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Report Highlights:

Since the commercial release of Bt Cowpea in January 2019, Nigeria biotech regulatory authorities are forging ahead with other approvals. Nigeria has also approved Bt Cotton for commercialization - a pilot group of one thousand farmers in 5 states now has access to biotech cottonseeds through the MAHYCO Seed Company Nigeria.

EXECUTIVE SUMMARY

Nigeria is Africa's largest economy with an estimated nominal Gross Domestic Product (GDP) of \$102.6 billion as of 2020 3rd Quarter Report from the National Bureau of Statistics (NBS). However, the COVID-19 pandemic and loss of revenue from oil has caused the economy to slip into a recession, having experienced two negative quarters. The devaluation of the local currency by 28 percent (%) also contributed to the worsening economic situation. The country is a major oil producer, with a population of 203.5 million (Central Intelligence Agency – July 2018, estimate) growing at 2.54 % per annum. Earnings from crude oil and gas exports contribute more than 80% of the country's total revenue. The agricultural sector is underdeveloped, accounting for around 25% of GDP and employing roughly 70% of the population.

Over the decades, successive governments have initiated policies to strengthen Nigeria's agricultural sector, but the country remains a net importer of food and agricultural products (approximately \$7 billion per annum). The lack of infrastructure, absence of effective policy formulation and implementation, insecurity, as well as negative impacts of climate change are factors that continue to impede Nigeria's agricultural growth.

In 2001, Nigeria established the National Biotechnology Development Agency (NABDA) to promote, commercialize, and regulate biotechnology products. The country also signed the biosafety bill into law—establishing the National Biosafety Management Agency (NBMA), assuming biotech regulatory authority from the NABDA in 2015. The National Biosafety Management Agency is Nigeria's focal point and authority on biosafety, providing oversight for the use of biotechnology and regulating the commercialization of biotechnology products. However, the law leans heavily on the precautionary approach and requires certification and mandatory labeling for imports of all biotechnology products.

The Nigeria government has publicly announced its interests in commercializing agricultural biotechnology as a tool to achieve food security in the country. Nigeria officially approved its first biotechnology crop, *Bacillus thuringiensis* (Bt) cotton, for commercialization in 2018. Next, in January 2019, Nigeria approved the commercial release of Pod-Borer Resistant (PBR) Cowpea event AAT709A. Other crops such as Africa Bio-fortified Sorghum, TELA Maize, Virca Plus Cassava, and Nitrogen- and Water-Use Efficient and Salt Tolerant (NEWEST) rice are at different stages of confined field trials (CFT) across the country.

Nigeria's biosafety law requires mandatory labeling of products containing genetically engineered (GE) products or ingredients exceeding four percent. Certain civil society groups and environmental activists have emerged and are intensifying their anti-GE campaigns. These are major limitations to commercialization of biotechnology. Farmers' positive attitude towards biotechnology needs to be leveraged to develop more effective strategic risk communication to address the anti-GE misconceptions and steer Nigerians towards embracing the benefits of modern agricultural biotechnology.

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CHAPTER 1: PLANT BIOTECHNOLOGY

PART A: PRODUCTION AND TRADE

a. PRODUCT DEVELOPMENT: The National Center for Genetic Resources and Biotechnology (NACGRAB) was established in 1987 by the Nigeria Federal Ministry of Science and Technology (FMST) to conduct research, gather data, and disseminate technological information on matters relating to genetic resources conservation, utilization, and biotechnology applications. The Center's regulatory authority is derived from Decree 33 of 1987 – regulating the seed, livestock, and fisheries industries through its Varietal Release Committees. Over the next five years, Nigeria seeks to develop and commercialize new genetically engineered (GE) crops:

- i. Herbicide Tolerant (HT) Soybeans Project in collaboration with Michigan State University (MSU), USA; National Cereals Research Institute (NCRI), Badeggi, Niger State.

The purpose of this field trial is to evaluate two glyphosate formulations (Roundup Ready MSU lines, E14086 and E14017). Applied glyphosate tolerant soybean will be compared to lead Nigerian commercial varieties. Weed management is one of the major problems limiting large scale production of soybean in Nigeria and introgression of the HT gene into Nigerian soybean commercial varieties will go a long way to alleviate the drudgery and cost of weed management. Less weed competition resulting from the adoption of this technology will boost soybean yield and productivity in Nigeria. Introgression and further field morpho-evaluations will be carried out and the yield response of transgenic soybean to protection from glyphosate will be determined.

Objectives:

- i. To screen HT soybean varieties with lead Nigerian commercial varieties
 - ii. To backcross HT soybean with those lead Nigerian commercial varieties
 - iii. To check for stability and efficacy of HT gene against Glyphosate in subsequent backcross progenies of Soybean
 - iv. To commercialize and popularize improved HT Soybean varieties
- ii. **Tomato Project:** This is being carried out in collaboration with IITA, Ibadan. There are 2 components of this project: A) Shelf-life elongation; B) Biocrops/NABDA Hybrid Tomato
 - iii. **Newest Rice:** The rice is stacked with nitrogen-use efficiency, water-use efficiency, and salt tolerance (NEWEST). The project develops and disseminates preferred and locally adapted rice varieties to smallholder farmers across Sub-Saharan Africa (SSA).

Updates on the Newest Rice

Proof of concept on Newest Rice has been done through selection of farmers that worked on introgression and backcrosses projects. The result indicated 10-15% improvement in yield, 30% Nitrogen use reduction, and 15% decrease in total production cost.

The expected benefits of this variety to the country are numerous and include yield increase by at least 20% over the current varieties, 10% reduction in Nigeria's rice deficit, and reduction in nitrogen run-off and emissions. Additionally, abandoned land can be used for rice production.

- iv. **Bt. Cowpea Project:** On December 15, 2019, the Federal Government of Nigeria approved registration, naming and release of a new Pod Borer Resistant (PBR) Cowpea variety for commercialization. The approval was granted by the National Committee on Naming, Registration and Release of Crop Varieties at its 28th meeting held in Ibadan on December 12, 2019. The new cowpea variety, SAMPEA 20-T, was developed by scientists at the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, in collaboration with several partners including NABDA under the auspices of the African Agricultural Technology Foundation (AATF).

In early 2019, NBMA confirmed that the product was safe for human and animal health and the environment. This approval paved the way for submission to the National Variety Release Committee to register the first variety containing the PBR Cowpea trait as a commercial crop in Nigeria.

The newly registered SAMPEA 20-T is highly resistant to *Maruca vitrata*, an insect pest that causes up to 90 percent yield loss in severe infestation cases. This new variety is early maturing (70 - 75 days) with semi-erect growth habit, insensitive to day-length, and has medium large white seeds. It is also resistant to Striga and Alectra, two notorious parasitic weeds.

The release of Bt cowpea will help farmers reduce the number of sprays they currently apply to their crops, from 6 to 7 times down to only 2 per cropping season. The latter will result in an increase in yield quantity and quality. Bt Cowpea will also contribute to reducing the 500,000 tons annual shortfall in cowpea production and improve the national productivity by 20%.

During the Multilocation Advanced Yield Trials conducted across Nigeria's agro-ecologies, researchers found SAMPEA 20-T to have highly stable grain yield across the test locations. The minimum observed average grain yield increase over the conventional cowpea varieties was at least 20% (3 tons per hectare), and this could be higher depending on the severity of the *Maruca* infestation.

- v. The Virus Resistant Cassava Plus Project in collaboration with the National Roots Crops Research Institute (NRCRI), Umudike and the Donald Danforth Plant Science Centre (Missouri, USA) are currently conducting confined field trials at Umudike.

About the VIRCA Plus Project

Cassava grows well in drought conditions and low fertility soils that are prevalent in many African countries. However, plant viral diseases can destroy up to 100% of a cassava crop yield, threatening livelihoods and leading to hunger. Although it is an excellent source of calories, cassava does not contain significant levels of key nutrients to meet minimum daily requirements, especially for women and children. In Nigeria, 75% of preschool children and 67% of pregnant women are anemic. Vitamin A deficiency affects almost 30% of preschool children, according to the [World Health Organization](#).

The VIRCA Plus collaboration is addressing these challenges by developing and delivering two products, one for East Africa and the second for Nigeria. The Nigerian VIRCA Plus product is a cassava variety with elevated levels of iron and zinc for improved nutrition, as well as disease resistance.

Further development of VIRCA Plus cassava varieties, which are high in iron and zinc is taking place in collaboration with the National Root Crops Research Institute (NRCRI), Nigeria. The team works with national government regulators, who will review safety data as part of the approval process before VIRCA Plus varieties are available to farmers. VIRCA varieties are expected to be accessible and available to farmers in a similar manner and cost to cassava currently available from national research organizations.

vi. Africa Bio-fortified Sorghum (ABS) Project.

The ABS project seeks to address several UN Sustainable Development Goals (SDGs); SDG 1 (No Poverty) seeks to build the resilience of the poor and reduce exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks; SDG 2 (Zero Hunger) seeks to end all forms of malnutrition, including stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons, and SDG 13 (Climate Action) seeks to strengthen resilience and adaptive capacity to climate-related hazards.

In 2004, a consortium was formed by Africa Harvest Biotech Foundation International (Africa Harvest) to develop a bio-fortified African sorghum through the ABS Project. Members of the consortium included: Pioneer-DuPont (now Corteva Agriscience) - USA, Institut de l'Environnement et Recherches Agricoles (INERA) - Burkina Faso, Kenya Agricultural and Livestock Research Organisation (KALRO), Institute for Agricultural Research (IAR) - Nigeria, University of Pretoria – South Africa, National Biotechnology Development Agency (NABDA) – Nigeria, Council for Scientific and Industrial Research (CSIR) - South Africa, African Agricultural Technology Foundation (AATF) - Kenya, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The consortium received its initial funding from the Bill and Melinda Gates Foundation (BMGF) to implement the ABS project. This was later supplemented by funding from the Howard Buffet Foundation, DuPont Pioneer, and an anonymous donor.

Project progress

The ABS consortium has delivered vital aspects of bio-fortified sorghum and is starting to consider the delivery process. As a result of the significant effort from the team, other subsidiary funds were competitively sought and utilized to pursue the project objectives from 2011 to 2018.

During this period:

- Sorghum transformation time has been reduced by 60% to four months and the transformation frequency increased by about 100-fold over previous capabilities.
- Scientific advances have enabled the use of direct and indirect transformation of select farmer preferred native African sorghum varieties.
- Beta (β)-carotene levels and stability in sorghum have been increased to 50-70 ug/g, with beta-carotene stability extended to nearly 10 weeks.
- Efficient bioconversion of bioavailable β -carotene to retinol, which becomes converted to vitamin A, has been demonstrated in a mammalian system.
- In addition, increased bioavailability of iron and zinc through reduction in phytate – without impact on seed germination – has been achieved.
- Multiple stacked constructs and “regulatory-ready” events have been confirmed in at least 2 different popular varieties.
- Procedures for regulated CFTs and transgenes introgression into local varieties have been developed and conducted in Nigeria and Kenya, demonstrating sound stewardship and compliance practices.

Project Update

The project is moving from development towards deregulation and subsequent commercialization of well-adapted cultivars with improved nutritional traits. De-regulation of the lead events will pave the way for commercial utilization of ABS sorghum in East and West Africa.

vii. Bio-crops Projects.

- i. Yam seedlings multiplication using Aeroponics/hydroponics systems; Temporary Immersion Bioreactor systems where seedlings are multiplied in the millions. Tissue Culture system - these systems can generate millions of seedlings that can benefit thousands of farmers in a more significant way.

b. COMMERCIAL PRODUCTION: Nigeria is commencing the commercial production of biotechnology crops. Bollgard II cotton has been released for commercialization. The Nigerian government organized a pilot group of one thousand farmers that started cultivation during the 2019 planting season. The commercial approval and cultivation are for fiber, feed, and food.

Bt Cotton Project - This is a collaborative project involving Bayer Agriculture Nigeria; Mahyco Agriculture Nigeria Private; Institute of Agricultural Research, Zaria; the National Biotechnology Development Agency (NABDA) and the National Agricultural Seed Council of Nigeria. The project goals align with the Federal Government's vision to revive the cotton sector. 2018 was a landmark year - Nigeria approved commercial cultivation of 2 *Bt* cotton hybrids (Mahyco C 567 BGII & Mahyco C 571 BGII) after two years of multi-location trials conducted by the Institute for Agricultural Research, Zaria (IAR).

Adoption of Mahyco Bollgard II Hybrid seed has the potential of reviving the cotton industry in the country. The released 'Mahyco Cotton Hybrids in Bollgard II' offer significantly higher yield levels, superior cotton quality and decrease the cost of pest control, thereby enhancing the income level of farmers. Reviving cotton farming will also strengthen the economy by creating new jobs while restoring the textile sector.

In 2019, one of Mahyco's objectives was to demonstrate the value of hybrids and technology to farmers in their own fields. During the 2019 wet season, more than 2,000 seed samples were distributed to selected farmers for planting. The company also trained farmers on appropriate agronomy skills to optimize and sustain yield. In addition, seed production trainings were conducted to reduce the impact of diseases, pests, and weeds.

More than 200 on-field farmers trainings on appropriate agronomic practices were conducted during various phases of crop growth across 12 states. Free samples were distributed through Mahyco and partners (private and institutional). The trainings focused on agronomy aspects such as land preparation, spacing, crop nutrition and other relevant yield-contributing factors.

More than 70 field days were conducted during harvesting time, to increase the awareness of the newly released Mahyco Cotton Hybrids. Across the targeted states an incremental yield advantage of 3 tons/ha or more was observed (over traditional cotton seed). Around 20,000 farmers have been exposed to the performance of Mahyco Bollgard2 cotton hybrids, in various phases of interactions from farmer meetings to field days. All the farmers who have experienced the value of these Mahyco Bollgard2 Hybrids, are keen to apply the seed next year. Mahyco will import the seeds and make them available to farmers in 2021.

Between 2023-25, the company is planning to meet at least part of the demand with local seed production, which will be expanded substantially by training registered farmers through various partners. By 2025, the objective is to create a significant pool of farmers who are adept in seed

production protocols and at delivering the product with 99 percent purity. Additionally, a quality analysis laboratory will be established to assess seed purity

c) EXPORTS: Nigeria does not export GE products.

d) IMPORTS: Nigeria permits the import of biotech crops. There is no ban on the import of GE products. The country authorizes the import of GE grains for poultry feed, as well seeds for research purposes. GE grains are imported in large quantities. An import permit approved by the NBMA is required; applications need to be submitted to the Director General at least 270 days prior to the import date. Non-compliant shipments will be rejected and refused entry into Nigeria. Importers are required to obtain from the NBMA the corresponding GE seed import permit prior to shipment.

e) FOOD AID: Nigeria does not provide food aid. It does, however, receive food aid, including GE corn-soy blend products.

f) TRADE BARRIERS: Nigeria maintains an open market for agricultural commodities and products derived through or produced with biotechnology. There are currently no biotechnology-related trade barriers affecting U.S. food and agricultural product exports to Nigeria.

PART B: POLICY

a) REGULATORY FRAMEWORK: The National Biosafety Management Agency is the government institution responsible for regulating GE products in Nigeria. The National Biosafety Committee reviews applications and carries out data analysis of socio-economic considerations of GE crops alongside risk assessment before recommending any products to the agency for approval. The provisions for the legislation and regulations regarding the approval and release of GE crops, including the National Biosafety Act 2015, National Biosafety Regulations 2017, and National Biosafety Guidelines 2018, can be found at www.nbma.gov.ng.

NIGERIAN INSTITUTIONS INVOLVED IN AGRICULTURAL BIOTECHNOLOGY

i. Nigeria Federal Ministry of Environment: Nigeria's Federal Ministry of Environment (FME) established the National Biosafety Management Agency as the national focal point and the competent authority for biosafety in the country. It is the regulating body for modern biotechnology activities. It provides biosafety regulation requirements for bringing into the country GE crops for testing and environmental release. The Ministry is the Nigerian government's liaison with the Secretariat of the Convention on Biological Diversity - required under the Cartagena Protocol on Biosafety.

ii. National Biosafety Management Agency: The agency is an independent biosafety and regulatory body for all biotechnology activities; the NBMA is responsible for all correspondence with importers, exporters, and applicants regarding movement of products of modern biotechnology.

Roles and Responsibilities:

- Defines modules of practice for modern biotechnology and the handling of its products to ensure safety to the environment and to human health.
- Provides guidance on safe application of modern biotechnology.
- Recognizes complex issues to be addressed by central authorities on the judicious application of modern biotechnology.
- Ensures that modern biotechnology activities and their products are safe for the environment and to human health.
- Bases the release of GE organisms on advance informed agreement.
- Defines responsibilities among designated bodies/institutions.
- Confers powers to authorize release of GE organisms and practice of modern biotechnology activities.
- Confers powers to carry out risk assessment/management.
- Defines offences and penalty for violation of the act.
- Covers all living modified organisms (LMOs), products food/feed and processing.
- Addresses socio-economic considerations in risk assessment and labeling of GE products.

The agency is responsible for providing the regulatory framework, institutional and administrative mechanisms for safety measures in the application of modern biotechnology. Its key objective is to prevent any adverse effect on human health, animals, plants, and the environment.

iii. Nigeria Federal Ministry of Agriculture and Rural Development: The Ministry of Agriculture and Rural Development (FMARD) oversees formulating agricultural policy relating to biotechnology, promoting, and facilitating agricultural activities, and implementing policies and programs. It houses all agricultural research institutions in the country.

iv. National Biotechnology Development Agency: The agency was established in 2001 under the Ministry of Science and Technology with the mandate to formulate biotechnology policy in Nigeria and

acquire, deploy, promote, and facilitate biotech activities for indigenous and self-reliant national growth. The agency is active in creating awareness for products of biotechnology. It conducts regular workshops for major biotechnology stakeholders (see Open Forum for Agricultural Biotechnology in Africa – Nigerian Chapter).

v. National Agency for Food and Drug Administration and Control (NAFDAC): The NAFDAC oversees all food safety including drugs, chemicals, and related issues. The agency regulates herbicide tolerance events to determine the maximum residue limits (MRL) in GE crops for food and feed.

vi. Sheda Science and Technology Complex (SHESTCO): The Center is a Nigerian government biotechnology research and training facility. It has the mandate to develop and use domestic technologies for the application of biotechnology in health, agriculture, and environment.

vii. Nigerian National Universities: Several National Universities are also involved in Research and Development aspects of Agricultural biotechnology including confined field trials. Most of these universities possess institutional biosafety committees.

viii. The National Biosafety Committee (NBC): The inter-ministerial NBC serves as the competent national authority for biosafety. The NBC is responsible for the safe management of biotechnology activities. The committee has 16 members drawn from the Ministries of Agriculture and Rural Development, Science and Technology, Environment, Commerce, Education, Health (NAFDAC), Industry, Foreign Affairs, Internal Affairs (Nigerian Customs Service), Justice, and the Nigerian Association of Chambers of Commerce, Industry, Mines, and Agriculture (NACCIMA) and other private sector organizations. The committee includes biologists, physical and social scientists, as well as representatives of environmental and conservation non-governmental organizations (NGO). The committee is required to review all applications for the release of bioengineered agricultural products, make recommendations to the Minister of Environment on whether to approve such products. It also oversees the implementation of the National Biotechnology Program and addresses any issues that may arise within the Biosafety Law.

The NBC established the National Biosafety Technical Subcommittees (NBTS) to focus on biotech interests expressed by agriculture, health, industry, and the environment sectors. The subcommittees review proposals for research and recommend the conditions under which experiments should be conducted. They provide technical advice to the NBC and contribute to its functions in relation to contained use, field trials, release, and market placement.

Currently, all applications for imported products containing GE for field trials, transit, and contained use must be routed through the National Biosafety Management Agency. The committee acts as liaison between the relevant NBTS to carry out risk assessment and ensure participation of all relevant stakeholders. Findings of the NBTS are submitted to the NBC and the agreed decision is conveyed to the applicant by the NBMA, which determines the issuance of licenses to carry out activities. The National Biosafety Management Agency is responsible for the safe application, use, and handling of GE organisms and their products.

ix. Open Forum for Agricultural Biotechnology: Nigerian government officials support agricultural biotechnology. The Open Forum for Agricultural Biotechnology holds sensitization activities to enhance the understanding and acceptance of GE crops. The forum is also building the capacity of journalists to effectively report science-based information. It engages policymakers including those from the Ministers of Agriculture, Environment, and Science and Technology.

b) APPROVALS: There are distinctions between the regulatory treatment of the approval for food, feed, processing, and environmental release. Bt. Cotton and cowpea are currently the only approved crops for environmental release (i.e., cultivation) in Nigeria, but imported GE corn and soybean varieties have been approved for food, feed, and oil processing. Operational guidelines for approval are reviewed by the National Biosafety Committee. The timeline for approvals is usually about 180 days.

c) STACKED OR PYRAMIDED EVENT APPROVALS: The approval process and conditions are the same as for single trait approvals.

d) FIELD TESTING: Field testing and evaluations are allowed.

With the approval of the National Biosafety Committee, the National Root Crops Research Institute-Umudike (NRCRI-Umudike), IAR-Zaria, and NCRI-Badeggi have carried out confined field trials on cassava, cotton, sorghum, cowpea, and rice. The approval is based on the provisions of the National Biosafety Guidelines, which include field-testing of bioengineered crops.

The National Biotechnology Development Agency collaborates with the NRCRI-Umudike, IAR-Zaria, and NCRI-Badeggi for creating awareness among Nigerian cowpea and cassava clientele, while the NBMA ensures compliance with Nigerian Biosafety Guidelines.

e) INNOVATIVE BIOTECHNOLOGIES: The National Biosafety Management Agency Act of 2015 remains current. It does not however apply at present to gene editing, but it is being considered and some anticipate that that incorporation could occur in the Act's next amendment.

f) COEXISTENCE: Policy is evolving. The National Biosafety Management Agency develops rules and guidelines to regulate GE crop cultivation.

g) LABELING AND TRACEABILITY: Regulations stipulate that products with four percent GE content should be labeled with statements such as:

- This product contains “genetically modified organisms” wherever there is evidence of the presence of genetically modified organisms
- The words “This product may contain genetically modified organisms” where the presence of GE component in a product cannot be excluded due to inconclusive evidence of any presence of GE content.

The purpose of the labeling is to enable consumers to make informed choices on products purchased. The biosafety law requires mandatory labeling of all products of agricultural biotechnology to protect “consumers’ right to know.” Although not specific to biotech products, existing labeling regulations are being enforced by NAFDAC, the government’s regulatory body responsible for food product manufacturing, importation, advertisement, and distribution in Nigeria. NAFDAC regulations require food labeling to be informative and accurate. FAS Lagos (Post) has an open dialogue with the NABDA, NAFDAC, NBMA and other key stakeholders on the operational guidelines of the law to ensure that the requirement of mandatory labeling does not obstruct free trade.

h) MONITORING AND TESTING: The National Biosafety Management Act includes a regulatory framework, as well as institutional, administrative, and monitoring mechanisms. The biosafety law also defines penalties for not complying with the regulations. Failure to obtain approval or proper permits before importing or releasing GE organisms into the environment is subject to the following stated penalties:

- Individuals can be fined Nigerian naira (NGN) 2.5 million (approximately \$6,900) or imprisoned for a period not less than five years or both, (NGN 360.33 = \$1.00).
- Corporations would pay a fine of at least NGN 5.0 million (approximately \$13,700) and the directors or officers of the body shall each be liable to a fine not less than NGN 2.5 million (approximately \$6,900) or imprisonment for a term not less than five years or to both fines and imprisonment;
- False information also results in the same penalty as failure to obtain approval.
- Obstruction results in NGN 2.5 million (approximately \$6,900) fine or imprisonment for not less than three years or both.

i) LOW LEVEL PRESENCE POLICY (LLP) POLICY: The tolerance for low level presence of approved events in the country of origin that are not yet approved in Nigeria is four percent.

j) ADDITIONAL REGULATORY REQUIREMENTS: After GE crop approval is given by the NBMA, the crop will also need to meet the requirements of other extant laws related to the seed system in Nigeria. Other agencies, which regulate new varieties or importation of plants or organisms (whether or not they are GE) include: the Nigeria Agricultural Quarantine Service, the National Varietal Release Committee, the National Agricultural Seed Council, and the National Agency for Food and Drug Administration and Control.

The National Agricultural Seed Council and the Varietal Release Committee will carry out additional registration of seeds/traits before commercialization. Once the variety is approved and released by the Varietal Release Committee and deregulated (in case of seeds), no further registration is required. For processed products containing GE products, registration with the NAFDAC may be required.

Insect resistance is registered through the Nigeria Federal Ministry of Agriculture and Rural Development. For herbicide tolerance traits, the herbicide needs to be registered differently by the

NAFDAC as the regulatory agency for food and drugs. Farmers may use the approved varieties after registration.

k) INTELLECTUAL PROPERTY RIGHTS (IPR): Legislation is evolving.

l) CARTAGENA PROTOCOL RATIFICATION: Nigeria signed the Cartagena Protocol on Biosafety in 2000 and its instrument of ratification was signed by the Nigerian President on November 30, 2002. The protocol came into force in September 2003.

m) INTERNATIONAL TREATIES AND FORA: Nigeria signed the Convention on Biological Diversity in 1992 and ratified the instrument in 1994. It was an active participant in the negotiations that led to the adoption of the Cartagena Protocol. Officials of key biotech agencies such as the Federal Ministry of Environment, NABDA and NMBA regularly attend meetings of international standard-setting bodies. Regulation of GE products in Nigeria is in line with the provisions of the *Codex Alimentarius* (Codex) guidelines.

n) RELATED ISSUES: FAS Lagos is not aware of any biotechnology-related trade barriers affecting U.S.-origin exports to Nigeria. However, the mandatory labeling requirement may restrict market access for GE products.

PART C: MARKETING

a) PUBLIC/PRIVATE OPINIONS: The Nigerian consumers have mixed opinions about GE food products. To some, it is very important in promoting food security. Others are concerned about potential safety and health issues. This opinion is often due to an information gap or limited understanding of the potential benefits of the technology. People with more knowledge of the technology tend to accept it. According to research, a higher number of the public believe Nigeria should domesticate the technology and build capacity to develop GE crops.

On the other hand, there are civil society groups and environmental activists campaigning against GE crops in Nigeria. Stakeholders however do not consider them a serious challenge considering the already wide availability and consumption of biotechnology food products. Farmers are also more interested in improving their yields and increasing income. Some members of the public have expressed concerns on the safety of GE crops. Strategic risk mitigation communication is required to address the misconceptions. Most Nigerians need to be more aware of products of modern agricultural biotechnology and the issues involved. Information sharing and discussions on modern biotechnology have been undertaken largely between Nigeria government officials, scientists, and researchers. Nigerian farmers and the public however need continuous education on the technology.

b) MARKET ACCEPTANCE/STUDIES: Nigerian farmers are willing to accept the commercialization of Bt. cotton because of the positive monetary benefits they expect from it. Farmers generally accept GE crops. Public attitudes towards biotech industries or research institutions in the country are cordial.

- **Review Article on Biotech Progress in Sub-Sahara Africa**

Frontiers in Plant science published an important peer-reviewed report entitled 'Biosafety Regulatory Reviews and Leeway to Operate: Case Studies From Sub-Sahara Africa'. The article analyses the increases in adoption and testing of new agricultural technologies such as genetically modified crops and novel regulatory approaches used in biosafety decision-making. It presents case studies for Ghana, Kenya, Malawi, Nigeria, and Uganda to illustrate successes and ongoing challenges and concludes with policy recommendations for emerging economies.

CHAPTER 2: ANIMAL BIOTECHNOLOGY

a. Product Development

Animal Biotechnology Projects- The goal of biotechnology intervention in animal agriculture in Nigeria is to sustainably reposition the sector for enhanced productivity and profitability by leveraging adaptive biotechniques to solve problems ravaging the sub sector.

Currently, efforts are directed toward fixing the animal genetic resources management problem linked to unmitigated genetic erosion and dilution among major species of farm animals in the country. Additionally, strides are being made to explore feed bioresources - to develop value added and novel feed ingredients.

The following research teams exist to support comprehensive interventions in the animal agriculture space.

- a. **Animal Genetic Resources (AnGR)** sustainable management through domestication of FAO's Global Plan of Action (GPAs) for collecting, processing, and preserving genetic resources both in situ and ex situ including sperm/bio banking. This project is in partnership with Department of Animal Husbandry services, Federal Ministry of Agriculture and Rural development and National Advisory committee on AnGR (www.angr.org.ng).
- b. **Assisted Reproductive Techniques (ARTs) in Livestock** – This project focuses on the use of available, adaptive, and accessible reproductive technologies to facilitate the breeding of livestock in the country. With a 5-year Memorandum of Understanding and Memorandum of Association with the Mississippi State University USA, strategies were set out to domesticate these technologies in Africa by modelling them with the context of climate smart animal agriculture. The focus technologies are artificial insemination, multiple ovulation and embryo transfer, estrous synchronization and local hormone development, and in vitro fertilization.
- c. **Animal Product Bio-Processing and Food Development-** The emphasis here is on the use of plant-based and organic preservatives to deliver safe animal products. The quality assurance of animal product and testing laboratories comes under this project.
- d. **Dairy Value Chain Development-** Due to the renewed national aspirations in this important sub sector, partnerships have been developed between several stakeholders in Nigeria's dairy industry - SMAP Farms Ltd, Nigeria Army Farms and Ranches, Salbari Farms - to achieve a sustainable genetic improvement and eventual development of dairy lines in the country. The present effort has yielded results, as indigenous cows on partners' farms now produce 15-20 liters of milk per day compared to the unimproved indigenous breeds that produce about 1-1.5 liters per day. The genetic improvement interventions are still on-

going. The goal of this project is to get an optimally performing Nigeria dairy cow – a collaborative effort largely between the private sector and farmers.

CHAPTER 3: MICROBIAL BIOTECHNOLOGY

PART G: PRODUCTION AND TRADE

a) COMMERCIAL PRODUCTION

Post is aware of microbial biotech product development in Nigeria for biopesticides and biopesticide production and ongoing research into industrial waste recovery

- i. **Microbial Biotechnology and Derived Products** – Like with plants and animals, biotechnology (biotech) can be utilized to alter one or more desired characteristics in single-celled microorganisms (microbes) such as bacteria or fungi. Microbial biotech produces ingredients that otherwise occur naturally in bacteria, fungi, plants, or animals but are challenging to extract at scale. Microbial biotech is an efficient and effective alternative to natural extraction. A range of biotech tools can be utilized; although, genetic engineering (GE) using recombinant DNA (rDNA) or transgenics remains predominant.

Example of microbial biotech-derived products and their uses

Microbial Derived Product	Biotech-	Ingredient Uses(s)	Product Use(s)
Chymosin		Enzyme	Cheese
Protease		Enzyme and additive	Infant formula, Protein Supplement, Meat Extracts (soy sauce, soups, sauces, snacks)
Asparaginases		Enzyme and additive	Baked/Fried foods
Oligosaccharide		Enzyme and additive	Sweetener, Fermented and Non-Dairy Products
Soy Leghemoglobin "Heme"		Flavoring and Coloring	Flavor/Color
Stevia Glycosides		Seasoning and Flavoring	Sweetener
Vanillin		Seasoning and Flavoring	Flavor and Aromatic
Colicin Preparations		Additive	Antimicrobial Agent
Biogums, Xanthan Gum		Additive	Geller, Thickener and Stabilizer
Vitamin A, B2/Riboflavin, C, D, and E		Vitamin	Fortifier and Preservative

- ii. **Animal Feed Bio-resources Development** – This project is focusing on leveraging science technology and innovation to solve the competition between the human and animal food vs feed value chains, which is leading to political crisis between herders and farmers. The problem has led to the death of many residents and citizens of the country and avoidable

loss of property. The project explores agricultural and industrial waste through microbial bio-fortification to develop novel feedstuff from waste material. Equally, deployment of fodder hydroponics systems is strategic to this intervention. Feed testing for quality and safety is equally part of the project's focus area of intervention including forage seed development program for the country.

- iii. **Bio-pesticides and Bio-fertilizer production** - This requires large scale fermentation equipment from USA.

b) EXPORTS

There are neither official statistics nor estimates on exports of microbial biotechnology products. However, Nigeria exports alcoholic beverages, dairy products, and processed products that may contain microbial biotech-derived food ingredients.

c) IMPORTS

The only microbial biotech-derived food ingredients imported by Nigeria are those traditionally used in the production of alcoholic beverages, dairy products, and processed products. Likewise, Nigeria imports alcoholic beverages, dairy products, and processed products that may contain microbial biotech-derived food ingredients.

d) TRADE BARRIERS

PART H: POLICY

a) REGULATORY FRAMEWORK

National Biosafety Management Agency Act No.20 2015, Section 33 provides full and detailed guidelines on microbes used in plant and animal production.

Attachments:

No Attachments