



The role of biotechnology in water resource and ecosystem management

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WATER SCARCITY HAS become a global phenomenon. This is mainly due to the increase in population, global climatic change, drought cycles and decertification (particularly in the Sub-Saharan Africa). Presently, about 2 billion people in 80 countries around the world suffer from chronic water shortages and Nigeria is unfortunately one of such countries. Many of the capital cities in Nigeria do not have adequate water supply. A number of water-borne and water related diseases such as typhoid, dysentery and dracunculiasis, which have become endemic in Nigeria, could easily be eradicated through proper sanitation and provision of adequate clean water. Without exaggeration, our industrial and agricultural productivities and consequently our social and economic emancipation as a nation are very much dependent on the availability and quality of water.

Agriculture and water resource management

Agriculture accounts for 70% of all water use. Primary food production and food processing depend critically on water availability and its quality. Sub-Saharan Africa has been named one of the world's food insecure regions (Alhassan, 2002) because of problems relating to climatic changes, drought, decertification and inappropriate farming like "slash and burn", post harvest losses, poor access to farm inputs (e.g., fertilizer), etc (FAO 2000).

Natural resources and ecosystem management

Nigeria is quite endowed not only with genetic resources but also with diverse natural resources, including crude oil. In the bid to harness and exploit these natural resources for social and economic development, our practices, including methods of exploitation and management, have contributed to the resources and the environment being endangered and degraded. Some of these practices include:

- deforestation and consequent hydrological imbalance resulting in reduced access to water resources and
- over-grazing, which causes loss of productivity of soil used for agriculture and pasture.

Crude oil, which is currently Nigeria's number one foreign exchange earner has become number one source of environmental degradation and pollution. The incessant oil spillages have constantly polluted our surrounding land

and surface and ground waters, thereby contributing to the shortage of available clean water. The ecosystem is slowly dying as the natural micro flora and fauna are seriously being endangered in the affected areas.

The whole situation therefore calls for urgent need to rescue our ecosystem and to use the available water in a most judicious manner, by applying all technologies at the disposal of all the stakeholders. While it is true that biotechnology holds great potential for the development of sustainable water resource and ecosystem management, it is not in any way a panacea for solving our nationwide water shortage problems. Biotechnology has been defined as "the exploitation of living organisms, generally microorganisms or biological processes in an industrial or commercial situation to provide desired goods or services (Sakytta, 1983). It is multidisciplinary and finds use in agriculture, health, industry and environment. It therefore involves a wide range of scientific techniques.

National Biotechnology Development Agency (NABDA)

NABDA was established in 2001 with the objective of promoting the attainment of self-reliance in the biotechnology industry and of ensuring that Nigerians have access to safe and profitable uses of biotech-based products and services among others. The achievement of these objectives are vigorously being pursued by NABDA through development of human resources and provision of Research and Development (R & D) facilities by both strengthening existing laboratories and setting up new ones in designated centres across the country for specific technique acquisition. Some of the problems highlighted above like ecosystem degradation and deforestation can be ameliorated through the application of the following biotechnology techniques:

Tissue culture technique

This technique is based on the ability of plant species to regenerate a whole plant from single cell. The advantage of plant cell culture is that it is free of pest infestation, it is unaffected by climate and weather, its defined growth conditions lead to more stable quality and consistency of product, it ensures production, when and as needed and it greatly reduces land utilisation (Joske et al., 1991). It can therefore be employed to replenish our fast depleting food crops and forest species and is one of the Agency's priority projects.

NABDA has consequently established Zonal Biotechnology Centres (Z.B.Cs) in the six geopolitical zones of the country namely: N.E.Z.B.C., N.W.Z.B.C., N.C.Z.B.C., S.W.Z.B.C., S.E.Z.B.C. and S.S.Z.B.C., corresponding respectively to the following six ecological zones: the semi-arid vegetation, savannah vegetation, montane/plateau vegetation, derived savannah, tropical rain forest and mangrove/swamp vegetation. One of the cardinal aims is for the centres to present information on the particular vegetation zone and to carry out research for the development of tissue culture protocols in order to ensure production of plant materials as and when needed.

Genetic engineering/recombinant DNA technology

One of the important factors in increasing water use efficiency is the ability of the crops to consume less water and to be able to survive in water-scarce environment during drought periods and desert conditions, for example. Biotechnology has made it possible for the development of transgenic crops (e.g. drought resistant crops), which are ideally suited for water scarce and drought conditions. This has been made possible due to recent advances in biotechnology whereby it has become possible to decipher the genetic code and to move genes responsible for various functions from one organism to another plant, animal or microorganism. The biotech centers in the six geopolitical zones have the mandate to carry out necessary research into the improvement of key crops in their zones. The N.E.Z.B.C., located in the semi-arid zone for example, is working on Gum Arabic for afforestation purposes.

Biological effluent treatment

The major cities in Nigeria are fast becoming overpopulated as a result of rural urban migration and additionally, the number of industries, (particularly small scale agro-based industries) are gradually increasing. The implication of this is an increase in the domestic and industrial effluent produced resulting in increased environmental pollution and further depletion of the scarce commodity (water). The effluent, instead of being discharged untreated into the environment can be treated through microbiological means using low technology, pond systems. The treated effluent can then be recycled for use by the industry or collected for use in irrigating and fertilizing the plantations (Onyia et al. 2001). For this reason, agro-based and food processing industries in many of the South East Asian countries are located very close to the plantations for efficient water use.

Bio-remediation/bio-augmentation

Oil spillage has become a common occurrence in some parts of our oil-rich States. The level of ground water and land contamination caused by leakages from NNPC pipelines has assumed an alarming rate. These environmental problems can be ameliorated through application of natu-

rally occurring microorganisms in a process known as bioremediation. In a more recalcitrant situation the system can be bio-augmented with carefully selected and cultured microorganisms or with genetically modified microbes (GMO's) that can clean up the polluted environment for land and water body reclamation. The Agency is collaborating with NNPC, Federal Ministry of Environment and other stakeholder in working out strategies for tackling this menace.

Polymerase Chain Reaction (PCR) Technique

The polymerase chain reaction (PCR) invented by Mullis in 1983 (Mullis and Taloona, 1987) is a technique used for gene amplification. Since invention, PCR has become one of the most useful and frequently used tools in molecular biology. Apart from its application in the construction of DNA "fingerprints" for crime detection and disease diagnosis, PCR is a very useful tool for quick identification of bacteria in the environment including water systems. Instead of the traditional ways of detecting the presence of coliforms in drinking water, PCR can be used to monitor the quality of water used for drinking and domestic uses, and to establish the presence of pathogens in the environment.

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