
Food Security and Biotechnology in Africa

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# MODULE 3
# PUBLIC RESPONSE TO THE RISE OF BIOTECHNOLOGY

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# UNIT 4:
# Biotechnology and African Agriculture
# (04 Hours)

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# Unit 4: Biotechnology and African Agriculture

## Objective

It is the aim of this unit to

- Highlight the status of African agriculture,
- Discuss the Challenges and opportunities facing Agriculture biotechnology in Africa
- Discuss the Prospect and Limitations of Agricultural biotechnology in developing African countries.
- Present an overview of status of adoption of biotechnology (GM crops) in African.

# African Agriculture and food security.

- African continent harbours about 900million people.
- About 200million of the population are undernourished.
- 33million children go to sleep hungry.
- There is high disease prevalence heightened by malnutrition.

# African agriculture and food security.

- Green revolution did not positively impact African agriculture as it did in Asia and South America due to the peculiar nature of the continents agriculture such as;
  - Absence of dominant (large scale) farming system (excessive reliance on subsistence farming).
  - Predominance of rain-fed agriculture.
  - Prevalence of soils of poor fertility and poor nutrient replacement.
  - Restrictive land holding system

# African agriculture and food security.

- Poverty does not allow the farmers to apply inorganic nutrients giving rise to poor yields.
- Poor crop performance results in reduced amount of organic matter to be returned to soil post harvest that could replenished the soil.
- Africa has the lowest crop yields per unit of cultivated land in the world with potato yields of 6tons per hectare compared with the global average of 14tons (Wambugu, 1999).

# African agriculture and food security.

- In addition, crop pests and disease causing pathogens are of high prevalence.
- The land tenure system in most parts of the continent is exacerbating the already bad food security situation.
- It is claimed to be responsible for the dearth of commercial agriculture where most farmers are small holders.
- As a result, the use of pesticides in African agriculture is very limited.

# Characteristics of African Agriculture.

- Only 21% of Africa's roads are paved making transportation of produce to markets difficult.
- Africa has limited agronomists for productivity improvement activities and its marketing systems for food crops are underdeveloped.
- There is near absence of credit systems which together with inadequate land tenure tend to retard investment and technology adoption.
- Little investment by government in agriculture (<4% of arable land under irrigation)

# Does African Agriculture need biotechnology?

- Adoption of biotechnology in agriculture is seen by member states of Sub Saharan Africa as of prime importance.
- This arose from their feeling that they lost out in the green revolution with its many benefits.
- Also, there is a mind-set that non adoption will be costly in the long run assuming that it brings improved yields and income.

# Does African Agriculture need biotechnology?

- Majority of African population are engaged in agriculture as source of food and income.
- It is believed that managed well, biotechnology could be simple and less expensive for resource poor farmers.
- With the current level of food insecurity and poverty, it is good that Africans adopts new technologies that promise increased yields and enhanced income for farmers.

# Does African Agriculture need biotechnology?

- With the malnutrition plaguing its population in form of micronutrient- iron and vitamin A, deficiencies, biotechnology adoption can reduce the levels of these scourges.
- Increasing yields from technology adoption will reduce the increases in cultivated plots predisposed to fragility and made prone to degradation.
- Reduction in the political relevance of inorganic fertilizers

# Does African Agriculture need biotechnology?

- Reduction in fertilizer use will translate to reduced water pollution and improved aquatic life.
- Same is applicable to reduction in pesticide use with its numerous human & environmental health consequences.

# Focus for biotechnology adoption African?

- The adoption of GM technology is at its initial stages in Africa and is currently faced with several constraints
  - lack of infrastructures,
  - inadequate human resource capacity,
  - poor education,
  - biosafety regulatory frameworks,
  - intellectual property rights
  - others.
- Concerted effort from developed countries and international organisations must be put in place to ensure that Africa benefits from this new technology

# Focus for biotechnology adoption African?

- African governments must also be involved in solving these problems themselves.
- They should come up with coherent strategies to adopt modern biotechnology including educating the public, farmers and government institutions, the media and private companies, and to increase understanding of GM technology (Adenle, 2011)

# Focus for biotechnology adoption African?

- Part of the strategy must include adoption of common policies and a regional platform through which African governments can engage in dialogue and develop a common biotechnology regulatory framework.
- A huge price will be paid in many years to come if the continent continues to depend on outsiders before making decisions that determine their future (Adenle, 2011).

# Focus for biotechnology adoption African?

- Europeans are food secure and may not necessarily require GM technology to boost their crop productions.
- However, African farmers need technologies that can solve part of their agricultural problems.

# Focus for biotechnology adoption African?

- Globally, adoption of agricultural biotechnology has been acknowledged to benefit to farmers via improved yields and income.
- In Africa, chronic nutrition problems are endemic and the capacity of GM crop adoption to address the situation will make manifest its usefulness especially in children.
- Thus, in Africa, the focus will still be to increase yields and improve income.

# Focus for biotechnology adoption African?

- It is a common knowledge that malnutrition and undernourishment common in African children are responsible for stunting and high mortality among this age group.
- Thus, innovation that enhances micronutrient contents of staples among the population will be greatly needed.
- Targeted micronutrients as Vit. A, Iron, and certain amino acids bio-fortified in the staples of African populations is a necessity.

# Focus for biotechnology adoption African?

- Due to poor storage facilities in the continent, delayed ripening of fruits to reduced post harvest spoilage is a biotechnology necessity.
- The appropriateness of biotech adoption should go the most staples; Maize and beans with serious insect pest infestation that impact seriously on food security and farmers income.
- Same is true of the fungal infestation that enhance mycotoxin levels in our grains.

# Appropriateness of biotechnology to African agriculture.

- The witch weed *Striga hermonthica* and *S. asiatica* decimate maize, millet , sorghum and upland rice in Sub Saharan Africa where 100 million people lose half their produce to this root parasites(Berner et al., 1995).
- Maize is a prime crop in the sub-continent for human use and livestock feed.
- Conventional methods of control which are not reliable include crop rotation and herbicide use.

# Appropriateness of biotechnology to African agriculture.

- Transgenic maize varieties resistant to herbicides that kill Striga has been produced.
- This will directly impact caloric intake and hunger reduction.
- More than half of the maize in developing countries are under serious insect infestation.
- In Kenya, losses due to stem borer is estimated at 15%. Such losses not only deprive people of vital income and also the needed calories.

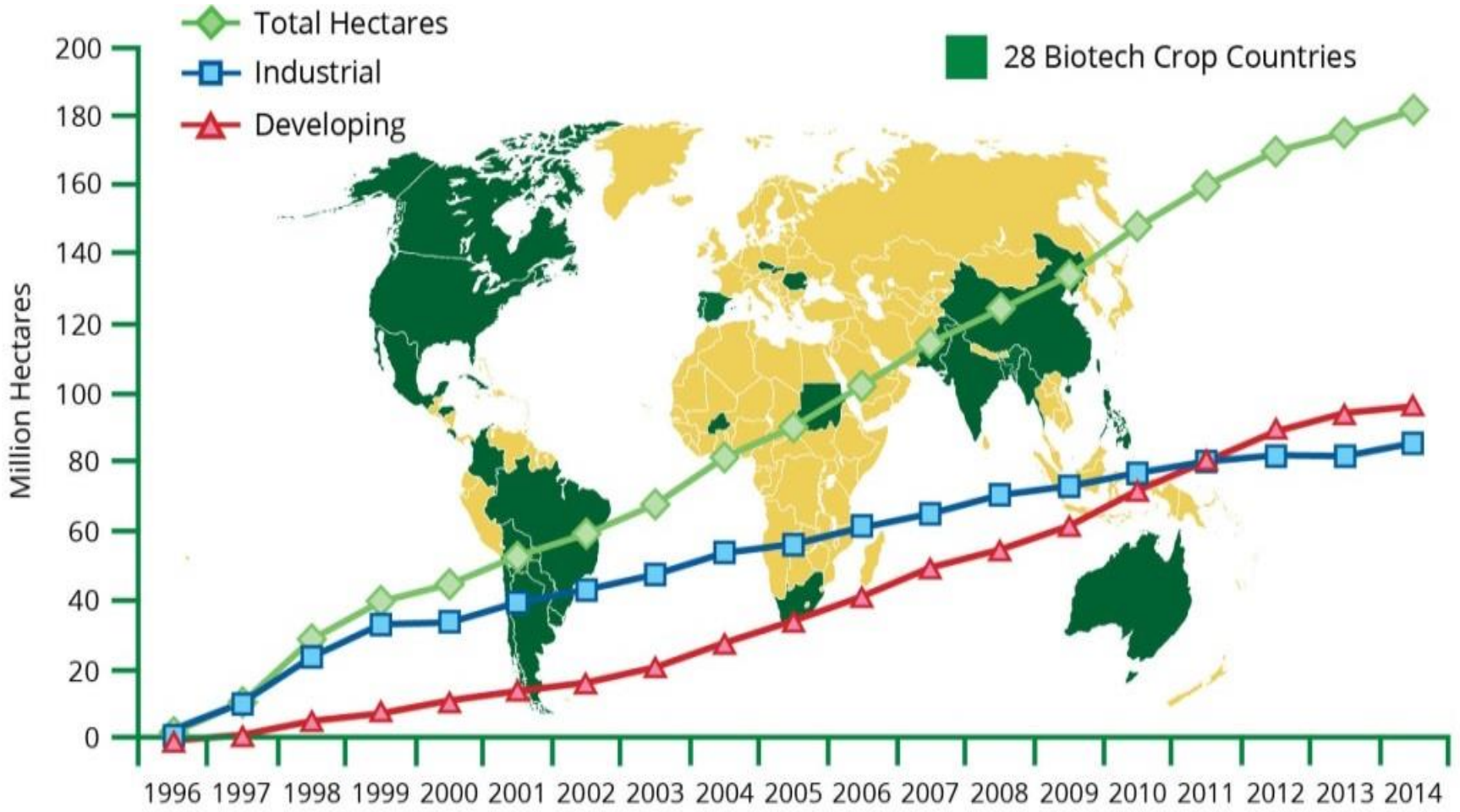
# Appropriateness of biotechnology to African agriculture.

- The toxin produced by the soil bacteria, *Bacillus thuringiensis* are lethal to stem borer and other insects.
- These toxins, Bt protein is active in only one or a few insect species.
- Bt genes were among the first to be introduced to maize and cotton thereby improving yields, reduces dependence on and exposure to costly herbicides.

# Adoption of Biotechnology in developing countries

- There had been a growing trend in the adoption of agricultural biotechnology including several developing countries.
- Commercialized in 1995, by 2014, GM crops were grown by more than 8million farmers in 17 countries and on over 81million hectares.
- Most widely grown GM crops include herbicide tolerant soybean, canola and insect resistant (based on Bt gene) maize and cotton.

# Global Area of Biotech Crops (1996-2014).



# Adoption of Biotechnology in developing countries

- Studies show that on the average benefits of adoption include income increases via reduced pesticide application and increased yields.
- They reported higher benefits in developing countries relative to developed countries.
- Following these is a new concern outside the traditional biotech concerns.
- That is: is GM technology, a developed world innovation in developing world?

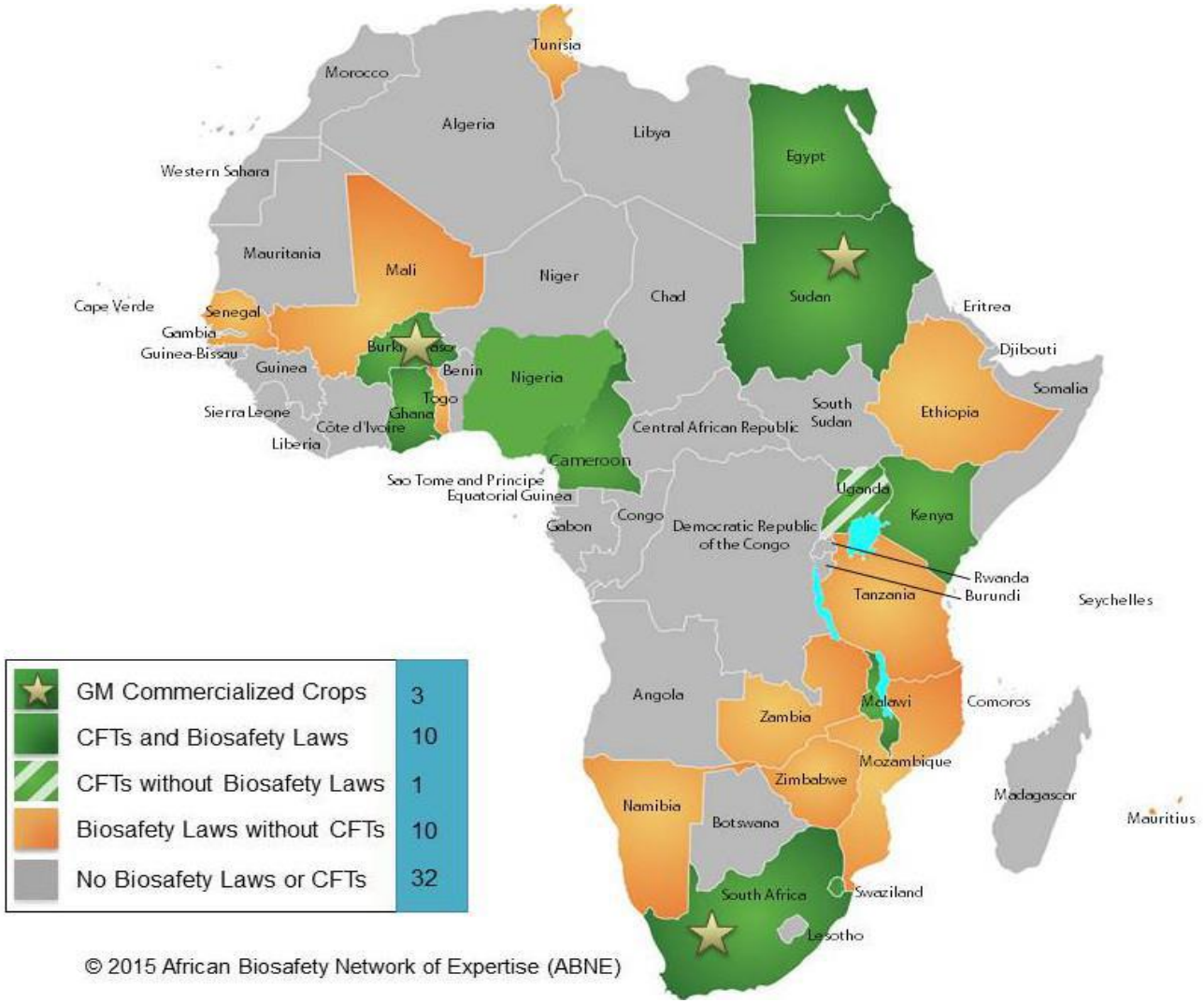
# Characteristics of GM crops.

- GM crops differ from the high yielding varieties of the green revolution.
- Traditional seed sources are dominant in developing countries .
- However, GM development & commercialization are driven by private sector.
- The above are associated with intellectual property rights.
- GM crops are also associated with uncertain environmental and human health risks.

# Characteristics of GM crops.

- As a result, there are regulatory frameworks for risk assessment and approval.
- Also, modern biotechnology allows separation between the act of developing a specific crop trait and breeding of local species adapted to any new environment.

# Status of African biotechnology Adoption.



# Status of Adoption-Burkina Faso.

| Crop | Trait | Status |
|---|---|---|
| **Cotton** | Insect resistance (Bt) | Commercialization (2008) Permit renewed for 10 years from 2013 |
| **Cotton** | Stacked : Insect resistance (Bollgard II) x Herbicide tolerance (RRF) | CFT |
| **Cowpea** | Insect (Maruca vitrata) resistance (Bt) | 4th year of CF |
| **Sorghum** | Vitamin A, Zinc | Approval for Greenhouse experiment |
| **Maize** | Stacked : Insect resistance (Bollgard II) x Herbicide tolerance (RRF) | CFT : approval in 2015 |
| **Non crop organisms** | Transgenic Mosquitoes Reduce malaria vector population (*Anopheles gambiae)* | *Application submitted in 2015* |

# Status of adoption in Ghana

| Trial (Trait) | Responsible Institution | Approval Category (Current Status) |
|---|---|---|
| **Herbicide tolerant Cotton** | Savannah Agricultural Research Institute (SARI) | Confined Field Trials Trial on-going |
| **Herbicide tolerant cotton x Bt cotton (Stacked traits)** | Savannah Agricultural Research Institute (SARI) | Confined Field Trials Trial on-going |
| **Nitrogen-use efficiency (NUE) rice** | Crop Research Institute (CRI) | Confined Trials on-going; Change of location approved |
| **Bt (Maruca resistant) Cowpea** | Savannah Agricultural Research Institute (SARI) | Multi Location Confined Field Trials Approved; to commence in 2016 |
| **High protein sweet potato** | Crop Research Institute (CRI) | Confined field trials yet to commence |

# Adoption status in Nigeria.

| Trial (Trait) | Responsible Institution | Approval Category (Current Status) |
|---|---|---|
| **Bio-fortified cassava increased beta-carotene, pro-vitamin A** | National Root Crops Research Institute | CFT completed for 2 seasons |
| **Biofortified cassava increased Iron content** | National Root Crops Research Institute | CFT completed for 2 seasons |
| **Maruca-resistant cowpea** | African Agricultural Technology Foundation (AATF); Institute of Agricultural Research (IAR) | CFT completed for 3 seasons, back crossed with preferred varieties; Multi-locational trials at 3 sites (Kaduna, Zamfara and Kano States) |
| **Bt (Maruca resistant) Cowpea** | Savannah Agricultural Research Institute (SARI) | Multi Location Confined Field Trials Approved; to commence in 2016 |
| **Biofortified sorghum (bioavailability of Iron, Zinc and increased Protein and Vitamin A contents)** | Africa Harvest, Pioneer-Hi-Breed (a DuPont company), IAR and National Biotechnology Development Agency | 3rd season of CFTs and back crossing with preferred local varieties |
| **Nitrogen-use, water-efficient and salt- tolerant (NUWEST) rice** | National Cereals Research Institute | Permit granted but trial yet to commence |
| **Cassava resistant to the African cassava mosaic virus (ACMV) and Cassava brown streak virus (CBSV)** | National Root Crops Research Institute | Permit granted but trial yet to commence |

# Factors Enhancing GM Crop Adoption in Developing Countries

Studies done in Nigeria and Ghana highlighted the following factors as enhancers to GM technology adoption.

- **The cost of the technology :** This may be a hindrance to adoption considering that it promises huge benefits with potentially commensurate cost.
  - As a result, government should subsidize the cost for the benefit of poor rural farmers.

# Factors enhancing GM crop adoption in developing countries.

- **Yield effect of GM technology.** The yield of genetic modification is one of the determining factors to its adoption or rejection.
  - The promise of yield increases was one of the major reasons for the adoption of the technology.
- **Nutritional quality of GM food products.** The taste of the food is usually associated with its nutritional quality with added market value.

# Factors Enhancing GM Crop Adoption in Developing Countries.

- **Growth period of crops.** Growing crops that require a short period to mature is highly accepted if GM can provide such crops.
  - This is demonstrated in either drought or salinity tolerant.
- Other factors include colour, shelf life, and suitability for cooking or processing that may determine its market value.

# Constraints to GM Adoption in Developing Countries.

The following are the major constraints to GM technology adoption in developing countries;

- Cost of the technology. the higher the cost, the less capable most poor farmers are in adopting the technology.
- Cost of regulation. This represents one of the most challenging issues regarding adoption among poor farmers.

# Constraints to GM Adoption in Developing Countries.

- High costs of compliance with biosafety regulation may deter small institutions from developing and commercializing GM products in developing countries.
- **Absence of manpower**. GM crops require special care and training different from the traditional approaches common in developing countries
  - technology fee,
  - land preparation,
  - terracing,
  - irrigation
  - machinery.

# Constraints to GM adoption in developing countries.

- Education. Low level of education among the farmers could undermine the adoption in light of the technical training required.
- Environment. The issue of the environmental implication of GM still pose a big challenge to adoption around the world including Africa.
- Factors such as cultural and 'spiritual' practices could affect GM crop adoption.

# Constraints to GM adoption in developing countries.

- Certain cultural practices with dogmatic characteristics where certain food but not others are desired could affect adoption.
- Also, where animals produced in a certain manner are preferred to those differently produced.