Food Security and Biotechnology in Africa

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MODULE I: UNIT 1

Introduction to Agricultural systems and Food security (4 hours)

Course Objective

Introduce the concept of biotechnology providing potential contributions to sustainable agricultural productivity and emphasize the need to integrate biotechnology into agricultural systems

Course structure:

The lecture will explain the agricultural systems, basing it on the African setup. Modern agriculture will be differentiated from tranditional agriculture, where the students will be guided to understand the growth of agriculture over time. This will help them to appreciate why the need to apply biotechnology and the interactions of biotechnology skills for agriculture development in Africa. This will be done using power point, practical exposure and lecture notes.

The students will be given some links to important literature to read and discuss in groups to get more disciplines involved in order to achieve a goal with a biotechnology aspect.

Methods of Course delivery:

Lectures, discussions, PowerPoint presentations and practicals in field and lab

Course notes

The following definitions will be given:

Agricultural systems

A population of individual farm systems that have broadly similar resource bases, enterprise patterns, households livelihoods and constrains and for which similar development strategies and interventions would be appropriate. Agricultural systems have evolved from traditional to modern agricultural systems. Traditional methods constitute with crop rotation, tradition irrigation, hand pruning as a control of weed. Modern agriculture constitute of agronomy, plant breeding, agrochemicals (pesticides and fertilizers) and technological improvement

Green revolution

This is described as the great increase in production of food grains (as rice and wheat) due to the introduction of high-yielding varieties, to the use of pesticides, and to better management techniques.

Food sovereignty

The right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agricultural systems.

Food security

A condition related to the supply of food and individuals access to it. It is a measure of resilience to future disruptions or unavailability of critical food supply due to various risk factors including drought, shipping disruptions, fuel shortages, economic instability and wars.

Food insecurity

Food insecurity is a situation of "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (according to the United States)

Causes of food insecurity

Causes of food insecurity will be discussed, which include

i) Climate change
ii) Post harvest losses
iii) Population increase
iv) Drought and other extreme weather events
v) Pest and diseases
vi) Cash crop dependence
vii) Aids, corruption and political instability

Biotechnology

There are several definitions of biotechnology for instance, the manipulation of natural biosystems with multiple disciplines for human benefits. In namely:

-agriculture

-environment

-forestry

-medicine

-industries

Biotechnology has also been defined as any technique that uses living organisms, or substances from those organisms to make or modify a product, to improve plants or animals or to develop micro organisms for specific uses.

Plant cell and tissue culture, molecular biology, biochemistry and plant breeding are basically the main pillars of biotechnology and further interaction with other disciplines can be achieved depending on the nature of the project.

For example: The main pillars of biotechnology for improving industrially important tree species in the developing countries like *acacia* spp., *Albizzia* spp., *Azadirachta indica* etc

Woody legumes can be the predominant species in certain ecosystems, especially in the

tropics [1] and their impact is immense in the tropical rainforests including the impact of substantial amount of nitrogen fixed through the symbiotic association between legumes and Rhizobium . There are many other benefits of the woody legumes.

Tissue culture offers great potential for the rapid multiplication of elite lines in large –scale production.[2] This technology is important for woody plants that have long maturation periods or ar difficult to multiply through conventional means. Several important woody plant species (legumes, conifers etc) cannot be improved through selection of elite trees for seed production owing to self –incompatibility or low seed viability.

The most commonly used tissue culture methods in forest biotechnology are:

i) Micropropagation
ii) Somatic embryogenesis
iii) Haploid production
iv) Somaclonal variation
v) Cryopreservation
vi) Somatic cell hybridization

Another example is the biopharmaceuticals which can combine ethnobotany, microbiology, chemistry etc disciplines. Biotechnology is responsible for recent rapid development of many new drugs. The pharmaceutical industry has shifted the former emphasis on chemical drug discovery and synthesis to drug discovery and development using the methodology of biotechnology. The term "biopharmaceuticals" reflects this approach. Many biotechnology companies now work with major pharmaceutical companies because of their experience in clinical testing, regulation, and marketing, all major activities necessary to bring a new biotechnology drug to the public.

Impact of Biotechnology

Biotechnology has innovative technologies that deploys a smart mix of farming techniques using genetic engineering.

Integrating these to small holders farming system will offer a bright prospect of meeting the growers demand for food by improving both yield and nutritional quality of crops and reducing environmental impact.

The technologies employed in biotechnology are the primary focus of the knowledge and skills offered in the **comprehensive academic Cell and Molecular Biology** (CMB) courses.

The CMB major consists of a core sequence of five courses that provide the backbone of knowledge and skills used in biotechnology. In addition, a selection of cell and molecular biology-based elective courses allows students to gain additional knowledge and skills which prepare them for specific careers or satisfy particular interests. The core sequence and many of the elective courses include:

1. learning and refining "hands on" laboratory skills.
2. The use of various databases begins in Genetics with a laboratory and Biomolecular Interactions, and culminates in Molecular Biology and Recombinant DNA Techniques
3. A specific elective course in Bioinformatics extends the student's core sequence experiences in utilizing various databases and biomedical resources.

For students expecting to find employment in biotechnology, a course in **Biotechnology** is available as an elective. This course is designed to help students transition from the environment of academia into the world of business and industry.

For the example above, it just shows one aspect of courses offered in the University depending on the particular area of biotechnology the student intends to end up with. These are basic interrelated courses, however, the final course of Biotechnology is the course that helps the student to transit from the world of academia to a world of business of choice. Therefore the Biotechnology elective course for this reason will depend on the area of interest. That is, for example, agricultural biotechnology for instance or medical biotechnology.

Biotechnology has proved valuable to agriculture in three main aspects:

a) Improved tolerance to biotic stresses, such as plaques and diseases which lead to reduction in the use of agrochemicals
b) Resistance to herbicides that favored soil conservation practices and opened opportunities for novel farming systems
c) Improved and diversified quality of agricultural products. These environments are a reality now partly because the relevant traits have a relatively simple inheritance and involve a few genes which are integrated in linear small networks, the G x E is small; there are no major scaling up or trade off issues (Struik et al., 2007). In contrast, the contribution of biotechnology to the increment in crop yield potential and yield stability is much more relegated because of its complex genetic and physiological mechanisms, strong G x E interactions (Compos et al., 2004).

Therefore, the new biotechnologies could play an important role in plant and animal breeding if integrated with physiology, molecular biology and breeding. knowledge in improving agricultural output

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