FIRST ANNUAL INTERNATIONAL CONFERENCE ON BIOSCIENCES RESEARCH

SUNCITY EXCLUSIVE HOTELS, AWKA, ANAMBRA STATE

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TITLE: BIOSCIENCES RESEARCH IN TODAY'S WORLD: BIOTECHNOLOGY PERSPECTIVE

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NATIONAL BIOTECHNOLOGY DEVELOPMENT AGENCY

PRESENTATION OUTLINE

- INTRODUCTION
  - BIOSCIENCES
  - BIOTECHNOLOGY

- GLOBAL TRENDS IN BIOTECHNOLOGY
- STATUS OF BIOTEHNOLOGY IN NIGERIA
  - ➢Agriculture and Food Security
  - ➢Environment and Bio-diversity conservation
  - ➢Medical Biotechnology and Healthcare
  - ➢BioDecs Impacts on Community Transformation
  - ➢Capacity Building in Biosciences/Biotechnology Research
- CONCLUSION

INTRODUCTION: BIOSCIENCES

- Biosciences have played a role in the development technologies for meeting the needs of mankind
- Researches in Biosciences have led to the emergence of revolutionary technologies that have applications in advancing civilization, one of which is Biotechnology
- WHAT IS BIO-SCIENCE?
  - A branch of sciences concerned with living organisms, ranging from micro-organisms to flowering plants and large mammals like elephants
  - It includes wide range of disciplines such as Biology, Microbiology, Biochemistry, Botany, Zoology, food science, bio-chemical engineering, Genetics, Ecology, Biophysics, Immunology, Bioethics
  - Biosciences can interchangeably be used with Life Sciences

BIOSCIENCES RESEARCH

- Bioscientists study the nature, behavior, evolutionary history, sustainability and the potential uses of living organisms and or their parts
- Most of the modern biosciences research works either start from or end up with laboratory investigations
- Bioscience research cuts across all disciplines of sciences that deal with living things, including:

Research to Nourish Africa

Bioscience Center

Germplasm characterization

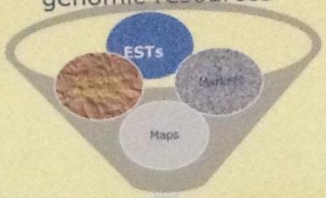
- **Diversity analysis**
  - SSR
  - SNP
  - DArT
- **Tissue culture**
  - Micropropagation
  - Embryo rescue

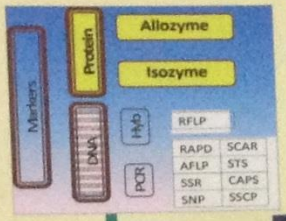
Molecular breeding

- **Genotyping**
  - DNA/RNA
  - Markers
- **Bioinformatics**
  - Comparative analysis
  - Gene discovery
- **Cytogenetics**
  - Ploidy analysis

Molecular Breeding

Development of genomic resources





Identify informative markers

Marker-trait association

Linkage mapping

Association mapping

Validate candidate markers

Validation GxE, Epistasis

Marker assisted Breeding

GMO

Integrate in breeding scheme

- Time
- Efficiency
- Effectiveness
- Cost

Genetic modification*

- **Transformation**
  - Agrobacterium
  - Gene gun
- **Vector construction**
  - cassava viruses
  - banana bacteria
  - cowpea pest

Diagnostics*

- **Pathogen characterization**
  - Viruses
  - Bacteria
  - Fungi
- **Molecular diagnostics**
  - PCR
  - DNA sequence

Capacity building

- **NARS scientists**
  - Individual training
  - Group training
- **Graduate students**
  - PhD
  - MSc
- **Interns\visiting scientists**

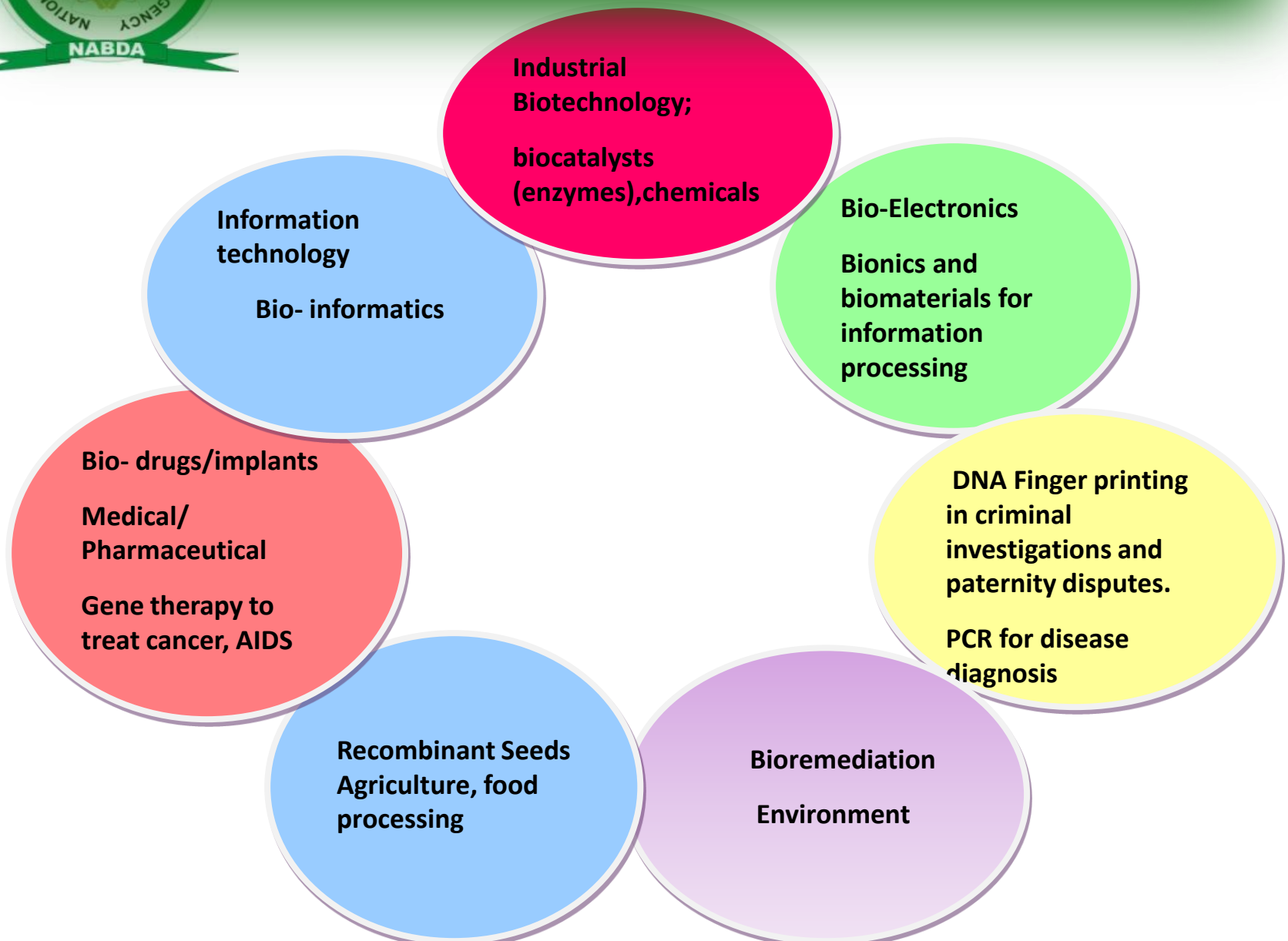
BIOTECHNOLOGY

- Biotechnology on the other hand is the “use of living systems and organisms to develop or make useful products”
- Biotechnology can also be defined as “Any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use” **UN Convention on Biological Diversity, Art. 2)**
- **American Chemical Society** defined Biotechnology as the “Application of biological organisms, systems, or processes by various industries to learning about the science of life and the improvement of the value of materials and organisms such as pharmaceuticals, crops and livestock.
- Biotechnology is the integration of natural science and organisms, cells, parts thereof, and molecular analogues for products and services. **European Federation of Biotechnology**

BIOTECHNOLOGY: SCOPE

- Biotechnology embraces wide range of pure biological sciences (animal cell culture, biochemistry, cell biology, embryology, genetics, microbiology and molecular biology; it is however dependent on knowledge and methods from outside the sphere of biology, which includes:
  - Bioinformatics;
  - Bioprocess engineering;
  - Bio robotics; and
  - Chemical Engineering.

Application of Biotechnology



BIOTECHNOLOGY: GLOBAL TRENDS IN MEDICINE AND HEALTH CARE DELIVEY

- Medical biotechnology revolution started in the 1970's with the development of recombinant DNA (rDNA) technology (Hsu *et. al*., 2007)
- rDNA or Genetic engineering allows Scientists to transfer genes from one organism to another, thereby evading the long sexual process; the technology thrived due to availability of several enzymes such as restriction enzymes, DNA ligase, DNA polymerase and DNA modification enzymes used by bacteria to manipulate DNA as part of their normal cellular process
- Advances in medical biotechnology have led Scientists to produce medicines and vaccines for prevention of diseases and reduction of side effects of medications by tailoring treatment to individuals.
- Some of the breakthroughs include stem cell technology.

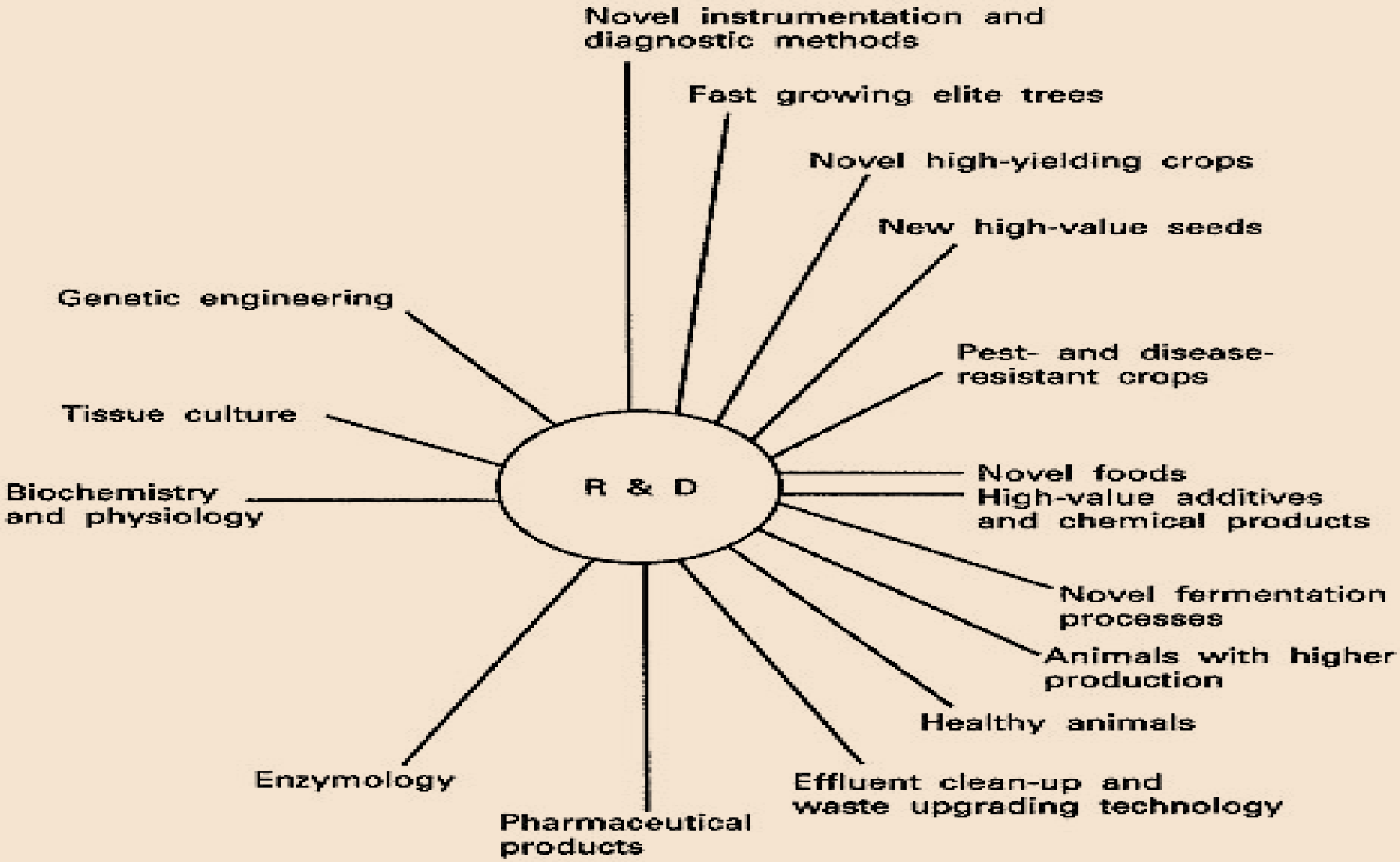
BIO-PHARMACEUTICALS

- Biopharmaceuticals are medical drugs produced through biotechnological means (i.e. production by means other than direct extraction from a native (non-engineered) biological source.
- Biopharmaceuticals are proteins (including antibodies); nucleic acids (DNA, RNA or antisense oligonucleotides) used for therapeutic or *in vivo* diagnostic purposes
- Pharmaceutical companies use pharmacogenomics to create drugs based on the proteins, enzymes, and RNA molecules that are associated with specific genes and diseases. The drugs take advantage of therapeutic effects and also decrease damage to nearby healthy cells.
- The first commercial application of rDNA was in mass production of human insulin that was genetically produced in 19788 (Gulzar and Riaz-ud-Din, 2006). Genetech joined a gene for insulin with a plasmid vector and put it into *Escherichia coli*, enabling the engineered organism to produce insulin in large quantities at very low cost.

DIAGNOSTICS

- Gene diagnosis is the process of testing suspected genetic defects before administering treatment; this discovery has transformed medical practice
- Diseases can now be detected/diagnosed on the basis of molecular information rather than on vague signs and symptoms
- The four diagnostic tests introduced as a consequence of medical biotechnology advances are Nucleic acid tests, Monoclonal Antibodies, Proteomics and Nanodiagnostics

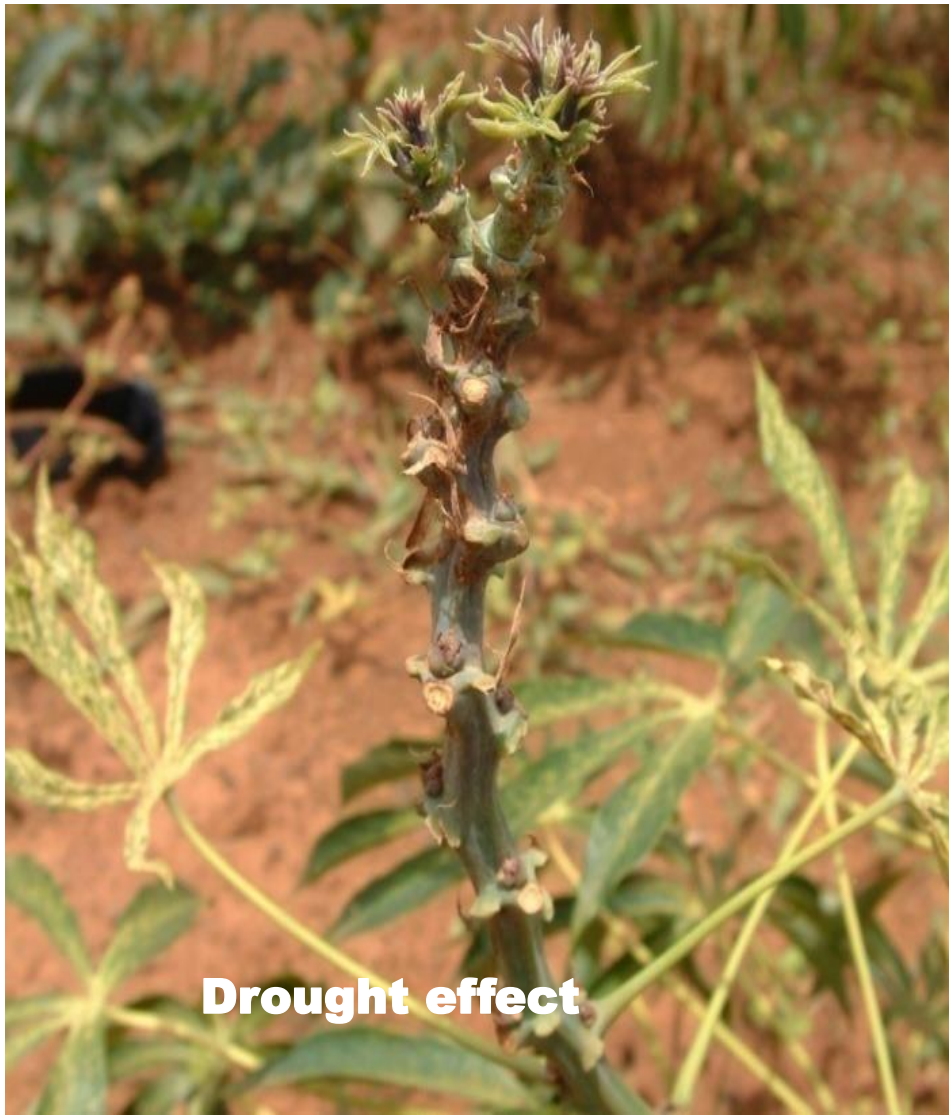
Biotechnology in Agriculture



CHALLENGES IN AGRICULTURE

- Pests and diseases
- Post Harvest storage problems – deterioration and pest infestation
- Poor farm in put – low productivity / low income
- Shrinking water bodies – depleting aqua culture
- Drought and desertification – depletion of arable land
- Wind and gully erosion – further encroaching on arable land
- Social unrest

Pests, Diseases and Climatic Conditions



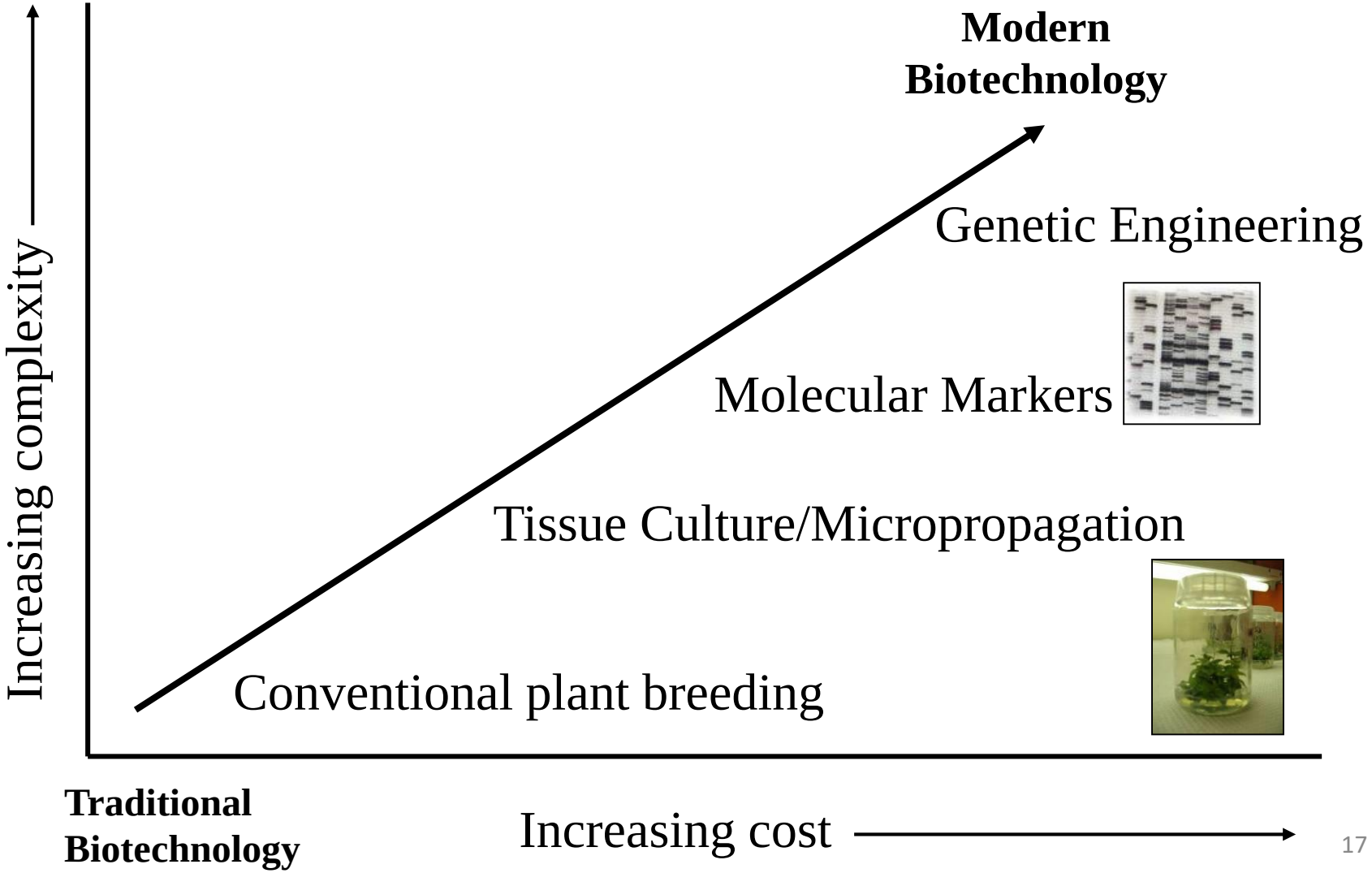
Post Harvest Challenges

The biotech tomato was engineered for delayed ripening by silencing two genes

The life span of the fruits were extended up to 45 days at room temperature.

Post harvest handling/storage of yam is still a big problem, being an orphan crop

Gradient of Biotechnology Applications in Agriculture

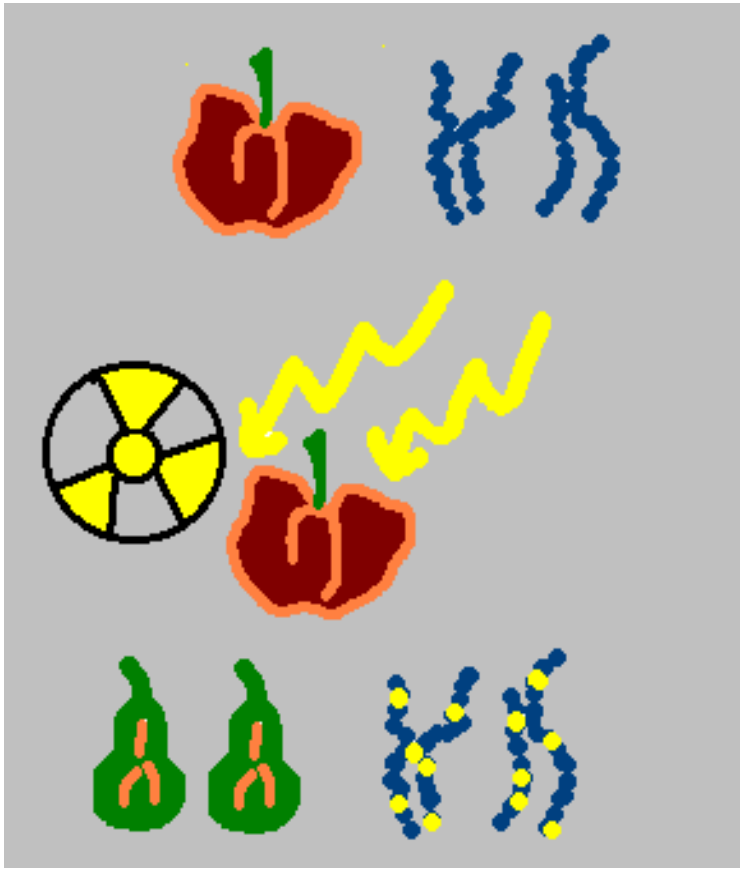


Conventional Breeding

- Age old biotechnological application (over thousands of years)
- Been used by farmers/breeders in selection for features such as;
  - faster growth,
  - higher yields,
  - pest and disease resistance,
  - larger seeds,
  - sweeter fruits
  - Etc

Conventional breeding requires specie compatibility

Mutation breeding



International Atomic Energy Agency:

- Used since 1963.
- 2,252 new plant varieties.
  - Includes: wheat, barley, oats, rice, soybeans, string beans, navy beans, potatoes, onions, cherries, apples, grapes and others
- Improved resistance, quality, yield and adaptability

Tissue Culture

- Tissue culture is the cultivation of plant cells, tissues, or organs on specially formulated nutrient media,
- Under the right conditions, an **entire plant** can be regenerated from a **single cell**,
- Plant tissue culture is a technique that has been around for several decades
- E.g. Anther culture, Micropropagation, Embryo rescue

Marker Assisted Breeding

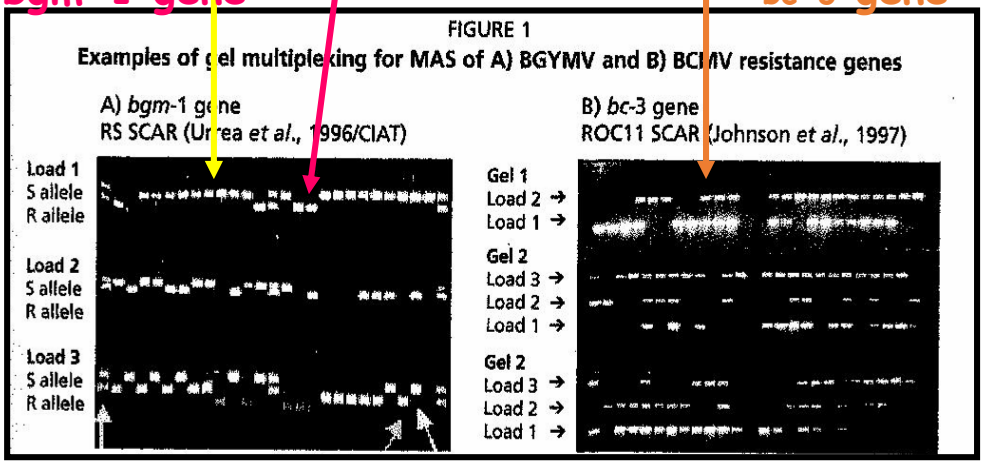
Molecular markers can help select plants with desirable traits (eg. Disease resistance)

Reduces breeding costs (eliminating land and labor costs by selecting and removal of susceptible individuals early on).

No biosafety regulations needed for Marker Assisted Breeding

bgm-1 gene

bc-3 gene



R band gives resistance

S band gives susceptibility

No band (bc-3 present) means resistant

Marker Assisted Selection, FAO 2007

Genetic Engineering

- Identifying genes of interest for a trait (insect resistant genes)
- Insert into susceptible plant to make it resistant
- Genes sources:
  - same plant species
  - wild relatives
  - another crop
  - bacteria (Bt) or another organism

What are GM Crops?

- Genetically Modified (GM) crops refer to crops that have had their DNA altered for a particular purpose.

Economic Impact of Agricultural Biotechnology

- 13.3 million crop farmers planted crops derived through biotechnology –
  - 12.3 million were small and resource-poor farmers.
- Farmers saw yield increases from 9 to 31%
- Pesticide application decreases from 39 to 60%
- Income increases from $117 to $250 per acre

THE AGENCY: NABDA

- The Nigerian Government, Convinced that

Biotechnology will drive the 21st Century's Global & Regional Economies in Areas such as:

- Agriculture & Food Security
- Healthcare Delivery
- Industrial Production
- Sustainable Environmental Management
- Biofuels & Renewable Energy Technologies among others
- Bio-entrepreneuship;

- Approved the National Biotechnology Policy in April, 2001.

- This led to the Establishment of the National Biotechnology Development Agency (NABDA)

VISION / MISSION STATEMENTS

- **VISION**: To make biotechnology a sustainable bedrock for national development and competitiveness in agriculture, environment, health care and the industrial sector of the national economy
- **MISSION:** To promote advanced biotechnology research and development activities so as to meet national goals and aspirations in food security, improved health care delivery, sustainable environment, employment and wealth creation, through research, partnership and international cooperation

NABDA'S KEY R&D ACTIVITIES: AGRICULTURE & FOOD

- Crop Improvement Targeted at Agricultural Transformation Agenda (ATA) Crops
  - Developing indigenous crop varieties that are tolerant to drought, flooding, salinity, herbicides, common pests & nitrogen deficiency
  - Developing crop varieties with enhanced nutrition profiles that solve vitamin & nutrient deficiencies
- Micro-propagation of target Crop Species
  - Mass propagation of Food & Tree Crops using Conventional Tissue Culture (TC) & Automated Temporary Immersion Bioreactor system (TIBs)
  - Development of Protocols for the Target crops
- Improvement & Development of Indigenous Animal Breeds for Enhanced Productivity & Efficiency
  - Sterile Transgenic Tilapia Development for Increased Efficiency & Carcass Quality
  - Selective Breeding of African Catfish for Optimal Quality & Quantity

TISSUE CULTURE & TIBS TECHNOLOGY

- Human Capacity
- Infrastructure Development
- Protocols Developed on Target Crops:
  - pineapple,
  - banana & plantain,
  - date palm,
  - Eucalyptus,
  - sugar cane etc.

PINEAPPLE PLANTLETS IN TIBS

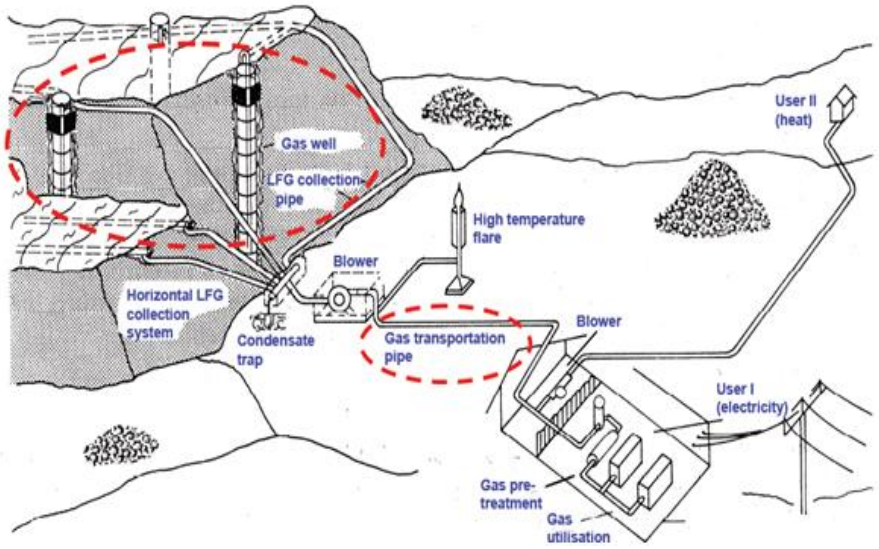
PINEAPPLE PLANTLETS IN CONVENTIONAL TISSUE CULTURE

DEVELOPMENT AND PROMOTION OF TRANSGENIC CROPS / LIVESTOCK

- Bio-cassava Plus Bio-fortified with Pro-Vitamin A, Iron and Zinc in partnership with NCRI, Umudike
- Africa Bio-fortified Sorghum (ABS) with Increased Vitamin A, iron and zinc
- *Maruca* Resistant Cowpea (Beans) in collaboration with Africa Harvest & IAR, Zaria
- Bt Cotton for higher yield, longer fibre & better lint quality in partnership with Mosanto seed coy & IAR, Zaria
- Nitrogen-use-efficient, water-use-efficient and salt tolerant (NUWEST) rice in partnership with (AATF), Kenya & NCRI, Badeggi
- Domestication of the Sterile Tilapia Technology for increased quality & quantity with NIFFR, New-Bussa

NABDA'S KEY R&D ACTIVITIES: ENVIRONMENT & RENEWABLE ENERGY

- Development of technologies for climate change mitigation by direct capture of green house gases from dumpsites



- Bio-conversion of organic municipal / agricultural wastes (biomass) to electricity and bio-fertilizer

NABDA'S KEY R&D ACTIVITIES: ENVIRONMENT & RENEWABLE ENERGY

- Establishment of DNA Barcoding / Forensic lab for controlling poaching and international trade in endangered species

- Establishment of Microbial Culture Collection

- Development of technologies for erosion / desertification control

NABDA'S KEY R&D ACTIVITIES: DNA BARCODING OF 50 ENDANGERED MAMMALIAN SPECIES

NABDA'S ACTIVITIES: BIODECS

- NABDA has 6 centres of excellence in the premier Universities in Bioresources development centres(BIODEC) in the geo-political zones of Nigeria, with the following mandates:
  - Conservation of the Biological Resources of Each Geopolitical Region
  - Sustainable Utilization of the Such Bioresources
  - Value Addition to the Available Resources
  - Community Transformation Through Trainings & Infrastructure Upgrade

BIORESOURCES DEVELOPMENT CENTRES ACHIEVEMENTS

- A wide Array of Products Are Being Produced.
  - Dietary Supplements e.g. *Moringa* Oil, Capsules & Powder, Various Balms
  - Cosmetics e.g. Shea Butter Cream & Other Oils
  - Bio-organic Fertilizer & Fish Meal (Already Deployed in Parts of the North East)
  - Bio-fortified Bread Fruit Powder (Already Deployed in Parts of the South West)
  - Preserved & Packaged Mushrooms (Already Deployed Nationally) etc.

Other Achievements

- Capacity Building
  - All the Achievements presented on the different R&D areas were made possible by the invaluable capacities developed in the respective areas.
  - NABDA has also developed linkages with relevant institutions to enhance their capacities to deploy biotechnology in their areas of mandate. These include the six centres of excellence in the six geopolitical regions, IA&R, Zaria, NIFFR, New Bussa, NCRI, Umudike etc.
- Public Enlightenment & Awareness on GMOs
  - The Open Forum on Agricultural Biotechnology (OFAB) in collaboration with AATF Kenya and Agricultural Research Council of Nigeria has been organizing monthly stakeholders meetings that so far covered all the six geopolitical zones.
- Biosafety Law
  - NABDA has played a central coordinating role in the conception and Facilitation of the signing of the Biosafety Bill into Law by Mr. President, Dr. Jonathan Ebele Jonathan.

Conclusion

- Biotechnology is Currently the Big Wheel Driving Global & Regional Economies.

- Nigeria's Biosafety bill has recently been signed into Law
- It is hoped that this will accelerate the development, deployment and commercialization of biotech products and services in the country, so as to revolutionize the economy.

ACKNOWLEDGEMENT

- DIRECTOR GENERAL – NABDA
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THANK YOU