GM Cotton CFTs In Uganda

Presentation to Top Management of MAAIF
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Introduction

- Cotton introduced to Uganda in 1903
- Quickly established as export crop
- Peak production in late 60s/early 70s
- Accounted for40% of foreign earnings
- Benefits 10% of population through
  - direct sale of produce
  - employment in the industry

Production

- Mainly by peasant farmers (2-5 acres)
- Affected by many insect pests, weeds, diseases and soil fertility
- Peak production of 500,000 bales of lint in 69/70 season
- Lowest production of 11,000 bales of lint in 86/87 season
- Govt. decided to revive the sector in 1994

Production continued

- Revival through
  - Structural changes creating CDO to oversee production, quality and marketing
  - Financial support to NARO and CDO
  - Liberalization of the industry which created private sector bodies like UGCEA, Textile and Oil millers

Production

- Govt. extended support to NARO for development and dissemination of technologies aimed at increasing productivity and production
- Combined effort of NARO, CDO, Ginners and APEP contributed to increased production of 257 bales in 2004/05 season.

Production

- Provided direct earnings to 3 million farmers

Government target

- Government set target of 1,000,000 bales of lint by 2010
- This can increase export earnings from US $ 40-50m to US $ 200m p.a.
- Can be realized if some of the factors below are considered

- Increase in farm families engaged in cotton production (from 350,000 to at least 418,000 a 3% increase p.a.)

Government target

- increase in acreage for cotton production from 1.2 to at least 2 acres per family a growth of 9 %
- National productivity increase from 200kg to at least 600kg/acre
- There are however constraints in achieving the above

Why go GMO?

- Cotton production stagnated at 20,000 Metric Tons in the past years
- A number of constraints still affect cotton production
- Losses due to insect pests' damage to the crop at all growth stages. Major ones being bollworms which can cause 40-100 % yield loss

Why go GMO?

- Weeds can cause up to 30% loss in yield (or 100% loss if the crop in neglected)
- Soil fertility. Mainly in major cotton growing areas of eastern and northern Uganda.
- Constraints above cause losses of up to 100,000 bales. This is equivalent of US $ 20m in export value

Available Options

- Cotton sector seeking options to solve these constraints to achieve govt. targets
- Stakeholder workshops were held at Kati Kati Hotel
- Options considered include Genetic Modifications

Available Options

- Bollworms and weeds were among key constraints considered
- Technical Facilitators were invited to discuss some of the available Gm technologies

- Bollgard II was identified as effective in controlling bollworm complex in cotton
- It reduces number of sprays to 2 or 3 instead of 6 and above
- Roudup Ready flex was identified as effective in controlling annual and perennial grasses as well as broad leaf weeds

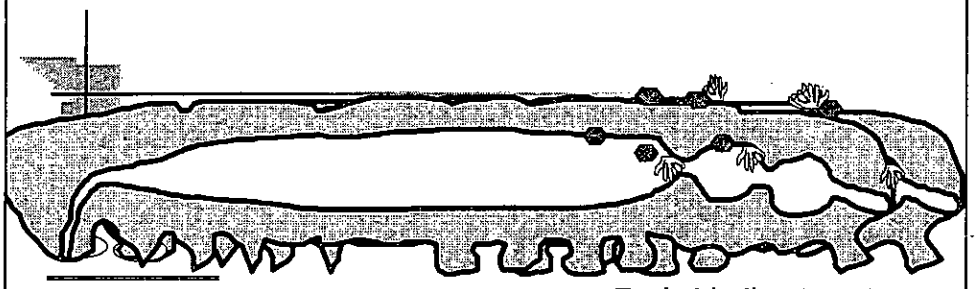
What is GM cotton?

- A transgenic plant
- Genes from other sources inserted into cotton plant
- Introduced gene(s) produce a product affecting target organism
- In our case the targets are bollworms and weeds
- Bollgard II is for bollworm control
- Roundup Ready Flex is for weed control

Bt Cotton

- Contains genes from common bacterium - *Bacillus thurigiensis*
- Genes produce a toxic/insecticidal protein specific to bollworm complex
- When ingested the protein binds to the receptors in the gut/stomach of the bollworm
- Leakage is created in the stomach membrane and the insect dies

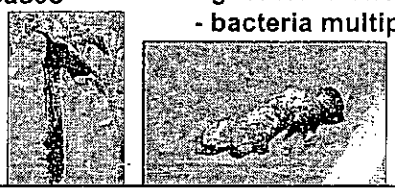
Bt Mode of Action



Ingestion of spores, crystal proteins (= protoxins)

Activation of toxin:
- crystals solubilized under high pH
- protein cleaved by gut proteases

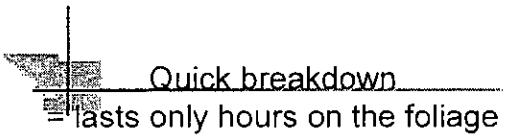
Toxin binding to gut receptors:
- paralyzes gut
- insects stops feeding
- gut membrane leaks
- bacteria multiply in body



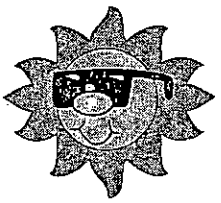
Bt versus *Conventional* Insecticides:

- high degree of specificity
- quick breakdown
  - ~ low residue
  - ~ apply close to harvest
- practically nontoxic to non-targets
  - ~ natural enemies
  - ~ bees
  - ~ mammals, fish, birds
  - ~ humans
- compatible w/ other practices

Limitations of Bt Insecticides



Quick breakdown
- lasts only hours on the foliage





Coverage & Timing are critical
- spores must be eaten to have activity
- small larvae are most susceptible

Cost: product + repeat applications

What is New in Bt Crops?



- In Bt crops modified version of the bacterial gene has been incorporated into the plant's own DNA
- **The plant produces the Bt toxin**
- When the insect eats a Bt-containing plant, it ingests the toxin and will die within a few days

Advantages of Bt Crops Over Bt insecticidal application

Breakdown: insecticide is within plant

Coverage: 100%, all plant parts make toxin

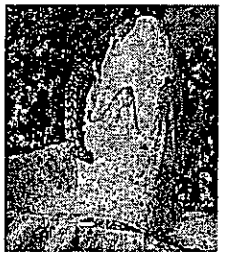
Timing: Insecticide is made all the time

Cost: part of the seed cost instead of application cost

Advantages of Insect Resistant Cotton

- **Reduced damage by bollworms**
- Reduced use of insecticides
- Reduced labour scouting







Examples of Bt Crops— produced to solve pest problems

- Bt corn for corn borers
- Bt corn for root worm control
- **Bt cotton for bollworm control**
- Bt Potato: for control of potato beetle
- Many other under research..

World Bt Cotton Adoption – 2003

Country	Year First Bt	Cotton mill ha	Area Bt cotton	% Area under Bt	Insecticide use in Non-BT	Insecticide use in BT	% sprays reduced
USA	1996	6.2	2.0	33	5	2	60%
Mexico	1996	0.08	0.028	35	4	2	50%
China	1997	4.8	1.5	51	20	7-13	50%
Australia	1997	0.4	0.146	36	11	6	45%
Argentina	1998	0.17	0.009	5	5	2	60%
S. Africa	1998	0.044	0.02	45	11	4	64%
Indonesia	2001	0.022	0.004	18	9	3	66%
Colombia	2002	0.041	0.004	10	6	2	66%
India	2002	8.5	0.28	3	14	7	50%

Herbicide Tolerant (HT) Cotton

- Contains a gene from herbicide resistant bacterium – *Agrobacterium tumefaciens*
- It encodes an EPSPS which is resistant to glyphosate
- It inhibits the enzyme essential for producing amino acids in plants, needed for survival
- The plant therefore dies

Herbicide Tolerant (HT) Cotton

The Cotton will withstand herbicide application

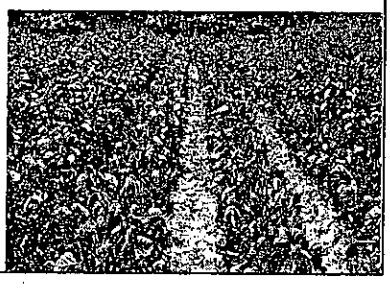
Advantages:

Excellent weed control– cleaner harvests

Flexibility to apply herbicide at later growth stages

Reduced labour on weeding

Reduced fuel on weeding

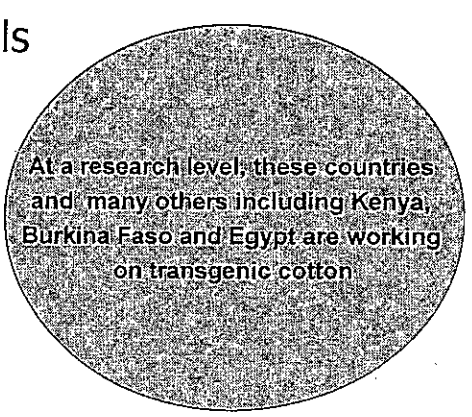


Examples of HT Crops

- Soya bean
- Cotton
- Maize
- Canola
- Rice

Countries Growing Transgenic Cotton

- Commercial levels
  - USA
  - China
  - India
  - Mexico
  - South Africa
  - Argentina
  - Brazil
  - Colombia



Is Transgenic Cotton Good Idea for Uganda ?

- **Uganda needs to find out for itself**
- Uganda needs to increase yields per unit area
- Need to increase country production
- Attracted by increased adoption globally..43% of cotton is GM
- Kenya has been studying Bt cotton since 2005. About to conduct MLTs
- Traits of interest were selected through a consultative process (KATIKATI Workshop involving MAAIF, NARO, CDO, UNNFF ++)
- Having Bt in appropriate variety is crucial

Key Questions

- Do our farmers need better insect pest control opportunities?
- Do our farmers need better weed management opportunities?
- Do our farmers need profit-making opportunities?
- All answers are yes

What has been done

- Uganda cotton stakeholders decided on the two technologies.
- Will they work for Uganda?
- There is need to test and make our own conclusions and decide on what way to go.
- Field visits made to India and RSA to observe biotechnology applications (by NARO, Private Sector MPs, UNCST, Media etc).
- Discussed with researchers and producers
- Discussed with technology providers
- Applications for the technologies discussed by IBC
- Applications submitted and discussed by NBC
- Research cleared by Presidents Office

Contd

- Sites at Serere and Mubuku clear
- Material for construction of confinement facility procured by APEP.
- Need to import planting material
- Technologies will be in confined Field trials
- Studies on effect on environment will be carried out
- Economic analysis will be carried out to enable informed decisions on the technologies
- All safety operational practices as set by UNCST will be adhered to.

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