Role of Science Diplomacy in Promoting Research Programmes in Nigeria

Abubakar Bello Usman*

Introduction

The Federal Republic of Nigeria, commonly referred to as Nigeria, is a federal republic in West Africa, bordering Benin in the west, Chad and Cameroon in the east, and Niger in the north. Its coast in the south lies on the Gulf of Guinea in the Atlantic Ocean. It comprises 36 states and the Federal Capital Territory, where the capital, Abuja, is located. Its largest cities include: Lagos, Kano, Ibadan, Benin and Port Harcourt. Nigeria is a democratic secular country.

In Nigeria, all the major stakeholders have realised the importance of science and technology (S&T) in driving rapid industrialisation and sustainable development. The government is also convinced that attaining of sustainable development is predicated on the design of an appropriate policy framework, based on the effective knowledge and quality information as well as on the effective scientific foreign collaborations.

National Science, Technology and Innovation Policies

Some of the specific objectives of the policies in Nigeria include, among others, initiating, supporting and strengthening strategic bilateral and multilateral cooperation in scientific, technological and innovation activities across all sectors of the economy. Facilitating acquisition of knowledge to adapt, utilise, replicate and diffuse technologies for growth of SMEs, agricultural development, health-care, food security, power generation and poverty reduction; supporting establishment and strengthening of organisations, institutions and structures for effective coordination and management of the STI activities within a virile national innovation system; supporting mechanisms to harness, promote,

*Assistant Research Fellow, Biotechnology Advanced Research Centre, Sheda Science and Technology Complex, Abuja, Nigeria

commercialise and diffuse globally competitive goods and services intensively utilising Nigeria's raw materials; and promoting activities for effective STI communication and inculcation of STI culture in Nigerians.

International Cooperation in STI

Bilateral cooperation between Nigeria and countries or regions include: Asia-Pacific (China, India, Japan-JICA, Korea-KOICA, etc; and Joint Commissions-Africa and Middle East, Europe, America, INGO, etc. Multilateral cooperations include, among others: the United Nations Development System (UNDS), European Union, Commonwealth Desk; UNESCO Special Plan of Cooperation with Nigeria: Project for Reform of the Nigerian STI System, JICA Technical (Cooperation Project) – Nigeria: Agricultural/ Rural Development Project on Rice Post-Harvest Processing and Marketing Pilot Project in Nasarawa and Niger States (RIPMAPP), African Business Education Initiative for youth (ABE Initiative). Master's Degree and Internship Programme, a JICA Support for National Polio Reference Laboratories in Nigeria 'Laboratory Equipment, Maintenance and Training, ect.

However, it has been observed that S&T policies in Nigeria have not been a critical determinant of national development performance. Also, the country has not fully realized its national objectives of S&T-driven rapid industrialisation and development. This in some part is attributed to ineffective utilisation of international cooperation programmes and poor networking for exchange of know-how among scientists, etc.

Sheda Science and Technology Complex (SHESTCO)

The Sheda Science and Technology Complex (SHESTCO) is a research center under the aegis of the Federal Ministry of Science and Technology. The complex was established for enabling institutions and individuals to undertake a wide range of multidisciplinary researches and developments in a comprehensive and organised manner, and provide opportunities for utilising high technology to contribute to uplift standard of living of the Nigerian citizenry. R&D activities of the complex are planned and organised under four main divisions. These are as follows.

National Advanced Laboratories which consists of:

- Physics Advanced Research Centre (PARC)
- Chemistry Advanced Research Centre (CARC)
- Biotechnology Advanced Research Centre (BARC)

Nuclear Technology Centre, consist of: Multipurpose Research Reactor and Gamma Irradiation Facility.

Science and Technology Information Centre, which consist of: Science and Technology Library.

Molecular and Agricultural Biotechnology Laboratories

Some research activities in these laboratories are as follows:

- Molecular transformation of Wheat [*Triticum aestivum* (L.)] for Drought Resistance, Cowpea (*Vigna unguiculata*) for Insect Resistance, Rice (*Oryza sativa*) for Rice Blast Fungus Resistance;
- Development of Mutant Varieties of Maize and Sorghum Resistant to *Striga hermonthica* through Physical mutagenesis and related biotechnologies;
- Micropropagation of woody plants; and
- DNA barcoding of Nigerian flora for molecular identification and conservation; authentication of herbal products.

Need for Science Diplomacy

Looking at the challenges technical or otherwise at the complex and in Nigeria as a whole, and the broad definition of science diplomacy as cooperation among countries, regions or institutes to solve a complex problem through scientific research, we wish to seize this golden opportunity to present to the Indian government through RIS our interests in building institutional collaborations between the ''Biotechnology Advanced Research Centre (BARC) and the

Sheda Science and Technology Complex, Abuja-Nigeria and other relevant research institutes in India aiming at promoting S&T activities, especially in agriculture (e.g. providing improved seeds for our local farmers), which would result in fighting hunger and ensuring sustainable development. Some research activities which may require diplomatic collaborative efforts by the countries in the South through science diplomacy include: traditional medicine research: herbal drug discovery and development. Nigeria is endowed with rich plant biodiversity to be exploited as potential candidate plants for herbal drug production as used by the locals while, on the other hand, India is blessed with the technology) and crop improvement either through Mutagenesis and related biotechnologies, TILLING, EcoTILLING, Transgenesis, Gene Editing, Marker-Assisted Breeding; etc

The Annexe table illustrates some examples of the research projects at the BARC, which can contribute toward promoting STI in Nigeria for sustainable development.

Table 1: Research Projects in BARC for Scientific Collaboration through Science Diplomacy

1	**Project Title**	**Herbal Drug Discovery and Development**							
1.2	**Goals**	**1. Development of Herbal Medicines for the Treatment of Typhoid Fever** **2. Development of Herbal Medicines for Oxidative Stress and Related Illnesses**							
1.3	**Objectives**	**Activities**	**Inputs**	**Timeline**	**Expected Outcome**	**Target**	**Responsible Parties**	**Role of Sciemce Diplomacy**	**Available Capacities**
	To find Nigerian indigenous plants used the treatment of typhoid fever through ethnobotany To find Nigerian indigenous plants used the treatment of oxidative stress through ethnobotany Laboratory Authentication of Ethnopharmacological claims of these medicinal plants Development of authenticated herbal drugs to be used for the treatment of typhoid fever Development of authenticated herbal drugs to be used for the treatment of oxidative stress and related diseases	Selecting a plant and sample collection Preparation of the plant material and activity-guided isolation of the active compounds Identification of biological targets Validation of biological targets Preclinical studies Clinical trials Formulations for clinical studies	Obtaining potential candidate plants for herbal drug development Getting an efficient bioassay protocol Purchase of consumables, chemicals and reagents Animal house	Six year project 2017-2022	Cheaper, safer and effective authenticated herbal drugs for the treatment of typhoid fever Cheaper, safer and effective authenticated herbal drugs for the treatment of oxidative stress and related diseases	To produce a plant-based medicines for treating typhoid fever and oxidative stress and its related illnesses form Nigerian flora	Biotechnology Advanced Research Centre, Nigeria	Access to standard animal house and equipments Training opportunities for improving technical capabilities	See project 2

Table 1 continued...

Table 1 continued...

2	Project Title	Crop improvement using physical mutagenesis and related biotechnologies							
2.2	Goals	1. Development of mutant varieties of Nigerian local varieties of sorghum and maize resistant to Striga hermonthica 2. Development of mutant varieties of Vigna unguiculata resistant to insect pests							
2.3	Objectives	Activities	Inputs	Timeline	Expected Outcome	Target	M&E Measures	Role Of Science Diplomacy	Available Capacities
	To assess the mutagenic effects of gamma irradiation on Nigerian local varieties of sorghum, maize and cowpea seeds To estimate the optimal radiation dose in order to induce genetic variability in sorghum, maize and cowpea genotypes Development of mutant varieties of sorghum and maize resistant to Striga hermonthica Development of mutant varieties of cowpea resistant to insect pests.	Germplasm collection Irradiation of seed samples Screen house establishment of breeding lines Morphological studies of radio sensitivity of each genotype to different irradiation doses Large scale mutagenesis Growing M_1, M_2, M_3 - - - to rise up to M_4 generation Phenotypic selection of putative mutants of each genotype Genotyping of putative mutants Screening of mutants.	Farmer varieties Irradiation services Screen house facility Seedling bags Labour for handling mutant generations	3-4 year project 2017-2020	Establishment LD_{50} for all the experimental genotypes Development of mutant varieties of sorghum and maize resistant to Striga hermonthica Development of mutant varieties of cowpea resistant of insect pests.	Development of mutant varieties of sorghum and maize resistant to Striga hermonthica Development of mutant varieties of cowpea resistant of insect pests	Success in: Establishment of LD_{50} for all the experimental genotypes Improved mutant varieties of sorghum, maize and cowpea	Availability and access to irradiation services, Growth chamber for tissue culture Funding for labour for handling mutant generations Proper training on plant mutation breeding techniques including mutant gene detection in plants TILLING and EcoTILLING	Human capacities: 2 Directors of Research (A Professor of Biochemistry and a Doctor of plant molecular biology), 3 Research Fellows and PhD students, 4 Technologists, 1 Agronomist. Facilities: Screenhouse, Demonstration farms, PCR, electroporesis machine, Gel doc., UV-Spec, UV transilluminator, electroporator, centrifuges, biosafety cabinet, Incubators, etc.

Table 1 continued...

Table 1 continued...

3	PROJECT TITLE	Crop improvement through biotechnology								
3.2	GOALS	Development of Nigerian wheat varieties that can grow in tropical region								
3.3	Objectives	Activities	Inputs	Timeline	Expected Outcome	Target	M&E Measures	Responsible Parties	Actions To Operationalise The Measures	Role of Science Diplomacy
	To develop a Nigerian wheat variety that can grow in our environment, to alleviate hunger and provide jobs: Through (1) Obtaining local varieties from farmers that are acceptable and preferred for bread pasta etc. (2) To develop an efficient regeneration system for wheat (3) To develop an efficient transformation system	(1) Sample collection (2) Obtaining necessary plasmids for cloning that can confer heat/drought resistance (3) Finding a robust regeneration system for wheat through experimental formulation of different media and hormones composition (4) Cloning: using vectors that have been obtained from IRRI and other sources (5) Transformation of wheat by (a) Direct and (b) Marker free	Obtaining genes for transformation Getting an efficient Agro bacterium transformation system Efficient regeneration system Molecular and Biosafety characterization	Four year project 2017-2020 (Purchasing consumables, reagents materials, Sample collection, Regeneration and cloning of vectors 2018- Transformation work molecular characterization 2019- 2020 Dissemination of varieties	(1) Plantlets obtained from calli and not directly from plantlet formation (2) Efficient transformation system for wheat that can grow in our climate	Develop wheat varieties that can grow in our Nigerian climate, which will reduce foreign import thus saving forex, alleviate hunger and create jobs.	Success in (1) Regeneration system (2) Transformation system (3) Right and correct insertion of genes through molecular characterization (4) Biosafety characterization	Plant Molecular Biology Team, BARC, Nigeria	Availability and access to all needed consumables and Instruments	Obtaining proper Equipments as: (1) -80^{0}C freezer (2) Incubators (3) Shakers (4) Water baths (5) Find funding for BARC laboratory Appropriate training for the plant molecular biology team members on plant molecular techniques

Table 1 continued...

Table 1 continued...

4	Project Title	Crop improvement through biotechnology								
4.2	Goals	Improvement of Nigerian rice varieties for biotic resistance (to rice blast fungus and bacterial disease)								
4.3	Objectives	Activities	Inputs	Timeline	Expected Outcome	Target	M&E Measures	Responsible Parties	Actions To Operationalise The Measures	Role Of Sciemce Diplomacy
	To find local varieties from farmers that are prominent, to get the best varieties. To develop an efficient transformation system To improve local Nigerian rice varieties against biotic stresses to increase production; thereby alleviating hunger and providing jobs and wealth creation	Sample collection Collect necessary plasmids for cloning that can confer such resistance. Finding a good regeneration system for rice varieties: -Different media formulation -Training Cloning: using the latest vectors Pi54RH, Wasabi Defensin contained in the plasmid pEKHSubWT Molecular and Biosafety characterization	Obtaining genes for transformation Getting an efficient Agro bacterium transformation system Efficient regeneration system Purchase of consumables, chemicals and reagents	Four year project 2017-2020 2017 - Purchasing consumables, reagents materials, Sample collection, Regeneration and cloning of vectors 2018- Transformation work molecular characterization 2019- 2020 Dissemination of varieties	An efficient regeneration system for rice. An efficient transformation system for rice Molecular and Biosafety characterization	Improvement of Nigerian rice varieties for biotic resistance (e. g. rice blast fungus and bacterial disease)	See project 3	Plant Molecular Biology Team, BARC, Nigeria	Must obtain the latest and crucially important Pi54RH, Wasabi Defensin contained in the plasmid pEKHSubWT	Same as project 3