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The potentials of agricultural biotechnology for food security and economic empowerment in Nigeria

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ABSTRACT

Present food situation in Nigeria depicts a dreadful scenario as food deficits and the resultant consequences of malnutrition, disease and hunger are common. The present mode of food production has not been able to address the tripartite requirements of food security; namely food availability, accessibility and utilization. This calls for the engagement of more viable time tested and scientifically proven approaches to contending with the challenges of food insecurity. This study examines one of such approaches which is agricultural biotechnology, through which higher yielding, quick maturing, nutritious crop varieties can be developed thereby enhancing availability, accessibility and utilization of food in the country. It discusses the challenges of food insecurity in Nigeria and pointed out their consequences on individual and national development. It also presented how agricultural biotechnology could be used to advance the course of attaining food security in Nigeria through the application of genetic engineering, tissue culture techniques and recombinant DNA techniques on some of our staple crops like maize, sorghum, yam, cassava and rice to enhance their production capacities. The study advocates the incorporation of biotechnologically enhanced crops in the production practices of Nigeria farmers given its wide spread potentials for attaining food security and economic empowerment, at household and national levels.

Keywords: Agricultural biotechnology, Potentials, food security and economic empowerment.

INTRODUCTION

Engulfed within the vortex of population growth, economic insatiability, and rapid climate change, attaining food security has become one intractable challenge for several nations of the world. With the energies and resources of the richer countries that do send food aid to vulnerable and poor countries being depleted by the global economic meltdown, the figure of persons who experience the kind of hardship caused by hunger will continue to rise in these countries. For Nigeria in particular, all the conventional indicators that point to food insecurity such as rapidly increasing energy prices, insufficient agricultural sector investment, population increase and rapid increase in the demand for food are prevalent. Thus, millions of Nigerians simply cannot afford the food they need for a healthy and productive life.

Today, 90 million Nigerians are in the state of vulnerability to different kinds of food and are faced with a kind of food insecurity known as household food insecurity. Whereby individuals sell their foods to provide basic needs of life like cloths, shelter, school fees, and others. (Abba-Ruma, 2009; Agbaegbu, 2009). The implication is that Nigeria should not take the issue of food security for granted. These and other overarching forces militating against food security in Nigeria when positioned against the back drop of rising number of consumers and shrinking per capital acreage of land for crop production brings the issue of food security in Nigeria to the fore front of national discourse..

Experts believe that Nigeria needs to rethink its current modes of agricultural practices which limit food production, purely to the amount of arable land available and engage technology to boost food production and to ensure food security for the populace. Commenting on the short comings of the present farming practices and the need to convince ourselves that the stereotype mode of farming no is longer sufficient for Nigeria's food security and development goals. Isu (2009) remarked that "Nigeria cannot achieve food security as expected and the seven point's agenda by procurement and annual distribution of fertilizers to peasant farmers". This makes a call to engage technological innovations in combating food insecurity even more poignant.

Stressing the importance of new technologies like biotechnology in the attainment of food security at national and international levels, the united nations general assembly advocated for stronger capacity in science and technology and innovations as prerequisites for sustained progress in reducing poverty and related problems like hunger (Mugabe, 2000). The increasing application of biotechnology in agriculture has transformed the agricultural sector of national and global economics in very profound ways. Through the application of biotechnology in agriculture millions have been fed in many poor countries on the Indian sub continent where human population is fairly large (Serageldin, 2009)

Within the Nigerian context Ishiyaku (2009) observed that there is a place for biotechnology in the nation's agricultural practices in the near future; given the economic benefits of its products especially improved varieties with high nutrient content for high nutrition and high productivity in the field. With this vista of possibilities as offered by biotechnology to boost food production, it is cogent and relevant to examine what particular contributions biotechnology can make towards the realization of food security in Nigeria.

This study aims at putting into perspective the potentials of agricultural biotechnology in particular as a mechanism for attaining food security status in Nigeria. It puts forward the challenges of food insecurity in Nigeria along with some of their consequence and highlighted the relationship between food security and agricultural biotechnology. Focusing majorly upon the potentials of agricultural biotechnology techniques such as genetic transformation, tissue culture, and bi- fortification in the area of crop production, it presents how these techniques can be harnessed to contribute to food security and economic empowerment in Nigeria.

Conceptual Issues

Agricultural Biotechnology is the use of natural resources base for the improvement and increased production of crops, livestock, fishes and trees. It is simply the process of using the techniques of biotechnology to enhance, improve and increase the productivity of crops, livestock and fish.

Through agricultural biotechnology crops, livestock and fish can be made to attain their optimum yield as their yield potentials are explored. Compared to the prevailing practice in conventional agriculture, agricultural biotechnology is simply a "high tech" version of traditional plant breeding through which the risk of introducing detrimental traits is reduced. It is a quicker, safer, and more precise means of identification, transfer and incorporation of desirable genes and traits during the plant breeding process. The application of biotechnology in agriculture is known to take two major forms: (i) Genetically engineering plants and crops to change and or enhance their genetic and phenotypic characteristics, and (ii) the use of biotechnological techniques such as tissue culture, genetic transformation and recombinant DNA (Mugabe, 2000).

Using these forms or a combination of these with other biological and chemical process, agricultural biotechnology has transcended the level of being use as a plant breeders' tool to becoming an industry of vast commercial and economic value raking in 2.5 billion dollars in 1999 alone. Thus, today agricultural biotechnology is not only the scientist/breeders' tool, but is as well an instrument for commerce, economic empowerment and food security (Mugabe, 2000).

Food security is a flexible concepts as found in its many definitions in research and policy usage, where its explicit or implied definitions exist. Due to the complexities of the technical and policy issues involved in the phenomenon of food security, considerable reconstruction of official thinking on issue of food security have continues to reshape its understanding as a problem of international and national concern.

Given its dimensions and dynamics a single definition of the concept of food security is most improvable. Thus rather than attempting to clarify its definition, in this paper an operational definition will be adopted. The world summit on food security held in Rome in November, 2009 explained the concept of food security thus: "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". We identifying the four pillars of food security to be (i) availability of food (ii) accessibility to the available food, (iii) utilization of available and accessed food; and (iv) stability of supplies.

The summit's conceptualization of food security stressed that, the nutritional dimension is integral to the concept of food security. On the national plane, a food secure nation is one that has:

- (1) Ensured that there is food available to all its citizens by removing all physical, social and economic impediments to access the food.
- (2) Ensured that the available food exist in such quantity that is sufficient, and in a condition that is safe and quality that is nutritious.
- (3) Ensured that the food available is found in an array of varieties that people can choose from a wide range of alternatives to meet their dietary needs and not just their "stomach" needs.

The questions to ask while formulating a working understanding of food security therefore, includes:

- (1) Is food available?
- (2) Is the available food, accessible?
- (3) Does the accessibility to the available food guaranteed, getting it in sufficient quantity for as long as required?
- (4) Is the food which has been accessed utilizable, that is does it exist in a form that can be utilized whereby the inherent nutrients can be readily used by the body?
- (5) Is the food safe for human consumption, at the time it is available for consumption and the consumer is ready for it?
- (6) Does the food come in varieties, diversities and forms that will give individuals wide amplitude of choice according to their preferences?.
- (7) Is the food of such quality as to guarantee proper nutrition of individuals for healthy and active lives?

From these standpoints, it can be deduced that food insecurity is not simply a failure of agriculture to produce the enough food, but is instead a failure of livelihoods to guarantee access to sufficient food at household levels. Food insecure people according to Fivims, are those whose intake of food falls below their minimum calorie requirement as well as those who exhibit physical symptoms caused by energy and nutrient deficiencies resulting from inadequate diet or from the body's inability to use food effectively because of infection or disease.

The Challenge of Food Security in Nigeria Today

Despite the rich agricultural resource and technical endowments as well as several intervention by successive administrations, Nigerian agricultural sector has been operating far below its potentials, consequently primary indices of food security at the national and the household levels are still unsatisfactory. Access to adequate and well balanced nutrition is limited, as nutritious food is all the times expensive. Food supply is very unstable, as post harvest losses put at between 15-40% percent tempers with the food supply chain, giving rise to loss of seventy percent (70%) of perishable food that are scarce off season and thirty percent (30%) of durable foods (Adesida, 2009). Due to the low economic statuses of most of the citizens with 70.8% living below poverty line, the food intake and the general nutritional well being of the populace is of low quality. Consequently, sixty five percent (65%) of Nigerians are reported to be malnourished (Ohakiim, 2008; Agbaegbu, 2009).

Also shortfalls in the national domestic foods demand is a regular phenomenon, as only 50% percent of the present cultivable land is under cultivation. And above 90% percent of this land mass is cultivated by small holder farmer who employ rudimentary production techniques cultivating less than two hectares per farmer with low attendant

yield resulting. Thus, the nation's national food demand by far exceeds the supplies that are derived from these farmers. This demand-supply disparity has pushed Nigeria into becoming a net importer of food.

Today, Nigeria spends about 3 billion dollars annually on food importation for local consumption only. The country is presently the highest importer of wheat and rice on the African continent, expending N80 billion on the importation of 500,000 tons of rice and the \$2 billion to import 1.6 million tones of fish in the year 2008 alone, and it is the second largest importer of food stuff in the world. Evident from these facts is that food insecurity is a palpable phenomenon in the lives of many Nigerians, and could cause setbacks for the strategic development of the nation as there can never be national security without food security.

Underscoring this fact (FAO, 2004), pointed out that loss of human of productivity over time has been identified among persons whose physical and intellectual capacities have been impaired by low birth weight, protein-energy malnutrition and the shortages of essential vitamins. This makes individual's self actualization impossible to attain and limits the level of contributions such persons could make to national development.

Elaborating the negative implication of food insecurity on the livelihood of humans, Lawal and Asala (200*0) posited that where there is a lack of calories in the body the physical composition of man suffers such that he may not reach his full potentialities in life. Pointing out the intellectual drawback of poor nutrition on individual development, Ohakim, (2008) said that individual particularly children that are not secured in terms of food will have their growths stunted and k their ability to learn mathematics also stunted. Thus, nutrient deficiencies lead to subnormal development of intellectual abilities which renders an individual more of a liability than an asset for national development.

Such loss of human productivity arising from poor nutrition deducts from the national economy and is not food for a country like Nigeria that is striving towards technological growth and development, whose basis is adequate and efficient human capital. On the whole, medical and anthropometric evidence has shown a very strong link between malnutrition and infant mortality, poor growth in children and reduced ability of adult immune system to fight disease. Because with enough nutrients individual body cells can reduce anti-bodies to fight off the disease agent before it establishes its fort in the body (Davies, 2009; Agbaegbu, 2009). Therefore, with inadequate food intake and poor nutrition, disease will be prevalent amongst not be properly attended to. And even the national workforce will continue to be negatively affected by absenteeism from workplace due to hospital visits and admissions, loss of family breadwinners from premature deaths and huge amount of money being spent by government on sick individuals (Osothemehin, 2009). These losses and expenses would have been reduced or totally avoided if there were proper nutrition.

Therefore, Nigeria is faced with a clear and present danger to its national and international strategic development interests due to food insecurity. Food insecurity demeans and decimates human capabilities which in turn subtracts from the national economy. It threatens individual and household survival by weakening the abilities of individuals to contribute labour for agriculture and other vital areas of human interests. For Nigerian in particular, food insecurity connotes less healthy and less cognitively sound individuals piloting the affairs of the nation and households. It also means a lot of individual and national expenditure on food, feeding and health care services for a dominantly hungry and sick populace. Because food is a strategic commodity at household and national levels, this scenario about food insecurity in Nigeria should attract urgent and serious attention to mitigate before it escalates into a national catastrophe which could compound into famine, mass hunger and the dreadful food crises. Knowing the ugly consequences food insecurity has created elsewhere and could create even in a country like Nigeria, the government needs to actively engage approaches to food availability, accessibility and utilization that are grounded in science and facts generate from research (Hartman, 2009). Following from its practical accomplishments in other sister developing nations like Zambagwe, South Africa, Kenya, Egypt, Uganda, Ghana, and Tanzania, agricultural biotechnology is a suitable approach to accelerate the attainment of food security in Nigeria.

AGRICULTURAL BIOTECHNOLOGY AND FOOD SECURITY: AN OVERVIEW

The positive correspondence between agricultural biotechnology and food security has for long been established. Early in December 199, the 54th UN general assembly session declared that the application of agricultural biotechnology in developing countries provides viable opportunities for improving productivity and increasing production capacity in the agricultural sector (Mugabe, 2000). And in connection to the green revolution, (Santaniello, 2005) pointed out that "agricultural biotechnology is the major technological innovation to be made

available to farmers after the end of the green revolution". These positions at once identify and recommend the application of biotechnology in agriculture as an apparatus for addressing food insecurity in developing countries.

Asserting the linkage between agricultural biotechnology and food security, it was pointed out that agricultural biotechnology promises to play a crucial role in improving agricultural productivity and reducing the environmental impact of agriculture leading to agricultural sustainability and food security in many regions of the world. Indeed, agricultural biotechnology has enlarged and increase the abilities of science to overcome genetic and environmental constraints which impose serious limitations on the capacities of crops and animals to yield their optimum outputs.

Through the tools of agricultural biotechnology, plant breeders can select single genes that produce a desired trait and move them onto another plant easily as the genetic barrier between these plants is completely overcome. Thus, through agricultural biotechnology, the yields of certain plants can be increase and even their nutrients content and nutritional values improved in a much easier and faster way than via the conventional plant breeding methods.

Applying the techniques of agricultural biotechnology in combination with other scientific techniques the insert and innate productivity potentials of some of our crops can be harnessed and unleashed to aid the nation as a whole to realize its dream of food security. Taking into cognizance the three pillars of food security in Nigeria in the following ways:

Ensuring Food Availability

Certain techniques of Agricultural Biotechnology can be applied to make food readily available.

(a) By Increasing per Seed Yield of some of our Crops – By the techniques of genetic transformation, through which a few genes can be transferred from one crop to another, and allowed to be incorporated into the gene of the recipient plant, high yielding, short maturing and pest resistant varieties of crops can be developed. This technique when adopted can be used to transfer genes that have the ability to confer high yields, into some of our major staple crops like maize, sorghum, cassava and yam. Also, through this process, genes that confer early maturity or enhanced growth can be imparted unto these crops thereby obtaining new cultivars that are both high yielding and early maturing. These cultivars will boost the output from individual plants and the total output per hectare. When short maturing varieties of these staple crops becomes available, the limitation imposed by crop production seasons and exacerbated presently by climate change and total absence of irrigation facilities, will be surmounted. This will give rise to two or even three harvest of these staples in one farming season, thus ensuring their availability in greater quantity. Again by adding genes to these to conventional crops to help them resist pest and diseases, all the crops losses in the field incurred due to pest and diseases attack will be curtailed, these crops will grow healthy from infancy to maturity and be harvested intact, and that harvest will certainly be greater.

(b) By Multiplying the Planting Materials for Farmers – Using the technique of tissue culture, healthy planting materials can be produced especially in the case of some of our crops in Nigeria that require high volume of materials for planting. For example, cassava stems, yam sets, potatoes cuttings, sugar cane stems, pineapple plantlets, can be multiplied into millions through tissue culture. This will substantially increase the volume of planting materials and the hectares of these crops under cultivation thus increasing the quantity of these crops harvested and available for food. Today the molecular Bioscience Ltd, a private sector biotechnology outfit in Calabar, Nigeria uses this technique to propagate pineapple plantlets for farmers in the country. Using this technique Nwakanma, 2005 reported that the institution has been able to produce 200-250 plantlets every two weeks from one plant cell. This feat can be replicated for other crops, thereby eliminating or reducing shortage of planting materials and boosting food production.

(c) By Increasing the Area of Land Under Cultivation – Also through the process of gene transfer, crops that can withstand biotic and abiotic stress can be developed. These crops are enabled genetically to grow successfully under extreme conditions in harsh agroecologies. This will significantly increase the area of land under cultivation since land areas that are hitherto not cultivable due to drought and excessive water logging will now be able to support and sustain crop production. With the incorporation of these non-cultivable land into the areas under cultivation a greater quantity of crops can be raised and more food can be produced.

Enhancing Nutritional Qualities of Some of Our Crops

Agricultural biotechnology techniques can also be used to enhance the nutritional qualities of some of our staple crops. Through the techniques of gene transfer the nutrient composition of some of our crops (cereals and legumes) can be altered to give a higher nutritive content and value. Also, some vital nutrients not readily available from the staple diets of Nigerian households can be inserted into the staple foods. This will provide highly nutritious foodstuff containing the appropriate minerals, vitamins, and hormones which are capable of providing high level of nutrition to individuals to keep them in good health. This will lead ultimately to drastically reducing the menace of malnutrition caused by food insecurity as individuals will be able to deploy their human and material endowments in this direction.

Also, less money will be spent by government on individual's health bills as good health from good nutrition will keep people from failing ill often. Moreover, absenteeism from work due to hospital visits and admissions, loss of family breadwinners due to ill health will decline drastically and individual's households' and national expenditures on health care will be curtailed and the money realized conserved and used for other developments.

Improving the Taste, Texture and Appearance of Some of Our Crops Some techniques of agricultural biotechnology can be used to slow down the process of spoilage so that fruits and other perishable foods seventy percent (70%) of which are spoilt in Nigeria today, can be preserved for a long time and yet be fit for consumption by the end user even long after harvest. As such these food items arrive at the end users table without any alteration in taste, texture and appearance. This enables crops that are ready for harvest in one of the seasons of the year in Nigeria and are scarce off season, to be preserved in taste, texture and appearance and made available experienced during scarcity. This makes these food stuff available and accessible to more people all year round.

Also, certain foods produced in the southern part of Nigeria and are not available in the north can conveniently be transported without alteration to their taste, texture and appearance to meet the demand in the north. While certain foods produced in the north and therefore not available in the south can also be transported with their taste, texture and appearance intact to the south to meet the demand for such products there. This will promote better food distribution and increase the availability and accessibility of these foods and enhance their utilization, thus contributing to food security.

Again improving the taste, texture and appearance of food through the delayed spoilage techniques of agricultural biotechnology can significantly decrease the level and amount of damage caused to crop produce and product, while in the store, thereby increasing food quantity and availability, preserving nutritional content, and enhancing food utilization. Further, with the availability of a variety of food stuff to people throughout the seasons of the year, coupled with other food materials not native to particular regions being available there, Nigerians now have a wide amplitude to choose from an array of food materials to meet their dietary needs. This enables people to eat what they choose, as it is typical under a condition of food security, and not just what is available.

Reduced Dependence on Agrochemicals

The potentials of agricultural biotechnology in producing crops that need less herbicide application than normal and are resistance to specific pest and disease whose infestation reduces crop yields and quality has been established (Isiyaku, 2010). Through some techniques of agricultural biotechnology crops have been generically engineered of acquire the ability to withstand high biotic pressure from weeds and pests, with less use of herbicides. Herbicide tolerant crops that have the potentials of withstanding the application of broad spectrum herbicides without phytotoxicity risks have been developed. Thus reducing the frequent use of herbicide application during the crop seasons, assuring less crop injury and increasing yields this principles can be applied on crops like maize, sorghum, millet, cassava, cowpea, groundnut, yam and sweet potato whose yield and quality are seriously hampered by weeds and pests.

Another principles of agricultural biotechnology has been used to engineer crop plants to develop resistance to specific insects that tends to cause damage to it. Such crops were made to produce certain chemicals which if ingested by the attacking insect in the process of feeding causes the insect to stop feeding and thereafter dies. This ensures that the yields from these crops which would have been reduced due to pest, weeds and disease infections are saved for harvest. The yields are also free from damage so food availability is enhanced.

Agricultural Biotechnology and Economic Empowerment in Nigeria

Beyond agricultural benefits, agricultural biotechnology could offer several economic benefits to individuals and the nation at large. As described earlier, agricultural biotechnology allows the farmers to increase crop yields, through the development of high yielding, quick maturing crop varieties. This will lead to increase in food production which makes for greater availability of food for individual, household and national consumptions. When this happens individuals will feed well on adequate and nutritious food and become healthy. These healthy individuals can contribute their energies and labours through gainful employment in other sectors including agriculture for a free or a wage, thus gaining economic empowerment out of poverty and disease.

Again individuals, households and national expenses on food will be minimized and then invested into other economic ventures for greater profits, thus bringing about financial independent and economic empowerment. Also with the abundance of healthy individuals, government and personal expenses on health care will be reduced and the money saved can be used to get other products to enhance people's quality of life for meaningful contribution to nation development.

Through decreased agro-chemicals usage yield of crops will also increase thereby lowering production costs with higher agricultural productivity and income. This will yield lower production cost and food prices and improve nutrition leading to conservation of funds.

CONCLUSION

Current food situation in Nigeria is fearful. Malnutrition, disease and hunger are prevalent as a result of food shortages. The present mode of food production falls short of addressing the issues of food availability, accessibility and utilization. A need then arises to use scientifically proven strategies such as agricultural biotechnology in dealing with food insecurity in the country. This will give rise to sufficient food for the citizen which will lead to some economic gains at individual, household and national levels.

Embracing this technology is therefore an urgent and a cogent requirement to move the nation to the status of food security. Based on the above study, the following recommendations were made;

- (1) More seminars, workshops and talks should be organized for scientist, policy, makers, farmers and agricultural extension agents on the gains that could be made from using genetically engineered crops to familiarize them with the benefits of embracing such technology. So as to engender a wide acceptance and participation in the use of this technology in crop production in Nigeria by them.
- (2) Government should buy biotechnologically engineered crops and distribute them to farmers to promote its full incorporation into the Nigerian farmer's crop production practices.
- (3) A public-private partnership deal should be made to enable massive funding to develop centers of excellence in agricultural biotechnology where special research can be undertaken to explore and use the genetic potentials of some of our staple crops to boost their production capacities.

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