Status of Research on GM Banana in Uganda

An overview of progress and adoption forecast

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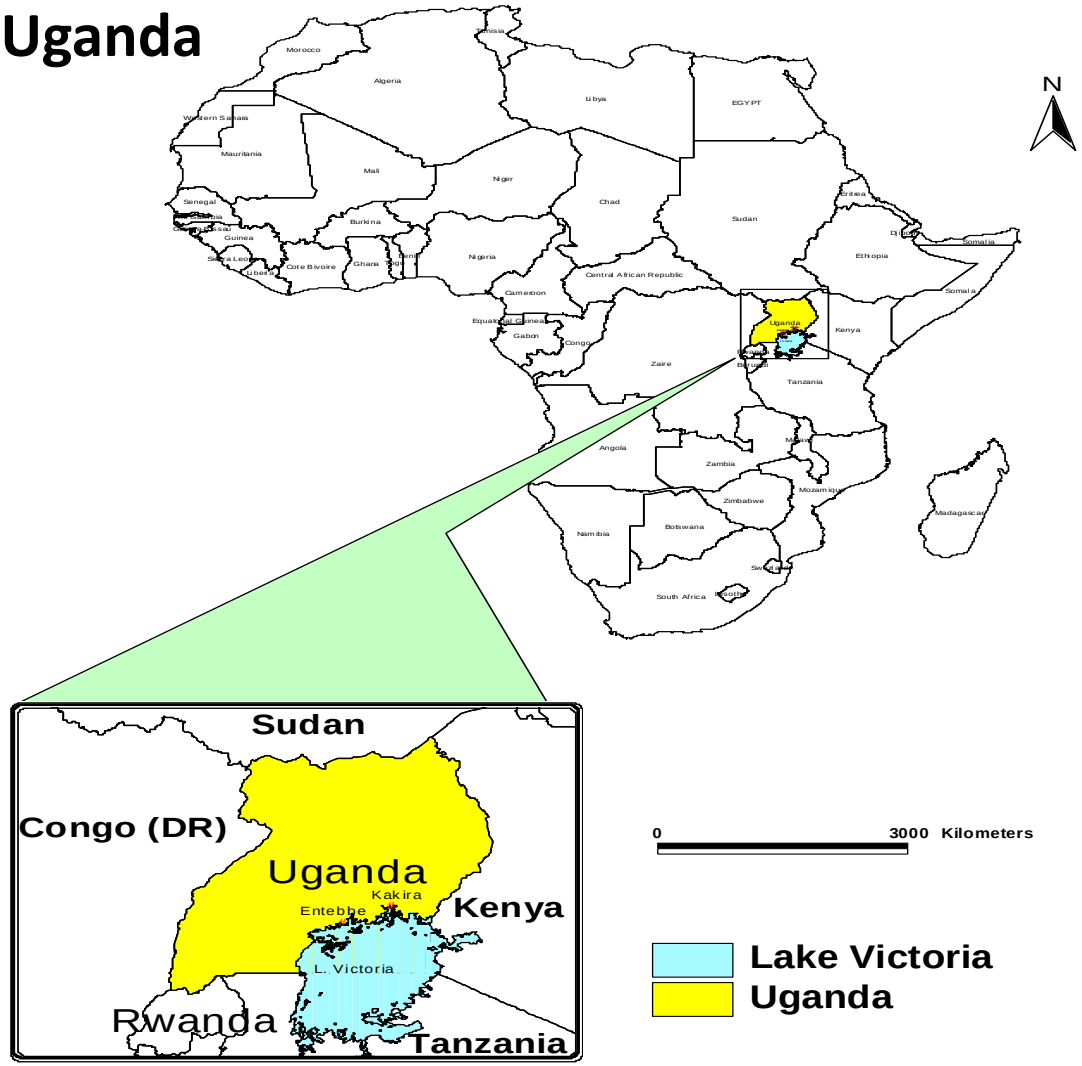
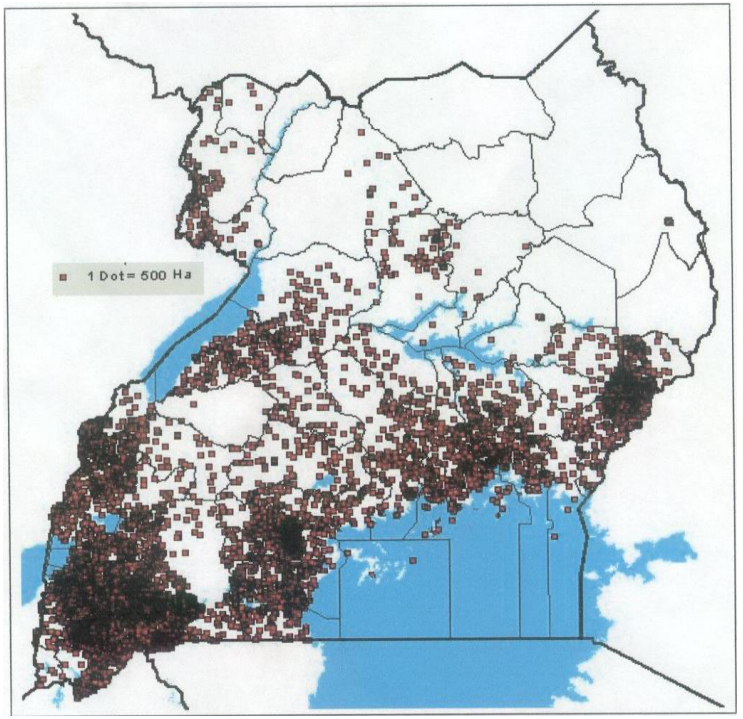
Background

Location of Uganda



General information about Uganda

- Size: Land locked east African country with land area of 241, 548 km^2
- Population: About 32 Million People
- Population Growth: 3.2 % per annum
- Contribution of agriculture: 20% to GDP and 48% to exports
- Priority food security crops: **Banana**, maize, beans, rice, cassava, potatoes and assorted fruits and vegetables
- Bananas grown mostly in southern Uganda



Importance of banana as a food security crop in Uganda

- Perennial ratooning crop that fruits any time of the year
- Food crop least disturbed by erratic rains, a result of climate change in East Africa
- All year round provision of food and family income; growers never get famine
- Production: About 10 m MT produced annually, mostly from small holdings of about 2 acres.
- Per capita consumption: about 250kg/person/year

Banana Diversity

East African cooking bananas account for 80% of production

EA-cooking banana (AAA)

Pisang awak (ABB)

Gros Michel (AAA)

Plantain (AAB)

Apple banana (AAB)

Banana production challenges

1. Short plantation life and low productivity due to:

- Pests (weevils, nematodes)
- Diseases(bacterial wilt, black Sigatoka, fusarium wilt, viruses)
- Soil fertility decline

2. Low fruit quality

- Key micronutrients in low levels (Pro-Vit A, iron, Zinc
- Poor taste in hybrids

3. Post harvest and marketing challenges

Priority pests

1. Banana weevil

2. Banana nematodes

Priority Banana Diseases

1. Banana Xanthomonas Wilt

2. Black Sigatoka

3. Fusarium wilt

Interventions since 1991

- 1991 -1994: Diagnosis and quantification of production problems: 40-60% yield lost due to pests and disease

- 1994: NARO identified use of resistant varieties highest priority intervention and in partnership with IITA initiated a breeding program

CROSS-BREEDING HIGHLAND BANANAS (MATOOKE)

Triploid female parent (3X)

X

Calcutta4 (2X)

Resistance to Black Sigatoka, Weevils and nematodes.

Tetraploid hybrid (4X)

X

Improved male male parent (2X)

Resistant hybrid

Encountered challenges of conventional breeding; need for a better approach

- Hybrids only marginally acceptable to rural consumers and not acceptable in urban markets
- Most popular cultivars were sterile and could not be improved conventionally
- For some problems such bacterial wilt, there were no sources of resistance in banana plants making conventional breeding impossible.

Genetic engineering appeared the most viable option for improving the banana.

The molecular breeding (biotechnology) objectives

- Build NARO's capacity for molecular breeding
  - Infrastructure
  - Human resources
- Use the capacity to develop transgenic crops that address problems recalcitrant to classical breeding

Progress highlights

Transgenic Crop Research Process

1. Gene discovery/access
2. Transformation
3. Green house evaluation
4. Confined field evaluation
5. Open field evaluation and regulatory data generation
6. Commercial release

Round 1. Proof of concept with a model variety (1-4)

Round 2. Product development using farmer preferred cultivars (2-6)

On going genetic engineering activities on banana

- Activities under proof of concept
  - RNAi strategy for control of nematodes, black sigatoka disease, fusaium wilt disease and weevils
  - Cystatin genes for control of nematodes and weevils
- Concept proven for the following activities which are now under product development phase
  - Bacterial wilt control using genes from sweet pepper (Uganda Gov/USAID/Cornell supported)
  - Provitamin A enhancement using genes from Asupina, a wild banana (Uganda Gov/BMGF/Queensland University of Technology supported)

NARO

Proof of concept results for bacterial wilt

- A partnership project between NARO/IITA/AATF and ABSP-Cornell.
- Confined field evaluation of gene in a model variety completed
- 11lines selected for multi locational and stability evaluation.

Proof of concept results for banana biofortification with Provitamin A

- First CFT with GM plants generated in Africa by Africans (2010).
- Two lines with 6 times the level of provitamin A selected.
- Process being repeated in farmer preferred cooking bananas.

Banana flour from transgenic banana lines (hybrid M9)

Projected product development milestones

- Complete generation of transgenic lines of highland bananas with enhanced provitamin A and separate lines with bacterial wilt resistance by Dec 2014.
- Complete confined field evaluations by Dec 2017
- Complete multi locational and biosafety regulatory evaluations by Dec 2020
- Release the transgenic varieties to farmers in 2021

Other GM food crops under development in Uganda

- Cassava with resistance to cassava brown streak disease; targeted for release in 2016
- Maize with drought tolerance; targeted for release in 2017
- Nitrogen efficient rice; Field evaluation approved to start
- Sweet potato with resistance to weevils and potato virus; application with NBC

Importance of the GMOs to food security

- Each of the production problem being addressed leads to yield loss of 50-100%
- No sources of resistance in cultivated or wild relatives so the problems cannot be solved through conventional breeding
- The GM approach is the only viable option to restore the production potential in the respective crops

Adoption forecast: The case of transgenic banana with bacterial wilt resistance (Kikulwe, 2010; PhD thesis)

58% of Ugandans expressed willingness to accept the GM banana when ready. Reason: because of likely benefits it will give them. Attributes of this group:

- Rural farmers who are also consumers (mostly consume what they produce)
- Have big families which they are struggling to feed (many take one meal a day)
- Have confidence that the GM banana will be safe if government clears it for use
- Most live in rural areas

Adoption forecast (cont.)

42% of Ugandans unwilling to accept the GM banana. Reason: Not completely convinced that the banana will be safe. Attributes of group:

- Urban wealthy/food secure consumers
- Educated (both urban and rural) consumers
- Accessible to sufficient food
- The benefits likely to accrue from the GM banana are not enough to convince them
- Most live in urban centers

Implication of these results for communication strategists in Uganda

- Messages should target the elites who mostly live in urban areas
- The messages should focus on assuring this group that the GMOs are safe and will not be controlled by multinational private companies
- Europeans and Americans who support use of GMOs should speak out in support of their safety, the need for public institutions to own them and acceptability in their countries.

Implication of these results for policy in Uganda

- The rural poor will benefit the most from the GM crops under development. Therefore, their development should be given high priority as other pro-poor activities already identified.
- By listening to anti GMO campaigners and delaying the biotechnology and biosafety law, the government has sided with the elites to deny the rural poor an option that will alleviate their severe food insecurity situation.
- Efforts to engage the Ugandan elites about GMOs should be intensified during the development phase of the products to reduce their negative influence on rural communities.

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