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Making Biotechnology Work for Farmers in Nigeria: The Role of Farmers' Cooperative Societies

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Abstract
This paper has reviewed the giant strides which biotechnology has made in agricultural development. The paper proposes that to make biotechnology work for farmers in Nigeria there should be a paradigm shift from reaching the farmers with biotechnology packages as individuals to reaching them on the platform of their cooperative societies. The nature of cooperatives and their ability to facilitate access of farmers to biotechnology have also been x-rayed. The paper urges policy makers to explore the opportunities of increasing access to biotechnology through pro-poor farmers' organisations like farmers cooperative societies.
Keywords: Biotechnology, Access, Farmers, Cooperative Societies.

1.0 The Concept of Biotechnology

Biotechnology refers generally to the application of a wide range of scientific procedures in the modification and improvement of plants, animals and micro-organisms that are of economic importance (Persely *et al.,* 1999). It can also be said to be a process of using living organisms (such as plants, animals, or microbes) or any part of these organisms to create new or improved products (Baiyeri and Aba, 2012). According to the UN Convention on Biological Diversity (http://www.cbd.int/convention/txt/, retrieved on 30th August, 2012) biotechnology or biotech is the use of living systems and organisms to develop or make useful products or any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use.

The concept of biotechnology encompasses a wide range of procedure for modifying living organisms according to human purposes – going back to domestication of animals, cultivation of plants, and improvements to these through breeding programmes that employ artificial selection and hybridization (http://www.europabio.org/what-biotechnology, retrieved on August 15, 2013). According to the American Chemical Society, biotechnology is the application of biological organisms, systems, or process by various industries to learning about the science of life and the improvement of the value of materials and organisms such as pharmaceuticals, crops and livestock (Baiyeri and Aba, 2012).

The science of biotechnology can be broken down into subdisciplines called red, white, green and blue biotechnology (Nwakwo, Peters and Bokemann, 2009). Red biotechnology involves medical processes such as using organisms to produce new drugs or using stem cells to regenerate damaged human tissues and perhaps re-grow entire organs. White (also called grey) biotechnology involves industrial processes such as the production of new chemicals or the development of new fuels for vehicles. Green biotechnology applies to agriculture and involves such processes as the development of pest-resistant grains or the accelerated evolution of disease resistant animals. Blue biotechnology encompasses activities in the marine and aquatic environments, such as controlling the proliferation of noxious water-borne organisms.

2.0 Biotechnology and Agricultural Development

There is presently a global concern for the rising food insecurity especially in the sub-Saharan African. Scientists and policy makers believe that agricultural biotechnology holds the key to solutions to global food insecurity (Gessel, 2008; Walgate, 1990; Wambugu, 1999; Woodward, Brink & Berger, 1999). There are, however, those that hold contrary opinions as to the potentials of biotechnology in tackling the lingering issue of food security including Alteri & Rosset, 1999; Greenpeace, 2002; Hine & Pretty, 2008. The greatest challenge to the involvement of biotechnology in agricultural development includes the issues of biosafety, moral justification and other environmental concerns (Lappe, 2002; Mellon, 2008; Van Wijk, 2000).

Some organisations have been in the forefront in the challenge against the involvement of biotechnology in the attempt to resolve the issue of food insecurity. Friends of the Earth (FOEI) is one of such organisations that have mounted numerous campaigns against biotechnology (FOEI, 2006). There are also legitimate concerns about grey areas of biotechnology that need further scientific explanation and clarification though many believe that some of these concerns are borne out of fears and uncertainties and not on empirical scientific realities (McHughen, 2008; Symth, Kerr, & Davey, 2006). Such concerns need not be glossed over but require further investigation especially the issue of how biotechnology can be of benefit to resource-poor farmers in developing

countries like Nigeria (Tripp, 2002).

Granted that there is a sustained effort at keeping the pace of research and development in biotechnology to address the remaining risk factors, the point needs to be made that most of the concerns about the risks associated with biotechnology follow the path obtainable in the adoption of new technologies (Walgate, 1990). Since there is no zero-risk new product the benefits of involvement of biotechnology in the fight against hunger and food insecurity appears to far outweigh the risks. This can be better appreciated in view of the slow pace of improvement in convential agricultural development paradigms such as organic farming.

In specific terms biotechnology has contributed immensely to agricultural development. One area where biotechnology has impacted positively on agriculture is in the impartation of new characters and traits leading to increased yield in agricultural products (Asian Development Bank, 2001). Though such increases have been more obvious in crop production (Bruce & Bruce, 1999) the impact of biotechnology on livestock production has also been tremendous. Many of the genetic characteristics associated with yield increases (e.g. enhanced growth) have been manipulated in such a way as to increase the overall yields of agricultural products (Bruce & Bruce, 1999).

Another area where biotechnology has been very beneficial is in the reduction of vulnerability of crops and animals to environmental stress (http://www.nih.gov/science /models/arabidopsis/index.html, visited on 30th August, 2013). Biotechnology has been beneficial in the reduction of vulnerability to two most limiting factors to increased crop yield namely drought and excessive salt content of soil. Researchers have also, for instance, successfully created transgenic rice plants that are resistant to rice yellow mottle virus (RYMV) which is one of the most dreaded of diseases of rice in Africa (National Academy of Sciences, 2001).

Improvement in the nutritional values of food through genetic modifications of proteins is another giant stride in biotechnology. For instance, proteins in cereals and legumes have been transformed, in many instances, to provide the amino acids needed by human beings to ensure balanced diet (Bruce & Bruce, 1999). The work of Professors Ingo Potrykus and Peter Beyer (http://www.nih.gov/science/models/arabidopsis/index.htm retrieved on 30th August, 2013) which employed the technique of genetic modification utilizing genetic materials from corn and a soil micro-organism to produce beta carotene is a typical example. The beta carotene content turned the colour of rice golden, hence its name, golden rice. Golden rice has been found to possess higher consumer appeal than other varieties in the market. This could translate into more income for farmers involved in its production.

Of note also is the use of modern biotechnology to slow down the process of spoilage in fruits thus enabling them to ripe more slowly (Martineau, 2011). This enables fruits to remain longer on their parent plants ensuring ease of transportation and longer shelf life. One noticeable impact of this is the expansion of fresh fruits markets and more income for farmers especially those in developing countries where fruits processing has not been very meaningful. Research reports from Indonesia, Malaysia, Thailand, Philippines and Vietnam (Krattiger, 2000) have clearly indicated a bright future for fruits farmers occasioned by break-throughs in genetically induced delayed fruits ripening (Martineau, 2011). Adding an enzyme called maltogenic amylase to wheat flour makes bread stay fresh longer (EuropaBio.org retrieved on 13th of August, 2013). If bread could be made to stay fresh longer, millions of tonnes of flour per year would be saved. This could translate into more money in the hands of farmers, bakers and consumers.

Biotechnology has had its commercial application mostly in the area of processes that reduce overdependence on agrochemicals by farmers. For instance the bacteria *Bacillus thoringiensis* (Bt) has been found to produce a protein with insecticidal qualities (Gianessi, Silvers, Sankula & Carpenter, 2002). There are now several Bt toxins used in crop protection, each being crop specific. Also, a process has been developed to engineer crop plants to contain and express Bt toxin genes that protect them from attack by insect pests.

It has also become possible to engineer crops to acquire tolerance to broad-spectrum herbicides. This ensures that farmers can use these broad-spectrum herbicides for weed management with little or no damage to crop plants (James, 2002). This is obviously a break-through in weed management and control. Broad spectrum herbicides like glyphosate, glufosinate and bromoxyl have been found to be tolerated by transegenic crops thereby reducing the number of herbicide applications in one cropping season as well as increasing yields due to improved weed management and reduced injury to crops (Pascual, 2007).

Biotechnology techniques have also become very useful in livestock production both in genetic improvement and in pharmaceutical and industrial applications. Molecular biology techniques have been employed to drive breeding programmes that help farmers to select superior animals. It is now possible to clone animals through somatic cell nuclear transfer (SCNT) which allows genetic replication of selected animals (Van Eenennaam, 2006).

3.0 Challenges of Involving Biotechnology in Agricultural Development

The issue of safety has been of utmost concern to consumers and environmentalists who feel that adequate effort has not been made to understand the dangers inherent in the use of transgenic crops and their potential long-term

impacts (Pascual, 2007). There is limited information, at times misinformation, about the health and environmental implications of transgenic crops. The issue of allergens and toxins arising from consumption of genetically modified crops and animal products has not been adequately studied. Adequate checks to ensure that the levels of naturally occurring allergens in foods made from transgenic organisms have not significantly increased above the natural range found in conventional foods have not been put in place (Dove, 2005).

Also of great concern is the fear that techniques used to ensure that gene transfer in the course of genetic modification is successful can also lead to the emergence of anti-biotic resistant strains of bacteria (Dove, 2005). This may lead to rise in the incidence of diseases that are resistant to treatment with common antibiotics. There are also the fear of the emergence of the so called "super weeds" which may become resistant to commonly used herbicides. A typical case in point is possibility that pollen transfer from glyphosate-resistant crops to related weeds can confer resistance to glyphosate, one of the commonly used herbicides (Watch.org retrieved on 13th August, 2013).

It is possible that once transgenic crops have been released into the environment they could produce unforeseen and undesirable effects.

Unless transgenic crops are rigorously tested before they are made commercially available they may produce some undesirable environmental side-effects (Diaz, 2008). Researchers in Cornell University found that Bt corn which produces herbicides that kill pests that feed on maize also killed harmless and beneficial Monarch Butterly Carterpillars (Martins, 2008). The issue of possible insecticide resistance is another concern normally raised by environmentalists concerning the use of biotechnology in agriculture. There is the fear that large scale use of Bt will result in rapid build up of resistance in pest population (Nigms.Nih.Gov.Nigms.Nih.Gov. Retrieved on 13th August, 2013).

Farmers and other stakeholders are also very concerned about loss of biodiversity in our natural environment as a result of increased adoption of conventionally bred crops (Diaz, 2008). Though there are research results (Martineau, 2001) that show that the use of genetically modified crops are not likely to impact negatively on biodiversity it is important that modern biotechnology programmes should have an in-built mechanism for preserving genetic materials (Krattiger, 2000).

4.0 Nature of Cooperatives

A cooperative society is an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (ICA, 1995). Cooperatives provide a platform which enables individuals and groups to tackle their own needs on the basis of active participation, collective action and responsibility as well as empowerment, sharing, enabling and equality (Maghsoudi, 2010). Cooperatives operate with a set of principles and core values which clearly distinguish them from other forms of business enterprises. These basic principles are (1) Voluntary and open membership, (2) Democratic member control, (3) Member economic participation, (4) Autonomy and independence, (5) Education, training and information, (6) Cooperation among cooperatives, (7) Concern for the community. Cooperatives are also guided by the core values of self-help, democracy, equality, equity and solidarity. Members of cooperative societies believe also in the ethical values of honesty, openness, social responsibility, and caring for others.

Cooperative as community based organisations are endowed with uncommon resilience. As people centred institutions cooperatives operate in all spheres of the social and economic systems including socialism, capitalism and mixed economies. Cooperative form of business is reputed as the only business system that survived the recent economic meltdown (Agbo, 2012). In their usual character of people centredness cooperatives adhere strictly, in their business approach, to the principle of "concern for the community" where they operate. This principle ensures that cooperatives have an obligation to participate in activities and issues that affect the welfare of the communities where they operate. They operate on the basis of owner-user thereby eliminating exploitation rampant among other forms of business. By their nature cooperatives are pro-active in the service of the communities where they operate more so when members are also beneficiaries of these community services.

In cooperatives, member education is a principal issue (Onuoha, 2000). Cooperatives are under obligation to provide both basic, functional cooperative and business education to members (Berko, 2001). On the platform of their cooperatives members devote time to spread relevant and appropriate information and techniques on the basis of shared experiences and responsibilities (Nweze, 2002). In this way cooperatives present very cost effective and efficient medium for exchange of innovation and other novel ideas that benefit the entire membership (Agbo, 2012).

Cooperatives offer platforms for basic democratic education. Appropriate democratic tenets are learnt by members through participation in cooperatives activities in adherence to the popular principle of "one person – one vote". Cooperatives, therefore, create opportunities for members to practice democracy and assume

collective responsibility (Ijere, 1979).
Cooperatives offer social and cultural platforms through which members assume mutual ownership of risks arising from business and daily living (Akinwumi, 1991). In this way members provide themselves social and business insurance services that come handy in times of need.
By its nature cooperative activities cut across all spheres of human activities providing for health services, educational services leisure, tourism, culture and antiquities, transportation, retirement and pension schemes, to mention just a few (Chavez, 2003). Cooperatives also provide a range of services in the areas of agricultural production, input procurement, marketing and other downstream activities in agribusiness (Akinwumi, 1991).

5.0 Disseminating Biotechnology Information and Products Through Cooperatives

Reaching farmers with innovation packages does not depend on chance but on properly planned and well laid-out procedures. This paper proposes a paradigm shift from reaching farmers with biotechnology packages as individuals to use of their cooperative society platform. This is partly because farmers prefer to work in concert with other farmers when the chance arises (Von Hipple, 1988). In many instances farmers have been found to make choice on the basis of what their peers have chosen (Shick, 1997). Farmers have also been found to diligently follow the paths charted by their leaders: be they opinion, religious or cooperative leaders (Marshalll, 2005; Pannell *et al.,* 2006). Available studies show that cooperative participation can play a significant role in the adoption process (Faturoti, Agwu, Igbokwe, Tekouna, 2008; Nielson, 2001). When a cooperative member adopts a new technology it is easier to share such knowledge with fellow cooperative members (Von Hipple, 1988).
Cooperatives are well known as platforms for participatory information sharing making it possible for more farmers to be reached at any instance (Katungi, Machette, & Smale, 2007). Cooperative organisations have also been known to act as pressure groups (socially and politically) in the actualization and defence of farmers' interests (Pannel *et al.,* 2006). The proposed paradigm shift presumes that biotech information passed through cooperatives to farmer-member would not be distorted since the farmers would have been well informed through a participatory decision making process which cooperatives are known for. The point being made here is that using cooperatives to disseminate biotechnology information will increase trust, reduce risk perception, and could result in more positive views of adoption (Katungi, Machethe, & Smale, 2007).
An earlier study carried out in Northeast, Nigeria (Nwankwo, Peters, & Bokelmann, 2009) demonstrated the superiority of cooperatives to other channels of disseminating biotechnology information. The study made some far reaching conclusions about the suitability of cooperatives as a platform dissemination of biotechnology information. For instance, most of the respondents in the study agreed that opinions/ideas from cooperative leaders had more impact on them than the contrary. Farmers in the study also adhered to the decisions of the cooperative leaders because they (leaders) had been proved capable of representing members' interests. Four major issues were raised in favour of cooperatives by the Nigerian study. First, farmers respect information from their leaders (source credibility) more than from other sources. Second, farmers are more willing to try out information gathered on the platform of the cooperatives. Third, cooperatives facilitate access to and purchase of biotechnology products. And fourth, cooperatives offer a better platform to reach more farmers and to receive feedback. In addition when a new technology is tried out on the platform of a cooperative society risks were more evenly spread. The more farmers know that they are not alone in the risk attendant to adoption of a new technology the more they are likely to be willing to adopt that technology. The study concluded that 61% of the farmers were willing to adopt biotechnology if it was disseminated through cooperatives. The chi-square test comparing respondents' choice between cooperatives and other channels of dissemination of biotechnology was found to be highly statistically significant (χ^2 55.40, d.f. 3 and $P < 0.001$) indicating that disseminating biotechnology through cooperatives had wider acceptance with a higher level of trust rating than through other channels.

6.0 Paradigm Shift

The paradigm (Figure I) for promoting the access of farmers to biotechnology and biotechnology products in Nigeria through farmers cooperative societies is premised on the fact that cooperative organisation in Nigeria follows a hierarchical structure from community based primary cooperative societies to state and national cooperative federations (Okonkwo, 1979). The federation is the policy making organ at both state and federal levels acting, as it were, in their capacity as the representative of the entire cooperative movement. Decisions taken at the level of the federation is passed down to members through their unions at the local government level and finally to the farmers through their primary cooperative societies. Feedback from the farmers follows the reverse direction. The point that is being made here is that once decision to adopt biotechnology is made at the highest organ of the cooperative movement the subsidiary units are not likely to act otherwise. Moreso, as earlier

pointed out farmers are more likely to accept information received on the platform of their cooperatives than that from any other source (Nwankwo, Peters and Bokelmann, 2009).

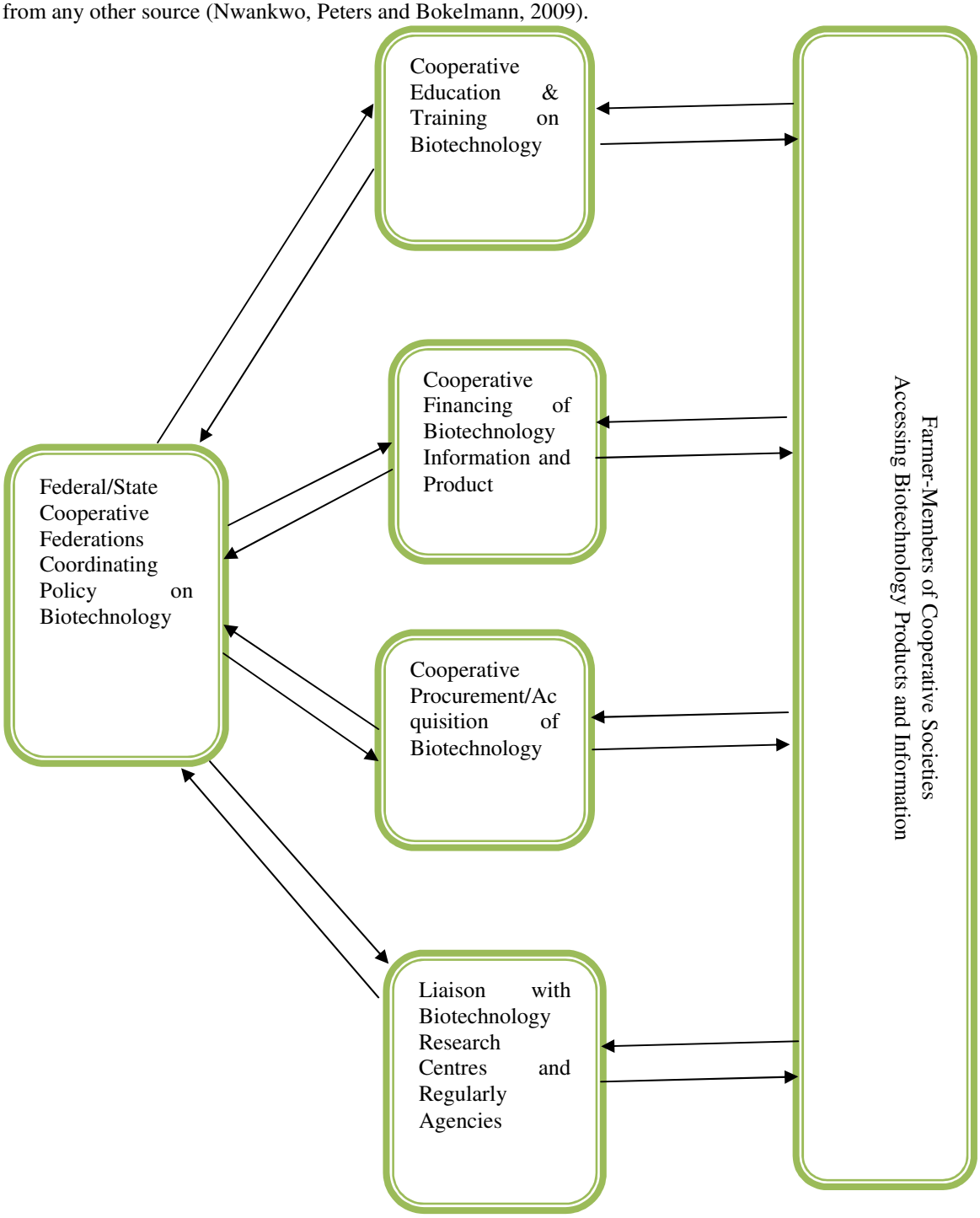

Fig. 1: Schematic representation of the paradigm for biotechnology transfer through cooperatives

One of the most important functions of cooperatives is member education (ICA, 1995). The meeting of a cooperative society is never complete until one type of cooperative education or the other is given to members (Okonkwo, 1979). On the platform of member education a cooperative society may organise an enlightenment programme on biotechnology and biotechnology products. Such enlightenment received on the platform of their cooperatives societies are likely to be taken more seriously than from any other source. Members adoption behaviours may also be monitored through the feedback process.

Lack of access to finance could be a major obstacle to farmers' adoption of an innovation (Faturoti, Agwu,

Igbokwe and Tekouna, 2006). A cooperative society guaranties easier access to finance to members than any other formal source (Ijere, 1979). Finance needed to purchase biotech products can be obtained from farmers' cooperative societies. On the platform of cooperative societies recovery of borrowed funds is much easier (Nweze, 2000).

Procurement of products for farmer-members is one of the services rendered by a cooperative society. When individual members find it difficult to procure products or services cooperatives come to the rescue. Bulk purchase of products to be distributed to members is a business which cooperative societies are good at. Procurement/acquisition of biotech products on behalf of members can be better handled by cooperative scoeites. One basic obstacle to adoption of biotechnology products is the weight of social concern regarding the safety of these products (Nwankwo, Peters and Bokelmann, 2006). Cooperatives are in a better position to handle the issue of biosafety for her members. Once the cooperative has certified that a biotech product is safe members may not hesitate to acquire and use the product. Moreover, cooperatives have a better capacity than its members to acquire research results. Such results needed to assure consumers that a particular biotech product is safe can be better accessed through their cooperative society.

7.0 Conclusion

Biotechnology has impacted positively on agricultural development, though its potentials are yet to be fully exploited. There are, however, concerns raised in several quarters with respect to the side effects of involving biotechnology in agricultural development. Access to biotechnology and its products have remained essentially in the domain of the elite with very little pro-poor strategies that will make for unfettered access by the poor and the rich. Farmers cooperative societies have been proposed as such pro-poor organisation that will increase the access of farmers and other less privileged members of the society to biotechnology and its products. There is, therefore, the need for researchers and policy makers to explore the opportunities of involving farmers' cooperative societies in the dissemination of biotechnology information and products.

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