Food Security and Biotechnology in Africa

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MODULE 3
PUBLIC RESPONSE TO THE RISE OF BIOTECHNOLOGY

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Objectives

- To introduce biotechnology and its relationship with agricultural production and food security.
  - What are genesis and trajectory of public concerns and responses to adoption and utilization of the biotechnology?
  - How have the societal response/concerns affected adoption and utilization of the technology in various cultures and societies?

UNIT 1:
Introduction to biotechnology
(03 Hours)

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Unit Objectives

- The objective of this unit is to introduce the students to the definition of basic terms, relationship to the technology, agriculture and public opinion.
  - What is biotechnology
  - What is the place of biotechnology in agriculture
  - How does this technology play in the opinion of the public

Introduction

- Agriculture: the science, art or practice of farming, including cultivation of the soil for the growing of crops, rearing of animals to provide food, fibre, wool, and other products.
  - It includes the preparation of plant and animal products for people to use and their distribution to markets.
- Agriculture has invested and benefited heavily from the new innovation called biotechnology.
- Scores of the products of this innovation find their way into the global food system.
- The innovation offers the promise for improved crop yields, pest and herbicide control and tolerance to drought and salinity and improved resource utilization

Introduction cont.

- This technology has met with controversy in many parts of the world, including developed, developing and underdeveloped countries.
- Among the issues involved in the agricultural biotech debate are:
  - the impacts on health of consumers of biotech foods,
  - effects of release in the environment,
  - effects on the global seed markets,
  - effect on farmer and others

Introduction Continued

- Consumer preferences and the role of risk assessment in evaluating the safety of transgenic seeds, food and food products
- The impact of the global use of genetically engineered crops on biodiversity.
- Biotechnology may not pose as much risks as is presented by the opponents of the technology.
- However, like most technologies, a high standard of oversight is necessary for the following reasons:

Introduction Contd.

- It would appear to have been less rigorously tested than other methods of crop production in terms of time scale.
  - Even though the exact contrast is the case
- The science involved in its application is advanced beyond the comprehension of outsiders to the discipline
- The fore-runners of the science of recombinant DNA technology upon which the technology is based were sceptical about the potential risks.
- It is recent and, relative to conventional breeding the growth and capabilities appear confounding

Introduction Contd.

- Below are the definitions of terms pertinent in the discussion of public response to rise in biotechnology for clarity and comprehensions.
- What is biotechnology?
- What is food security?
- What are Agrochemicals;
  - herbicides
  - pesticides
    - in relation to agriculture?

Biotechnology.

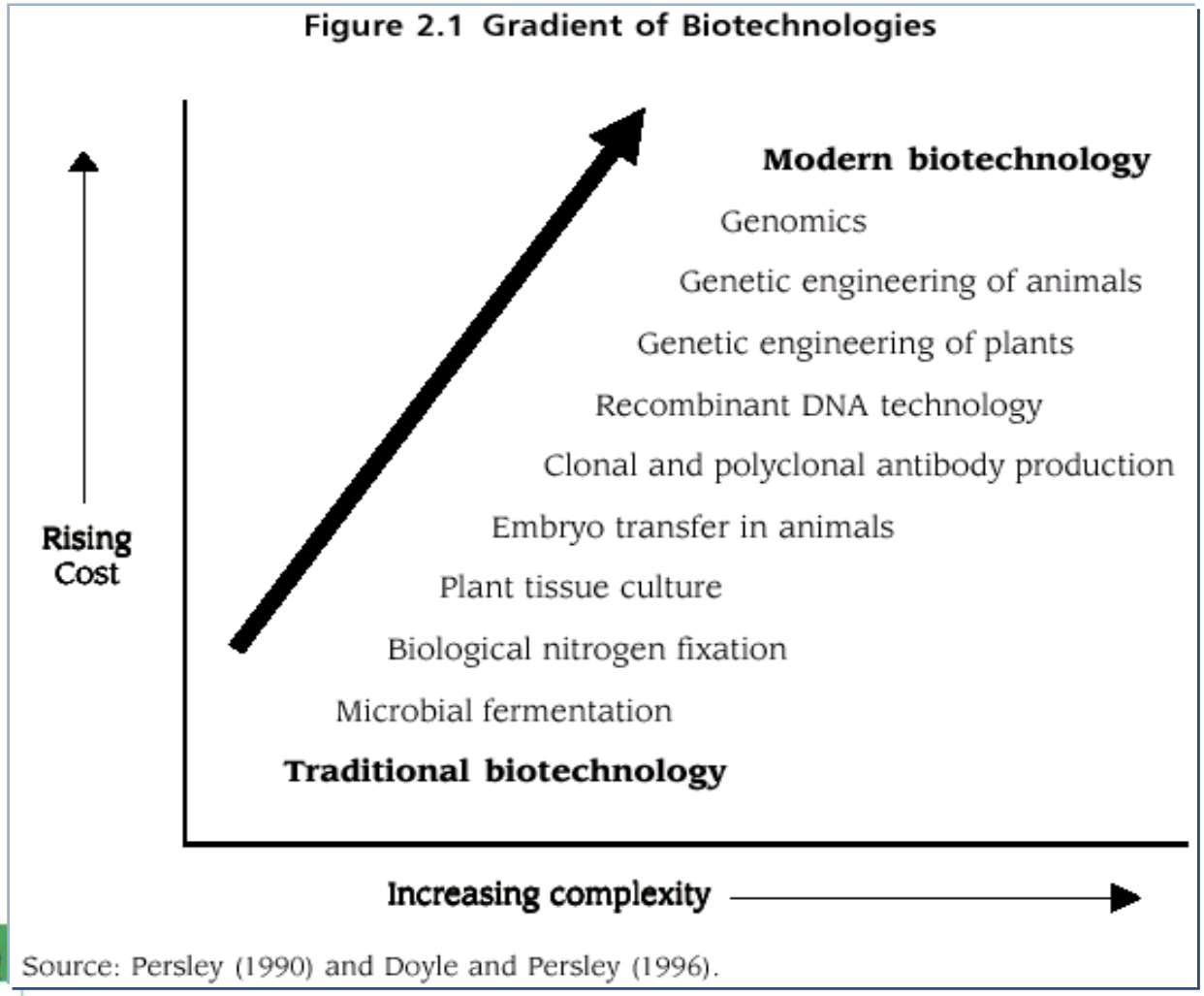
- **BIOTECHNOLOGY**
  - This is defined as a set of tools that use living organisms (or parts) of living organisms to make or modify a product, improve plants, trees or animals or develop microorganisms for special uses. (See CBD of the UN; article 3)
    - This new technology has applications in many disciplines but in the context of food crop production will include conferring high yielding capacity, herbicide and pest tolerance among others.

Agricultural biotechnology.

- It uses tools such as elements of conventional breeding, bioinformatics, microbiology, molecular genetics , biochemistry , plants physiology and molecular biology. Agricultural biotechnology include the following:
  - i) Conventional plant building
  - ii) Tissue culture and micro-propagation
  - iii) marker assisted selection
  - v) Genetic engineering
  - vi) Molecular diagnostic tools
    - And many new related tools that seek to achieve the end of improving the performance of plant, animal or microbial organism.
      - Many of the new techniques do not involve direct molecular interventions

(ISAAA, 2015)

Biotechnology development trajectories.



Modern biotechnology encompass a range of new related techniques that seek to directly achieve the improvement through the application of molecular biology or genomic techniques

Agrochemicals, types, uses and limitations

- Agrochemicals cover a wide range of compounds used to kill or control pests in agricultural system.
  - They include herbicides for weeds, insecticides for insects pests, fungicides (fungi) nematocides for nematodes, and rodenticides (vertebrate poisons), fertilizers and hormones.
- They are used to increase crop yields by controlling crop pests.
- Improved income by farmers from high yields and
- Improved food security

Limitations of agrochemicals use

- Limitations to the use of agrochemicals are associated with their potential negative effects on human health, wildlife and aquatic life populations and water pollution.
  - Human cancer cases,
  - mortalities,
  - losses in environmental biodiversity and aquatic life forms.
- Others include; teratogenicity, reproductive and immune function disorders.
- Reduction in soil fertility due to effect on beneficial soil micro-organisms.
  - Innovations in biotechnology are meant to address some of these real and perceived limitations.

Genetic Engineering

- Genetic engineering is one of the agro-biotechnological tools based on recombinant DNA technology also called gene modification.
- This involves a process by which the genetic makeup of an organism can be altered.
- Here, specific genes of microbes, plants or animals can be deleted, altered or edited.
- Foreign genes can be introduced into a plant, creating transgenic plants that express foreign traits/properties.
- The ability to manipulate genes and transfer genes between species that would not readily interbreed is what differentiates GE from classical plant breeding.

Genetically Modified Organisms (GMO)

- These are organisms-microbes, plants or animals whose genetic make up have been altered by the methods modern genetic engineering.
  - The modification may or may not involve the introduction of foreign genetic elements
- Plants/ animals or microorganisms so modified are called transgenic or genetically modified plants, animals or microorganisms.

Food safety

- **Food safety** is a scientific discipline that deals with means of handling, preparation, and storage of food in ways that prevent food-borne illness.
- In the context of crop biotechnology, food safety deals with the potential health risks associated with the consumption of genetically modified food and food products.
- However, biotechnology like any new technology is subject to risk assessments before full adoption.
- Health risks thought to have been associated with products made from GE include toxicity, allergenicity among others.

Food safety contd.

- Food safety measures provide systematic monitoring of those risks in the GM food and food products.
- provides for appropriate corrective measures in the events that those potential risks are real.
- provides for the regular review of the program by the food business to ensure its adequacy; and
- provides for appropriate records to be made and kept by the food business demonstrating action taken in relation to, or in compliance with, the food safety program.

Food security

- According to Food and Agricultural Organization (FAO) of the United Nations, food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996; Schmidhuber and Tubiello, 2007).

Food security contd.

In the context of biotechnology, improvement in crop yield is seen as a very significant factor for the innovation.

Also, the improvement in nutritional quality of food products as in bio-fortification addresses food security.

Furthermore, increasing the use otherwise useless land for agricultural activities will also increase the scope of agricultural activities and food availability.

Causes of rise in agro-biotechnology

- One perspective on why there are increasing adoption of biotechnology in world agriculture points at the current world food problems;
  - Feeding the growing global population
- Improving production in the face of dwindling agro-resources-land, water and climate change etc.
- The Food and Agricultural Organisation estimates that today, over 800 million people do not have enough to eat.

Causes of rise in Agro-biotechnology contd.

- The increasing need to feed the poor of the developing countries.
- Empowerment of the resource poor farm and agricultural dependent developing nations
- Need to address issues related to pesticide toxicity in man, environmental pollution and biodiversity loss.
- Alternative to failing/ slow classical crop improvement technique and pest control strategies

Causes of the rise in Biotech contd.

- As a means of addressing the poor quality of food items in developing countries via bio-fortification thereby averting many deficiency diseases.
- Improvements in the shelf life of food items especially fruits etc.

State of biotechnology adoption in Africa

- By 2011, Africa accounted for less than 1.6% of the 160 million hectares world wide planted with GM crops (IFPRI, 2013)
  - Causes include; Insufficient level of research and development (R &D) investments by member states.

The low availability of human and economic resources in the region

- Poor biosafety regulatory frameworks among member states.
- Unattractive land tenure system and weak farmer demand.
- The popular GM crops are outside African food staples.

Reasons for the poor state of adoption of GM crops in Africa.

- Poor institutional setting in which the technology was introduced; Type of crop and trait of interest.
- Poor policy environment resulting in insufficient public private efforts to develop biotechnology.
- European costly biosafety precautionary approach despite divergent priorities.
- Poor market access and competitive disadvantage with developed nations.

States of GM crops development in Africa

Country	Crop/trait	Status
Burkina Faso	Cowpea-pod borer	Confined field trail (CFT)
	Rice-water efficient	Lab regeneration (LR)
	Sorghum-bio-fortification	CFT
Ghana	Rice-water efficient	LR
	Cowpea-pod borer	CFT
Kenya	Cassava-mosaic	CFT
	Cassava-bio-fortification	CFT
	Maize –Stem borer	CFT
	Maize- drought resistance	CFT
	Sorghum-bio-fortification	CFT
Nigeria	Cassava-bio-fortification	CFT
	Cowpea-pod borer	CFT
	Rice –water efficiency	LR
	Sorghum-bio-fortification	CFT

State of GM Crop Development contd.

Country	Crop/trait	Status
South Africa	Maize-streak virus	Green house containment
	Maize drought resistance	Same
	Sorghum- bio-fortification	Same
Tanzania	Maize-drought tolerance	Stalled, awaiting regulation
Mozambique	Maize-same	Same
Uganda	Banana-bacterial wilt resist.	CFT
	Banana-drought tolerance	CFT
SOURCE: Namuddu,A and Grumet, R. 2013 GMO under research in Africa, ABNE.		

Global status of biotech crop

- A record of 185.1 million hectares of biotech crops were planted in 2016.
- Annual growth /adoption rate of 3% with 100% repeat planting.
- 27 countries grew biotech crops in 2013 , 19 developing and 8 developed countries.
- More than 60% of the world population live in countries that are agro-biotech compliant.
- 18 million farmers (90% of who were resource poor) benefited from biotech crops.

Global status contd.

Between 2012 -2013, developing countries planted more biotech crops than industrialized countries.

China, India, Brazil, Argentina and South Africa collectively grew 82.7 million hectares, 47% of the global and represent 41% of the global 7 billion people.

USA maintains the lead in biotech crop production with 70. 1 million hectares.

In Africa, Burkina Faso and Sudan have increased their Bt cotton hectares substantially .

One hour recap discussion

- Discussions on the local situations on the state of food insecurity, food safety.
- Local examples on the use of agrochemicals and potential threats to health.
- Issues of environmental effects of agrochemical use.

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