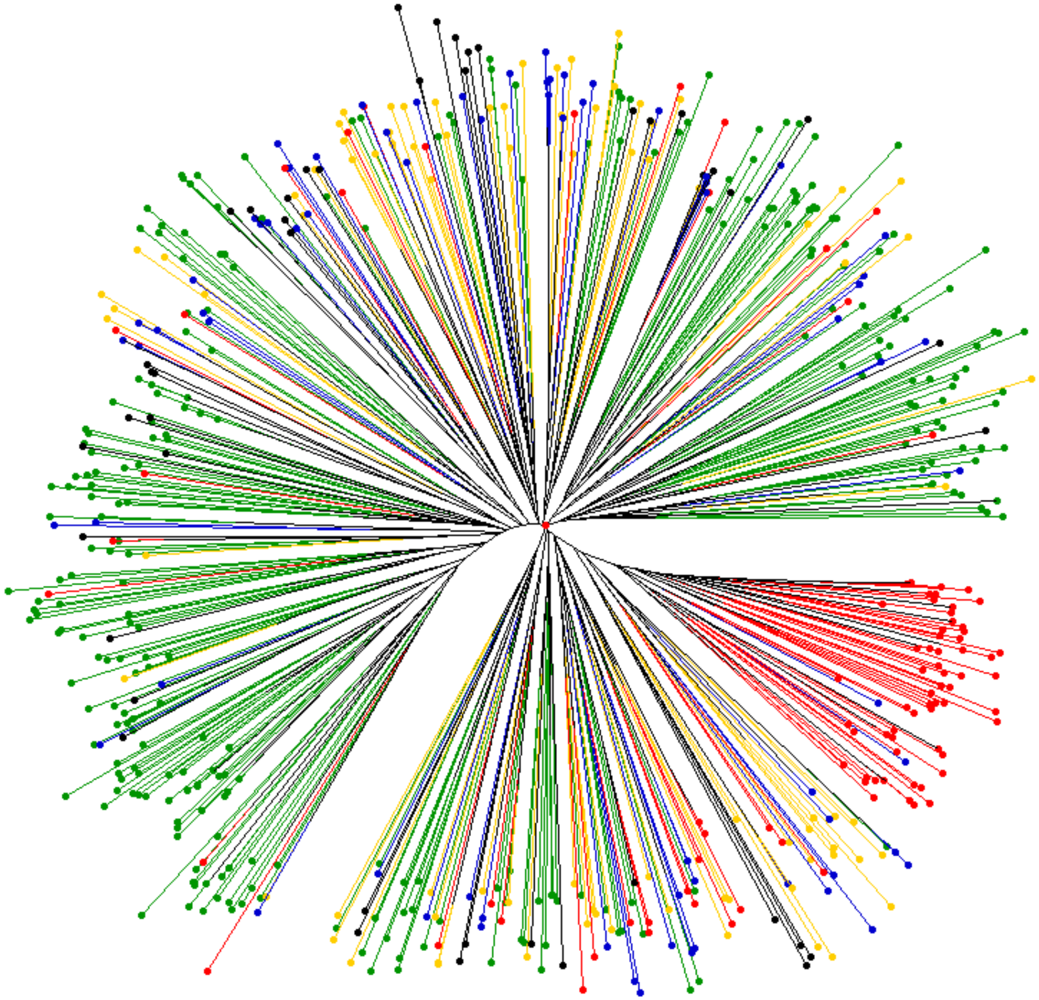


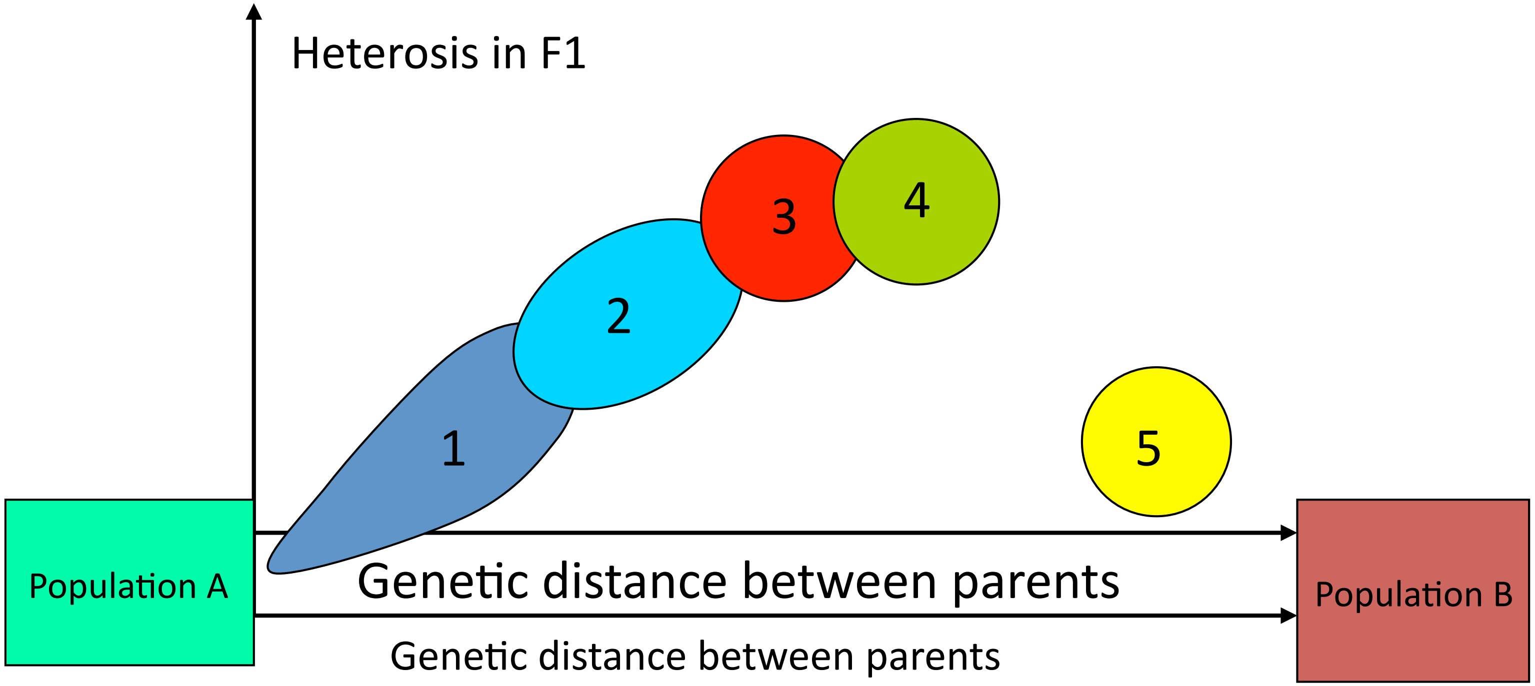
Fig. Cluster analysis of 575 accessions of sweetpotato based on 20 SSR markers

(Central and North America in black, South America in green, Pacific including New Zealand, Austria and Papua New Guinea in blue, Asia in yellow and Sub Saharan Africa in red).

Marker Application for Heterosis and Genetic Distance

Heterosis increases with the Genetic Distance

& deceases if the Genetic distance is to large



Schematic representation of the relationship between mid-parent heterosis for yield and parental genetic distance based on unselected DNA markers (1) Crosses between related parents (2) intra-genepool crosses between unrelated lines (3) - (5) inter-genepool crosses (Lefort-Buson 1985, Melchinger 1999, modified)

Germplasm Exchange + Seed System Support

Example: Recognized viruses that infect sweetpotato

Genus	Virus	Transmission	Distribution
Potyvirus	SPFMV	Aphid	Worldwide
	SPLV	Aphid	Taiwan, China, Japan, Indonesia, Philippines, India, Egypt
	SPMSV	Aphid	Argentina, Peru, Indonesia, Philippines, China, Egypt, South Africa, Nigeria, New Zealand
	SPVG	Aphid	China, Japan, USA, Egypt, Ethiopia, Nigeria, Barbados, Peru, Spain, South Africa
	SPV2	Aphid	USA, Taiwan, China, South Africa, Portugal, Australia, Barbados
	SPCSV?	Unknown	Caribbean Region, Zimbabwe, Uganda, Kenya
	SPVMV	Aphid	Argentina
Ipomovirus	SPMMV	Whitefly?	Africa, Indonesia, China, PNG, India, Egypt, New Zealand
	SPYDV	Whitefly	Taiwan, Far East
Crinivirus	SPCSV	Whitefly	Worldwide
Cucumovirus	CMV	Aphid	Israel, Egypt, Kenya, South Africa, Japan, New Zealand
Begomovirus	SPLCV	Whitefly	Far East, USA, China, Taiwan, Japan, Korea, Europe, Africa?, Peru
	SPLCGV	Whitefly	USA, Puerto Rico
	IYVV	Whitefly	Spain, Italy
	ICLCV	Whitefly	Israel
Carlavirus	SPCFV	Unknown	Africa, China, Taiwan, North Korea, Cuba, Panama, South Americaa, N. Zealand
	C-6?	Unknown	USA, Peru, Cuba, Dom. Rep., Indonesia, Philippines, P. Rico, Egypt, Kenya, South Africa, New Zealand
Nepovirus	SPRSV	Unknown	Papua New Guinea, Kenya?
Caulimovirus	SPCaLV	Unknown	South Pacific Region, Madeira, China, Egypt, P. Rico, Nigeria, Kenya?
Ilarvirus	TSV	Unknown	Guatemala
Polerovirus	SPLSV	Aphid	Peru, Cuba
Tobamovirus	TMV	None	USA
Unknown	C-3	Unknown	Brazil. Unknown in others countries
	C-9	Unknown	?

Courtesy: Segundo, CIP

Importance for seed systems

- Recognized potential impact on poverty
- Impact on yield/quality/income
  - Provision of clean planting material alone can yield rates of return of between 56-84%.
- Pathway for dissemination of new varieties
- Provision of **timely** (clean) planting material of appropriate varieties to extend availability of the crop and in times of crisis

The Sweetpotato Community of Practice survey questionnaire indicated that "**quality and availability of planting material**" is the most important limiting factor in developing the sweetpotato crop in all three sub-regions

Virus-free sweetpotato planting material in Shandong province, China

- CIP technology (virus testing and tissue culture) transferred to China (1988-1998)

- Technology adopted over 80% of area (17Mt; 12% global): 1994-1998. Average yield increase of 30%

- Annual productivity increases by 1998 valued at $145M p.a. (NPV $550M; IRR of 202%)

- Agricultural income of 7M smallholders improved by 3-4%.

Varieties vary in their ability to resist viruses over time

Viruses more of a problem in areas where sweetpotato is grown year-round and aphid and white fly pressure is high

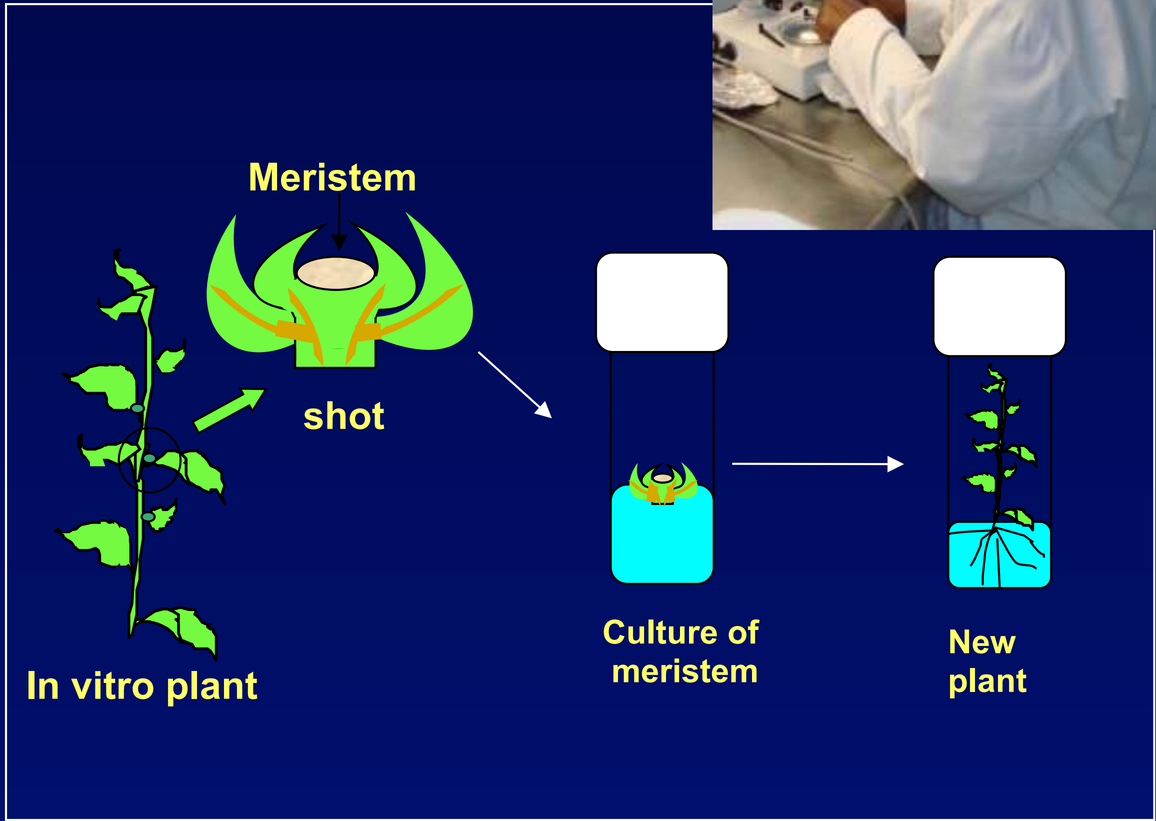
Requirements for high quality foundation (pre-basic) planting usually maintained by national programs

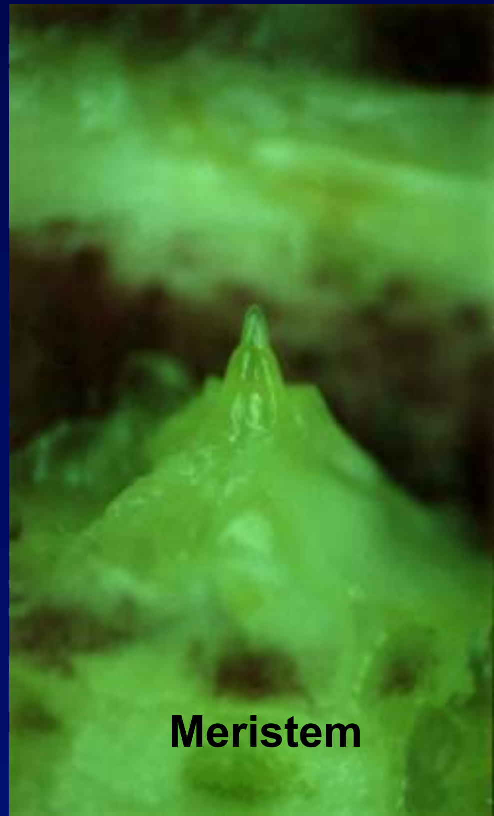
- Critical enabling technologies.
  - In vitro conservation of germplasm
  - Virus clean up capacity (thermotherapy)
  - Virus diagnostic capacity (safe movement)
- In vitro multiplication capacity
- Screenhouse and field multiplication of clean vines

Thermotherapy (34-36°C for 1 month)

Growth chamber

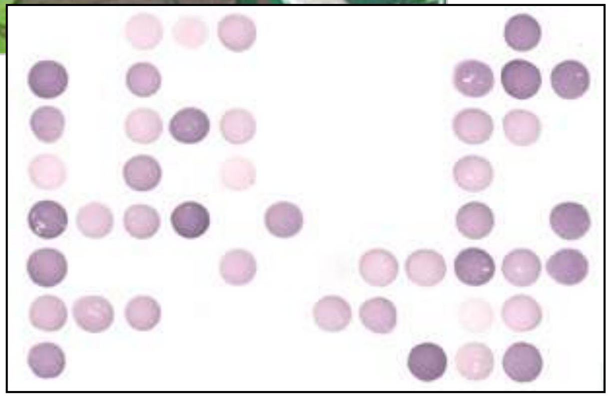
Meristem culture

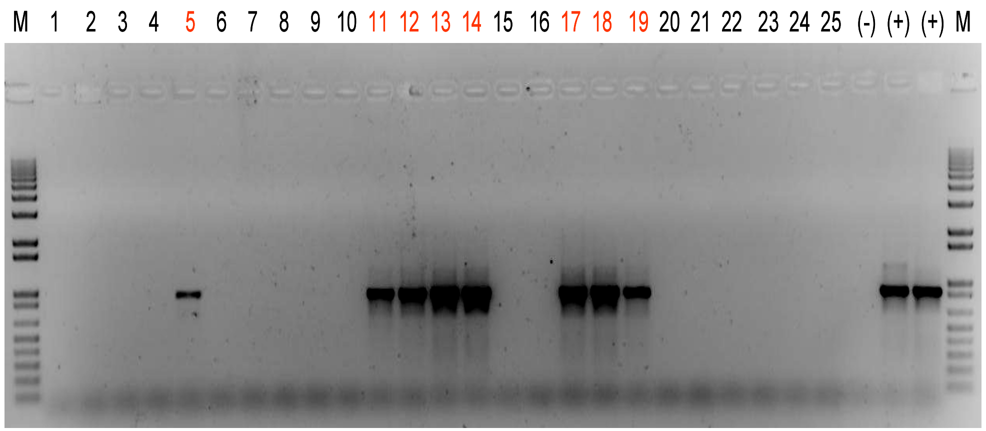




Virus indexing

- Cleaned plant are first indexed for viruses through:
  - Grafting in I. setosa
  - NCM ELISA
  - PCR





Diagnostic equipments

Realtime PCR

Growing plantlets in a greenhouse

Plantlets for hardening

Transferred to Hardening shade

Ukerewe – Primary multiplication beds

Ejumula – Primary multiplication beds

Identified Challenges

1. How to maintain vines during the dry season, particularly when access to lowlands is limited?

2. How to assure that adequate quanties of quality vines are available at the beginning of the rains?

- Results from some experiments to date start to answer these questions

Strategies to conserve vines through dry seasons and extend availability of crop: buried roots and sources of water

Protected Root Bed Research in Uganda Built upon A Traditional Practice

Tradition in dry areas: leave a few unharvested roots in the ground and when the rains re-start the next season, they sprout

Drawbacks:

- Small amounts of material that need to be further multiplied so miss the productivity gain that comes with planting during the initial rains
- Or have small plots
- Material may not be healthy

Selected small but healthy roots and harvest time and store in sand during the dry season (Namanda PhD research)

Sand prevents weevil attack, better quality root storage than ash

Plant roots 10 cm deep, slanted, 20 cm (between rows) X 10 cm in protected area 6-10 weeks prior to expected start of rains

Initial water applications to be fortnightly to keep the roots moist, and then gradually be increased to weekly as the demand from the foliage increases Two weeks prior to harvesting, reduce watering to harden off the foliage. Biggest problem: pests!

Which technology is best for helping smallholders maintain vines during the dry season?

Treadle pumps require 2-3 people to manage and hard to repair; hose easily damaged; higher output with manual irrigation. Small-scale drip irrigation (bucket +100 sq m) promising. Output 36% higher than manual irrigation in one trial. Farmers may diversify use.

What rapid multiplication techniques can be adopted by farmer multipliers?

Existing recommendation:

- Short 2-3 node cuttings
- 10 cm X 10 cm spacing
- Intensive management
  - Just not adopted over time
  - Used at stations with resources

35-50 Vines per root

Revised recommendation (Uganda):

- Apply farm yard manure/compost at a rate of 2.5 kg m^{-2} or NPK (25-5-5) at the rate of 100g per m^2 within 10-15cm depth (*fertilization doubles yields*)
- 20 cms cuttings, 2/3 below surface
- 20 X 10 cm spacing

Managing for dual purpose use: maximizing root and vine yields in Mozambique

Experimental design:

- Varied vine harvesting times: 60, 100, 150 days after planting (dap)
- Length of cutting: 15 vs 30 cm
- Planting density: 15 cm X100 cm vs 30 cm X 100 cm
- Two varieties: Resisto vs MgCL01
- No fertilization

35-50 Vines per root

Results from 1st year:

- Best combination (total roots + vines):
  - vine harvesting 100 dap
  - 15 cm length cuttings
  - 15 cm X 100 cm planting density
- Worst combination: 60 dap; 15 cm cuttings, 15 cm X 100 cm spacing
  - Early vine harvesting negatively affects root production

Building a Community of Practice

- Automated breeding data management
- Hands-on experience

Thank-you for your Attention and Hospitality