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Can Cooperative Membership and Participation Affect Adoption Decisions? Issues for Sustainable Biotechnology Dissemination

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Biotechnology has become the dominate technology in the agricultural environment globally, possessing the capacity to address issues related to food insecurity and low productivity. Developing countries therefore cannot afford to be left behind. Despite how beneficial biotechnology is portrayed, the major task hinges on how to ensure that farmers in developing countries adopt it amid various controversies and perceptions surrounding its application. This article studies the effects of cooperative membership and participation on adoption decision of agricultural innovations in the states of Kaduna and Borno in Nigeria. A semi-structured questionnaire was used to obtain empirical data from 1,120 respondents. Results revealed that the majority of farmers belonged to cooperative organizations due to several reasons, including the need for information and social capital. Participation in cooperative activities was frequent and information disseminated was adjudged relevant to members' needs. The level of trust ascribed to information from cooperative activities was higher than other sources. Farmers became aware of recently adopted innovations through cooperatives. Willingness to adopt biotechnology was higher if disseminated through cooperatives than other channels. Intuitively, disseminating biotech information through cooperatives will ensure increased awareness levels in less time than other approaches.

Key words: biotechnology, decision, information, innovation, risk perception.

Introduction

New-product introduction is catalytic to successful growth and economic well-being of competitive organizations (Pfeffer, 1995). The same can be argued for the agricultural sector, where sustainable growth and farmers' economic empowerment can be accomplished through incremental improvement of existing techniques. However, the decision to adopt an innovation, despite how rewarding it is portrayed, is affected by several exogenous and endogenous factors. In some instances, innovations can be accepted in a society, but emerging information from opinion leaders[1] or further scientific evidence can alter the adoption-decision process. The adoption process begins with information seeking and processing within and outside the environment of the adopter. Individuals tend to confirm and reconfirm information during the decision-making process (Rogers, 2003). Farmers in developing countries face diverse constraints, while resources to satisfy the constraints are scarce. The desire to seek information to overcome farming problems is a continuous process. Conversely, the actual decision to implement such innovation-based information depends on how individuals perceive the communication method, sources, ownership, cost, availability, and accessibility of such information. These factors are significantly related to decision-making as they shape adoption, rejection, or deferred adoption. When farmers fail to apply a given information set, they do so rationally. Farmers seek information from various sources in order to reduce risk and uncertainty so that expected utility from any given solution package can be maximized. Notably, relevant and reliable information from close relatives is regarded as more authentic than from entirely outside sources. However, if a receiver has proved information from an outside source as being reliable and compatible over time, the probability of applying subsequent information from such source increases. Farmers, as well as most individuals, have people who they tend to depend on or to whom they ascribe trust and allegiance. Information

1. *The polio vaccine incident in Northern Nigeria is a vivid illustration of how opinion leaders can alter the adoption process due to perception problems on the motives/intentions of the disseminating agent. Some Northern opinion leaders perceived the vaccine as a plot by the Western world, especially the United States, to reduce the population of the Northerners (see also Barrett, 2007; Da Costa, 2007).*

or suggestions from such sources always influences decision-making. Moreover, there are forms of expected conduct and other factors that determine overt behavior in specific societies.

Evidently, economic reasons rather than religious and cultural considerations may greatly determine adoption decisions of new products. Influences from social institutions, religion, culture, environment, and externalities cannot be underestimated. Such environment produces a mixed grill of factors that climax into increased risk and uncertainty tendencies. Attitude toward risk is understood to be responsible for differentiating adopters into categories (Rogers, 2003; von Hipple, 1988), although this is not always true (Nwankwo, Peters, & Bokelmann, 2009b). New technologies (products or process) such as biotechnology present higher risk than old ones whose outcomes are relatively known by the users. Therefore, not all farmers will be willing to be the first to try new products. Some would probably wait until they observed others adopting or until they received more convincing information. The adoption and/or consumption of modern biotech products is accompanied by several controversies. These have garnered varied feelings and polarization of positions, especially in developed countries. The resulting effects in developing countries are increased risk, uncertainty perception, and mixed feelings. The numerous constraints faced by farmers in developing countries require urgent attention. It is widely believed that biotechnology can be of remarkable help. However, agricultural biotechnology is not an end itself to global food insecurity or the copious constraints facing agribusiness, especially in Africa. Notwithstanding, farmers in some cases devise several methods to overcome or reduce risk factors through collective effort, without external influence. This is because cooperative activities present a form of social capital.

This article explores the following questions: What are the types of innovations disseminated to farmers in the study areas? What is the nature of cooperatives in these areas and how does information seeking and processing among cooperative groups affect adoption decisions? How is biotechnology perceived among farmers and what is the awareness level? Is it logical to assert that disseminating biotechnology though farmers' cooperatives will be more reliable, effective, and sustainable than through marketing channels? Finally, would farmers adopt biotech if the information is disseminated through the cooperatives?

Intuitively, biotech companies may be new to socio-cultural and socio-economic terrain where farmers make decisions regarding on which innovation to expand scarce resources. This factor can affect communication, perception, and expected conducts that may affect adoption decisions. Hence, the article further explores farmers' motivations for taking part in cooperative activities, the level of relevance and trust members ascribed to information received during cooperative activities, and whether a member had adopted innovations recommended through cooperative groups. Farmers participated actively in cooperative activities because information shared was significant to members' needs; conversely organizational structure addressed farming and social needs.

Objective of This Article

This article argues that disseminating biotechnology information through agricultural cooperatives will ensure a wider coverage, increase trust, reduce risk perception, and thus, enhance adoption decision.

Arguably, biotechnology possesses some potential for improved agricultural productivity. Dissemination approaches, especially in developing countries, will determine its acceptance or rejection. Based on mixed feelings surrounding genetically modified organisms (GMOs), farmers in developing countries may show skepticism in receiving biotechnology information when it comes entirely from outside sources. Therefore it is necessary to involve farmers in the dissemination process by using cooperatives to disseminate information about the innovation. Intuitively, farmers have more confidence and trust in information emanating from farmers themselves than from other sources. Moreover, cooperatives have been shown to possess some form of social capital, while other cooperative groups maintain group farms where trials of GMOs can be conducted for demonstration purposes.

Literature

Innovation availability and affordability does not necessarily imply high adoption rates among the target group. Several systemic factors determine adoption decisions. Innovation has been defined by Rogers (2003). Tidd, Bessant, and Pavitt (2003) and Utterback (1996) have grouped innovations into product and process forms. The food-production index of some developing countries has seen a gradual net increase, due in part to improvements on old agricultural technologies and availability of new ones, or as a result of land expansion (Asiabaka, 2002). Notwithstanding, some countries recorded a drop in production index between 2005 and

2006 (FAO, 2008), most likely caused by unsustainable agricultural practices and several climatic and edaphic factors. Rising food insecurity, especially in Sub-Saharan African, is of global concern. Is agricultural biotechnology one of the solutions for alleviating the problems of food insecurity or reducing the limitations associated with unsustainable conventional agricultural practices? Some scientists believe that this is possible (Gressel, 2008; Krattiger, 2000; McHughen, 2008; Ozor, 2008; Walgate, 1990; Wambugu, 1999; Woodward, Brink, & Berger, 1999). Others believe the contrary (Altieri & Rosset, 1999; Greenpeace, 2002; Hine & Pretty, 2008). Views on the potentials of biotechnology have been challenged based on biosafety, moral justification, and other contending issues (Lappe, 2002; Mellon, 2008; van Wijk, 2000). Organizations such as Friends of the Earth (FOEI) have mounted numerous campaigns against biotechnology (FOEI, 2006). Others have expressed concerns on legitimate grey areas requiring further scientific explanation and clarification. Agreeably, some of these concerns cannot be dismissed uninvestigated, e.g., how the innovation can benefit resource-poor farmers in developing countries (Tripp, 2002). Other concerns are hinged on fears and uncertainties rather than scientifically proven realities (McHughen, 2008; Smyth, Kerr, & Davey, 2006). Although it is necessary to continue the pace of research and development of biotechnology in order to address the remaining risk factors, some have contended that the risks and criticisms associated with biotechnology are not uncommonly dissimilar to those obtainable in new technologies (Walgate, 1990). Hence, there are no zero-risk new products, but the risk factor reduces as research progresses. Irrespective of the argument divide, the problem of overcoming global food insecurity in an agricultural environment that has witnessed severe degradation is overwhelming. Even if solutions can be found through improvement on conventional practices, organic farming, or agricultural biotechnology, determining how such incremental improvement can be accepted by the target users remains a burgeoning concern. For an innovation to work commercially it has to be successfully accepted and adopted by the target users (Tidd et al., 2003). This process is affected by several factors (Abadi, Pannell, & Burton, 2005; Lindner, 1997; Marra, Pannell, & Abadi, 2003; Monge, Hartwick, & Halgin, 2008; Pannell & Zilberman, 2001). As adopters sift through innovation attributes based on available information, they demonstrate an objective adoption decision based on rational perception and judgment. Such perceptions are affected by communication method, attributes of the communicators, information content, and other factors. This is why information source, cost, ownership, availability, and accessibility are key components in shaping adopters' opinions (Gündel, 1998; Waithaka, 1998).

Another factor affecting acceptance/rejection of information content is the level of trust and reliability ascribed to the source. Depending on the type and nature of information, adopters trust information from close relatives or associates more than information emanating entirely from outsiders unless the outside source has been proved reliable over time. Hence, farmers know whom they trust and hold in high esteem. Studies have revealed a positive significant connection between agricultural cooperatives and adoption (Clark & Akinbode, 1968; Feder & Umali, 1993; Gündel, 1998; Lapbim, Gockowski, Tchouamo, & Wandji, 2008; Lindner, 1997). Conceptually, cooperatives are all types of business enterprises or organizations owned and controlled by members in the pursuit of perceived mutual benefits and need actualization (see Trewin, 2003). There are different forms of cooperatives societies (Ruben, 1997). However, emphasis here is only on farmer/producer cooperative societies.

Model Proposition

Two strategy scenarios are presented here. The first is the traditional view of innovation dissemination through marketing channels or targeting progressive farmers in the hope of attaining the trickledown effect. The second is an alternative approach to disseminating biotech information through cooperatives in order to reach more farmers per time and space. These two strategies include (a) using a marketing concept approach (traditional view) or (b) using agricultural cooperatives as proxies or lead adopters. In the first strategy (Figure 1), information about GMOs is designed to be introduced into Country A through marketing channels by biotech companies or research institutions. Before this is done however, regulatory authorities must issue approvals for trials and subsequent dissemination. Conversely, there are two information lines: biotech information line (*BIL*) and counter information line (*CIL*).

Biotechnology Introduction Through the Marketing Process

Naturally, bureaucratic processes and modus operandi of such institutions may pose vast delays in approval time as a result of conflicts, duplication of roles, or unfavorable attitudes about GMOs.[2] The arrow pointing

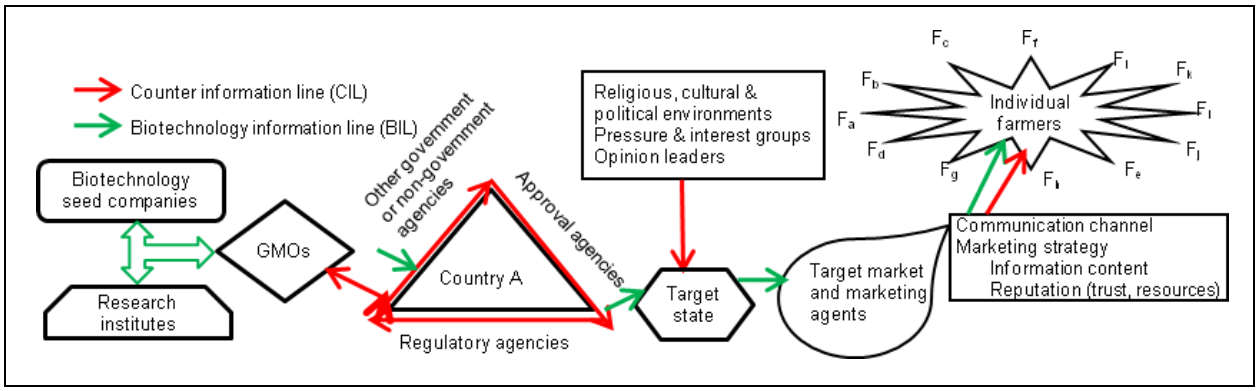

Figure 1. Traditional view of innovation dissemination.

in different directions depicts this phenomenon (Figure 1). In addition, other stakeholders and pressure groups may support or oppose *BIL*, giving rise to distortion of information and increased risk perception to potential adopters. Such mixed reactions can occur both at the national and state levels. After approval and successful trials, *BIL* is channeled through the traditional innovation disseminating system (marketing process) to individual farmers in the respective state or geopolitical zones (in the case of Nigeria); this is represented by $F_{a\text{-}k}$. Through this mechanism, opinion leaders or the so-called progressive farmers are often the first target by extension or market agents, with the view that other farmers will copy from them. Conversely, actual acceptance and utilization of *BIL* is affected by the nature of information available to users in the end.

Disseminating Biotechnology Information Through Cooperatives

The second scenario represents the argument in this article. Reaching a wider audience of farmers with biotechnology information will not depend on chance, happenstance, or circumstances. Rather, it will hinge on a well-defined, diligent, and consciously-crafted institutional approach. This model suggests an approach that entails disseminating biotechnology information through cooperatives.

Like the first approach, regulatory approvals are still required before GMOs are disseminated. However, by collaborating with cooperatives, biotech companies stand to gain farmers' trust and confidence through participation. This approach presupposes causal decision theory. Adoption of new technologies involves making rational choices between continuing with an old technology whose outcome is relatively predictable and stable or choosing to accept an entirely new product or process whose outcome is probabilistic. This theory implies that for every event to occur (such as a farmer changing from conventional agricultural practices to biotech practices) there has to be a cause (such as the availability of information about an innovation, communication channels, and the probability of the innovation to satisfy predetermined subjective attributes). Causal asymmetry in effect suggests that *x* causes *y* if and only if *x* can be used as a means to bring about *y*. Another aspect of causality is contiguity, which implies that cause and effect must have spatial contact or be connected by a link of intermediate activities (Hausman, 1998; Joyce, 1999). Notably, individuals (farmers) do not act alone. In some instances, farmers make choices based on what certain others are choosing (Schick, 1997). Conversely, certain individuals (opinion, religious, or cooperative leaders) influence the choices or decisions of those who look up to them (Marshall, 2005; Pannell et al., 2006). By implication, the choices farmers make are embedded in the interest of others as they tend to emulate actions of progressive farmers or leaders. Such progressive individuals possess attributes of lead users (von Hipple, 1988). With respect to the causal effect mechanism, it is expected that cooperatives can act as proxies between farmers and biotech companies in disseminating biotechnology information. This can be achieved through a participatory approach and information sharing among stakeholders and by involving cooperatives from inception. Through this process, the number of farmers reached per time will be higher, indicated by *N* number of farmers in each cooperative group (*N* ranges from 50 to 10,000 members per cooperative

2. *This type of scenario has been responsible for the delay in approval or field trials of transgenic crops in Europe and other countries, especially when some members of the respective approval institutions are do not favor the use of GMOs.*

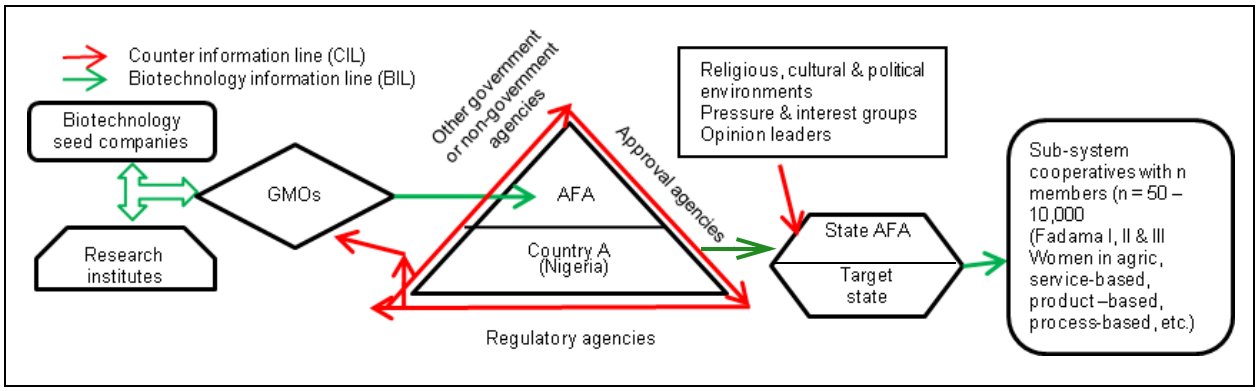

Figure 2. Alternative approach of *BIL* dissemination (AFA=All Farmers Association).

group). Such cooperative organizations can also act as pressure groups (socially and politically) for the actualization of farmers' interests. Presumably, information (*BIL*) that will reach users will not be distorted since farmers would have been well-informed about the working dynamics of biotech innovation and since the innovation would incorporate subjective views of the users. Therefore, a participatory approach increases the size of *BIL*, as shown in the Figure 2. The argument here is that using cooperatives in biotechnology information dissemination will undisputedly increase trust, reduce risk perception, and probably entail more positive views of adoption (Katungi, Machethe, & Smale, 2007). The main objective, however, will be to attain wider coverage of information dissemination over time. Rogers (2003) noted that it takes about eight years to attain reasonable adoption levels. Reaching out to individual farmers will take longer time through the traditional view. Gaskell (2008) advanced some overarching issues that bothered on approach, which contributed to defining public stances on GMOs across Europe.

Survey Data

The current study is part of a wider case study that covered six geopolitical divisions of Nigeria. A purposive and multi-stage sampling technique was used for random selection of six states in the six geopolitical zones. We conducted the survey twice between July through October 2006 and March through July 2007. The study focused on factors that were capable of affecting sustainable biotechnology adoption in Nigeria and other developing countries in general through a survey on the type of innovations adopted by farmers in the study areas and factors that influenced adoption decisions. The rationale for taking demographic division into perspective was to have a fairly representative view of the country. Nigeria is comprised of three major ethnic groups and other minority groups whose views and opinions differ considerably due to cultural distinction and sometimes religious divide.

Research Design

Empirical data were obtained through a multi-method approach, which combined quantitative and qualitative techniques. A semi-structured questionnaire, which combined open-ended questions, multiple choice responses, scale questions, and provisions for additional comments, were used in obtaining quantitative date. Qualitative data were obtained through personal interviews, participant observation during cooperative meetings, farmers' field days, fortnightly training meetings (FNT), and review of secondary data from agricultural development programs (ADPs) and the Ministry of Agriculture (MoA) in the respective state. The dataset presented here, which is majorly quantitative, represented that of Kaduna State (North-West) and Borno State (North-East). Qualitative data (in the form of photographs) are used to create a dense illustration of the quantitative data.

Description of the Study Areas

Borno State covers a land mass of 61,435 km^2 with a population of over 4.2 million and population density of approximately 60 people per km^2 according to the 2006 population census estimate. There are about 536,222 farming households in the state (National Agricultural Extension and Research Liaison Service [NAERLS], 2008). Geographically, Borno State is located within longitude 11° 30′ E and 14° 45′ E and latitude 10° N and 14° N. The climatic situation is that of a very severe hot and dry season for a greater part of the year, with temperatures exceeding 40° C in some cases (Sabo, 2007).

Apart from incidences of drought and flooding, incessant and unregulated tree cutting has resulted in severe dessert encroachment, especially in the Chad Basin. Agricultural productivity is generally low, compounding the problems of food insecurity. Some of the major hindrances to low food production are lack of improved agricultural inputs and prevalent striga-witch weed infestation (Nwankwo, Bett, Peters, & Bokelmann, 2009a).

On the other hand, Kaduna State, which was created in 1976 with its capital in Kaduna, was formally the center of the Northern region during the colonial and precolonial era. The state still maintains the status of the commercial and political nerve center of present-day Northern Nigeria. Geographically, Kaduna State is located along longitude 6° 10′ and 9° E and latitude 8° 45′ and 11° 30′ N of the equator. Within Nigeria, Kaduna State occupies a central portion of Northern Nigeria and covers approximately 48,473.2 km^2. With a population estimate of over 6 million people (National Population Commission [NPC], 2006) and population density of about 500 people per km^2 (especially within the Kaduna/Zaria area), Kaduna ranks 3rd highest in the country in terms of population. Agricultural innovations are disseminated to about 551,113 farming families majorly through the Kaduna Agricultural Development Program (KADP). Nevertheless, inadequate extension agents are still a major handicap, as well as food insecurity.

Empirical Data Collection

In the first phase, random data were obtained from 40 respondents in two villages (extension blocks) from two local government areas (LGA) of each state. During the second phase, data collection was reduced to 30 respondents in each village. Data from Borno State covered the Northern Guinea Savannah (NGS), Southern Guinea Savannah (SGS), and Sudan Savannah (SS) of the state's agricultural zone. A total of 1,120 respondents were interviewed from the following villages and LGAs.

State	LGA	Villages
Borno	Biu	Maina-Hari, Miringa
	Hawul	Mbulatawiwi, Yimirshika
	Kwaya-Kusar	Guwal, Kwaya-Kusar
	Damboa	Damboa Central, Sabon-Gari
Kaduna	Birni-Gwari	Bagoma, Birni-Gwari
	Chikun	Gonigora, Kujama
	Kaduna South	Barnawa, Tudun Wada
	Kajuru	Kasuwa Magani, Maraba Kajuru

Approach Utilized for Empirical Data Collection

Currently, there are no officially[3] commercialized transgenic products in Nigeria, although plans are underway to conduct a field trial of transgenic cassava. Nonetheless, the Nigerian Government is determined to pursue a strong biotechnology implementation policy for several reasons. The main objectives are to revitalize the ailing agricultural sector, reduce food insecurity, and empower farmers, as well as industrial purposes. Since there were no officially introduced GMOs in the country yet, studying biotechnology adoption trends was difficult. Apparently, there were other innovation packages disseminated to farmers in the study areas through the World-Bank-assisted ADPs. Some of these innovations incorporated the use of traditional biotechnology techniques (tissue culture or micro propagation) in developing disease-resistant varieties or multiplication of improved planting materials. For this reason, it was inevitable to work in cooperation with ADPs in the two states to determine types of innovation packages disseminated to farmers, the factors which affected adoption or rejection, and the roles that cooperatives played in the adoption-decision process. Notably, ADPs encourage farmers' group activities and participation. In Borno State, an agency known as Promoting Sustainable Agriculture in Borno State (PROSAB) disseminated several innovations such as soybean, early maturing maize, different fertilizer application rates, folio fertilizers, New Rice for Africa (Nerica 1), management and processing techniques, etc. PROSAB is a non-governmental organization (NGO) established in conjunction with the International Institute of Tropical Agriculture (IITA), Canadian International Development Agency (CIDA), and Borno State Agricultural Development Program (BOSADP). Prior to PROSAB's introduction of alternating soybean production with other crops for the purpose of fighting severe incidence of striga-witch weed infestation, soybeans were not cultivated by farmers in the state (Nwankwo et al., 2009a). Some of these and other innovations were disseminated to farmers in Kaduna State except the use of soybean to reduce striga-

3. *New varieties of soybean, maize, rice, and groundnut were disseminated to farmers in Borno by an NGO called PROSAB; however, it was not clear whether the soybeans that were disseminated to farmers for fighting Striga witch weed menace were transgenic or not.*

witch weed bank in the soil. Some of the identified innovations were entirely new, while others were incremental improvements on existing technologies. Although these innovations may be regarded as being dissimilar to GMOs, nevertheless, adoption of these innovations involved decision-making about alternative product or process innovations. Moreover, the use of traditional biotech techniques is rampant in the country. Hence, factors that affected adoption decisions of these innovations will also play significant roles in adoption decisions of GMOs. Moreover, farmers distinguished traditional biotech from modern biotech or sometimes substituted high breed crops and animals with GMOs.

Adopter Categories

The baseline questionnaire (entitled Sustainable Biotechnology Adoption Questionnaire) was aimed at eliciting information from respondents on several overarching theoretical principles that have been postulated to affect adoption decision (Kleyngeld, 1974; Pannell & Zilberman, 2001; Rogers, 2003). The initial questionnaire structure contained eight pages. This was reduced to five pages after the second day of personal and group interviews in Borno State.

Adopter categories were determined based on how an individual farmer reacted when he/she first received information about a new product or process innovation[4] (Nerica1, Soybean, early-maturing maize, yam minisett, agrochemicals). Those who applied the information immediately were designated as innovators/early adopters, those who first verified if the information was correct and relevant were regarded as early majorities, those who waited until they received more information before considering adoption were listed as late majorities, while those who waited until they observed other farmers adopting first were noted as laggards. The distinguishing factor between early majorities and late majorities was the 'waiting' period. Notably, information verification can occur during dissemination by extension agents through asking further questions. Nevertheless, this topic may be a source of further discussion (see also Marra et al., 2003; Pannell & Zilberman, 2001). Although biotechnology is surrounded with copious controversies, general adoption theories can be used to understand how farmers will react to it. A more important issue, however, will be the approach employed by the stakeholders in their dissemination.

Data Analysis

Data was analyzed using descriptive, inferential statistics and correlation analysis. Chi-square, Friedman's test, and correlation are widely used analytical tools in social research. The appropriate Chi-square test and correlation analysis were utilized based on data type (Field, 2005; Kennedy, 1992; Webster, 1998). For data which were ranked based on a respondent's preference on which information source were regarded as more authentic, motivation for cooperative membership, or attribute preferences they expected biotechnology to incorporate, Friedman's test of ranking was used. Ranking of variables was necessary to overcome the problem of measuring feelings. This was done in order to determine the payoff or preferences that adopters assigned to innovation attributes and other variables. Ranking (payoff) ranged from 0 to 6, with 6 the highest, 1 the least, and 0 the worst payoff.

Results and Discussion

Sustainable Biotechnology Innovation is Desirable, but How?

Nigeria is an agrarian society where more than three-quarters of the population are engaged in subsistence farming. In Kaduna and Borno States, agriculture constituted the predominant occupation. Farming occupation was practiced with other professions (Table 1), such as civil servant and handiwork. Those whose major occupation was farming (core farmers) accounted for 79% of the respondents. Invariably, three-quarters of the respondents whose primary occupation was farming depended entirely on it (source of living). Generally, 81% depended completely on agriculture as their source of livelihood. The implication of this result is that any sustainable innovation adopted by a majority of the respondents would positively affect living standards, especially if the innovation yields marketable products. The reverse will be the case in the event of an unsustainable innovation.

Results (Table 1) further revealed that less than one-seventh had no basic education. The rest acquired some form of educational training in conjunction with several years of farming experience.

4. *No particular innovation was targeted a priori as we envisaged that different state ADPs may be disseminating different innovations specific to a particular area. The objective was to identify such innovations and study adoption trends. However, it turned out that similar innovations (such as Boost Xtra, yam minisett, Nerica1, and others) were disseminated across the states.*

Table 1. Characteristics of respondents (n=1120).

Occupation	Frequency	%
Farming	887	79.2
Civil servant	46	4.1
Farming and civil servant	58	5.2
Others	129	11.5
Age (years)		
Below 20	2	0.2
21-30	127	11.3
31-40	419	37.4
41-50	440	39.3
Above 60	132	11.8
Education		
No basic education	153	13.7
Primary/adult education	339	30.3
Uncompleted Secondary	30	2.7
Secondary education	279	24.9
Diploma	126	11.2
Religious education	119	10.6
Higher education	73	6.5
Do you earn income?		
No	315	28.1
Not really	314	28.0
Not as I wanted	294	26.2
Yes	197	17.6

Irrespective of educational level and the realization that majority of respondents (76.7%) were within the active farming age (average of 40.5 years), the adoption rate was very low. Income from farming was also considerably low.

Only 17.6% earned satisfactory income, and 26.2% did not earn income as they would have wanted it. This was linked to marketing problems and activities of organized middlemen. In Borno State though, the adoption rate of soybeans was very high due to the institutional approach (Nwankwo et al., 2009a).

Constraints to Increased Food Production

Over the years, Nigeria Government has implemented several projects aimed at improving food productivity and living standards. Some of these projects have been judged unsustainable based on approach (Idachaba, 1997). Many Sub-Saharan African countries still depend on food aid despite that a high portion of the population are engaged in farming. Several factors have been responsible viz: environmental, political, institutional, sociological and economic issues. In Kaduna and Borno, some factors were noted to have affected agri-

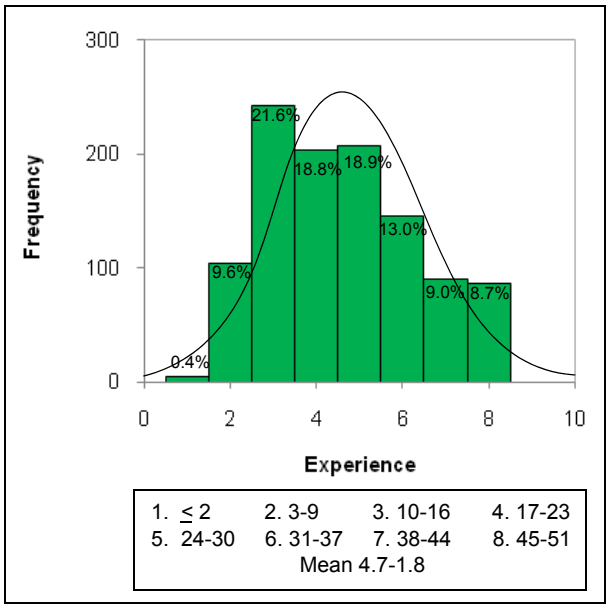

Figure 3. Experience.

cultural productivity. These are grouped into (a) structural problems, (b) unpredictable natural conditions and (c) personal problems. Structural problems are more related to institutional failures, sociopolitical problems, policy environment, externalities and innovation dissemination approach vis-à-vis farmers' response to them. Unpredicted natural conditions relates to biotic and abiotic factors with their associated risks and uncertainties. Personal problems stems from a combination of aforementioned constraints and interaction with individual endogenous factors (also Heim, 1990). Using a multiple choice criteria for farming constraints, results revealed that fertilizer-related problems constituted a major constraint (92%), weed-related problems accounted for 89%. Sometimes farmers received fertilizer after the time of its application was over. Despite the high cost of fertilizer, three-quarter of farmers faced problems of low-quality and high cost of agrochemicals, 55% recorded information-related problems while lack of good and quality seed as well as high cost of seeds accounted for 51%. The cost of hiring labor was also high. Farmers' inability to hire labor for weeding their farms in due season, resulted into low yields. These numerous constraints are indicative that biotechnology is not an end itself. Hence, Government and policy makers should strive to determine farmers' urgent needs a prior. Although biotechnology may solve problems of low yield but it cannot 'empower' farmers without access to market and market information. Such information and structural deficiencies (bad road or market

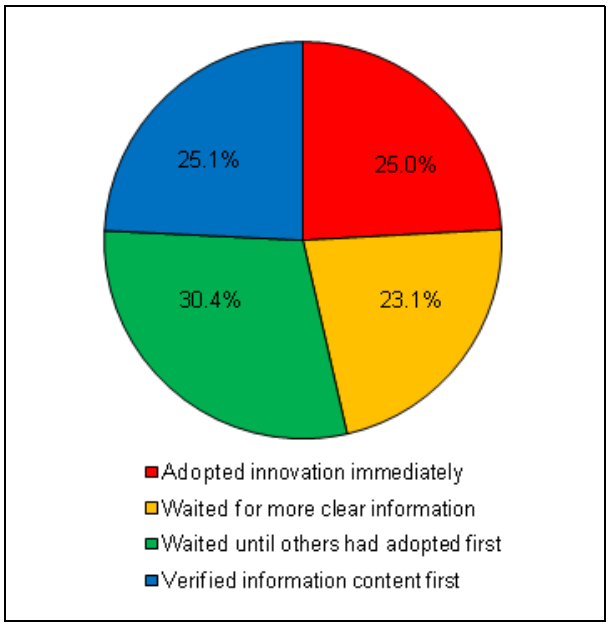

Figure 4. Adopter category.

information) affected income despite educational level or the number of years (experience) devoted to farming. Results (Figure 3) revealed that only 0.4% had a minimum of two years of farming experience while 8.7% had more than an average of forty-eight years of farming experience. There were 46% female and 54% male farmers among the respondents. Education only affected adoption rate in terms of the capacity to understand information content or the capacity to apply it in the absence of extension agents or further explanation. This is the case especially when information was disseminated in English language.

However, in instances where information was disseminated in local languages; neither education nor years of experience had a significant effect on rate of adoption.

Gender only affected rate of adoption in instances were female farmers were denied access to external or male extension agents and in instances were female farmers were denied access to land. In Borno State women were allocated lands that had proximity to homes for the purpose of close monitoring and observation. Such lands were usually infertile due to over usage and in some cases, the lands were fragmented according to number of wives. However, a seemingly change of institutional approach in adoption process can yield radical change in adoption decision (Nwankwo et al., 2009a). This is possible only through participatory approach and collaboration with farmer cooperative groups.

Table 2. Friedman's ANOVA test on motivation to adopt new technologies (n=1120).

MFANI	Mean	Test statistics
1. Market product and make more money	4.7±1.3	
2. Produce more than current production level	4.0±1.5	
3. Overcome problems the old innovation could not solve	3.7±1.3	
4. Manage the innovation and the resultant product	3.1±1.2	
5. Availability and affordability of new technology	3.6±1.3	$\chi^2 = 588.0^{**}$ *d.f* = 4

MFANI = Motivating factor for innovation adoption

Motivating Factors for Innovation Adoption

The view that indigenous farmers resist change can pose a misleading conclusion while the claim that education and age affects adoption rate without proper synthesis of factors such as extractable knowledge (what the individual farmer can understand from information content) and applicable knowledge (the part of information content which individual farmer can apply in the absence of external help or further information) can result in misrepresentation of real issues (Nwankwo et al., 2009b).

Information dissemination approach is very significant while innovation attributes, the communicator, the receiver or institutional environment also affects adoption decision. Results (Figure 4) revealed that one-fourth of the respondents were innovators/early adopters, 30.4% were laggards. The laggards noted that information received were not in the form that could be applied without further explanation or presence of extension agents. For fear of risking entire investment (for instance animal treatment/chemical application) or limited resources, some farmers resorted to 'seeing-is-believing' attitude. In some instances, trials were carried out on cooperative lands before individual adoption. Conversely, trails can be carried out by extension agents on lead farmers' plot through small plot adoption technique (SPATS). This is usually a measured 10 by 10 meter plot often located in strategic areas where other farmers can observe demonstration results. Some innovations disseminated to farmers in Kaduna and Borno States are shown in Figure 5.

As expected, economic reasons rather than religious or cultural issues was the major motivation for adopted innovations. Results (Table 2) revealed that farmers preferred innovations which were capable of yielding mar-

Figure 5. Some innovations adopted by respondents.
A = soybean variety for reducing striga witch weed infestation, B = trial plot for Nerica 1, C = yam minisett plot, D = hybrid corn variety, E&F = improved planting materials (banana, plantain, cassava, soybean) developed through traditional biotech.

ketable products over attributes for increased production (Mean ranking=4.7±1.3 and 4.0±1.5, respectively). The reason was because farmers lacked market access.

Conversely, affordable and available innovation was preferred over ability to manage new technology and its products. The result was statistically significant (χ^2 588.03, *d.f* 4, p<0.001).

Biotechnology awareness level was very low in the two states. Notwithstanding, farmers had preferences on what the innovation should address in order of priority. Contrary to expectation, results (Table 3) revealed that religious/cultural factors were not considered a very important priority on GMO adoption or consumption. Generally, the major factor capable of motivating farmers into biotechnology adoption was its ability to address farmers' specific needs (mean ranking 4.9±0.9). However, if the innovation conflicts with farmers' needs, farmers will reject it. Farmers were also concerned about the future impact of the innovation as well as risks involved in its adoption (mean ranking 4.5±1.2 and 3.8±1.1, respectively). Intuitively, farmers have not fully grasped the full advantages of biotech or its disadvantage due to low awareness and information availability.

Therefore, farmers would like to know the future impact and the risk involved in adopting biotech products. The statistically significant result of the Friedman's ANOVA test on the motivating factor for GMOs adoption indicated that farmers have preferences and priorities when considering which innovation to adopt given scarce resources and uncertainties.

The level of agreement on innovation preferences was measured by a Kendall's test of concordance which was statistically significant (W 0.384, χ^2 158.36, *d.f* 4, and p<0.001). If biotechnology innovation do not meet predetermined preferences, the tendency to reject it is higher, such priority needs can only be known if farmers participated in development and dissemination process.

Motivation for Participation in Cooperative Activities

The need to spread risk can be among the reasons why farmers join cooperatives. Results revealed that more

Table 3. Friedman's ANOVA test on motivation to adopt GMOs (n=1120).

MFAGMOs	Mean	Test statistics
1. Accept if it addresses farmers' specific needs	4.9±0.9	
2. Reject if it conflicts with farmers' needs	4.6±1.2	
3. Reject if it conflicts with farmer's belief/culture	2.0±1.5	
4. Accept if farmer knows the future impact	4.5±1.2	
5. Accept if farmer knows the risk involved	3.8±1.1	$\chi^2 = 158.4^{**}$ *d.f* = 4

MFAGMOs = Motivating factor to adopt GMOs

Table 4. Friedman's analysis on motivation for cooperative membership (n=1120).

MCMP	Mean	Test statistics
1. Because fellow farmers joined	3.1±1.2	
2. Organizational structure addresses farming needs	5.3±0.78	
3. Information disseminated was relevant to farming needs	5.4±0.63	
4. Organizational structure addresses social needs	3.7±0.84	
5. There was no reason for membership	0.2±0.64	$\chi^2 = 209.0^{**}$ *d.f* = 4

MCMP = motivation for cooperative membership and participation

than 90% of respondents were members of at least one cooperative group. However, risk perception alone was not the major motive for cooperative membership and participation. Information received by farmers during cooperative meetings was relevant to members' agricultural and social needs. Moreover, in order to obtain loans provided by the government or from Agricultural Development Banks, farmers were required to form cooperatives.

Nevertheless, cooperative participation was voluntary. Comparatively, farmers envisaged the benefits for such participation, thus explaining why majority became members. Such motivation is embedded on the fact that farmers actively seek information to overcome farming constraints.

Results of Freidman's ANOVA test (Table 4) indicated that the first motivation for cooperative membership and participation was due to relationship between information relevance (5.4±0.63). The second motivation was the relevance of organizational structure in

Table 5. Correlation analysis on cooperative membership and information relevance (n=1120).

Control variable		1	2	3	4	5
Cooperative participation	1	1.0				
	2	0.192^{**}				
	3	0.925^{***}	0.169^{**}			
	4	-0.113^{**}	$-0.059^{n.s}$	-0.099^{**}		
	5	0.697^{***}	0.102^{**}	0.686^{***}	-0.138^{**}	1.00

*** = Significant at 1%, ** = significant at 5% (2-tailed respectively)

Where 1 = cooperative membership, 2 = Cooperative information helpful but not adequate, 3 = trust ascribed to cooperative information, 4 = information was helpful but expensive, 5 = information was helpful and accurate to farming needs.

addressing members' farming needs or political representation of members' interest. The result was statistically significant (χ^2 209.0, *d.f* 4, and $p<0.001$), with a Kendall's test of concordance of 0.842 (84.2%) which showed the level of agreement on farmers' motivation for cooperative membership.

Several well-established cooperative organizations exist in the study areas. The umbrella farmers' cooperative in Nigeria is All Farmers Association of Nigeria which covers the entire 36 States. AFAN membership is not restricted to commodity distinction, gender, religious divide or ethnicity, membership is open to all farmers. Another reason why farmers joined cooperatives was for social needs. Collectivism was a motivating factor as farmers tried to identify with their peers in the same profession as well as learn from each other. Farmers also consulted other stakeholders for problem solution or became aware of new technologies from several other sources apart from cooperatives. However, results indicated that the highest awareness source for new technologies was cooperative members. Extension agents were reckoned second in terms of awareness source. Members were allowed free consultation access with leaders and meetings were held weekly. Apart from discussing farming problems, cooperatives also served as political pressure bloc. Farmers favored more contact with extension officers because they were presumed to have acquired various professional trainings to deal with farmers' constraints. Contact and consultation with extension agents were regrettably limited due to lack of manpower. Apart from the fact that cooperative members and leaders ranked the highest source of information about innovations, farmers also attributed high trust level on information from cooperative members and

leaders more than information from other sources. Results indicated that 95.6% envisaged cooperative information as accurate and helpful to members' needs, although 63.9% noted that information were quite helpful but not adequate, hence more information were needed.

Results from correlation analysis between cooperative information relevance and cooperative membership are presented in Table 5. There was a strong correlation between cooperative membership and the level of trust ascribed to information from cooperatives which indicated that farmers adopted innovations disseminated through cooperatives due to trustworthiness of information content and source (r 0.925, p<0.001, 2-tailed). Information disseminated during cooperative meetings was also accurate and tailored to members farming and social needs. The strong statistically significant correlation between 'cooperative membership' and 'information from cooperative was helpful and accurate' explained why farmers participated in cooperative activities very often (r 0.697, p<0.001, 2-tailed). As anticipated, a strong statistically significant correlation also existed between cooperative information trust and information being helpful and accurate. Intuitively, if the information was not helpful and accurate, farmers would not regard it as relevant nor would they continue to spend financial or non-financial resources in cooperative participation. On the other hand, a negative but statistically significant correlation existed between cooperative membership and the variable 'information was helpful but expensive' (r -0.113, p<0.01, 2-tailed), although active or passive information involves some cost, however the benefits farmers derived from cooperative membership and participation surpassed any cost incurred from such activities.

A mild positive statistically significant correlation existed between cooperative membership and the variable 'information was helpful but not adequate (r 0.192, p<0.01, 2-tailed). Although cooperative information was relevant, still farmers were destitute of adequate information. Farmers sometimes hold on to old practices until they discover an alternative that have been proved successful and reliable. Trust is one ingredient necessary for accepting information content. For the same reason, farmers participated in cooperative activities because information was relevant to farming needs over time. There were four categories of cooperative participation. Results indicated that 29% participated in cooperative activities very often, 44% participated often, 19% participated once in a while and 7% participated when less busy. Lack of relevant information can make farmers defer adoption till they are well disposed to utilize the information. Although some farmers noted that 'seeing-is-believing' others asserted that information were not adequate for immediate utilization. Hence they waited till they observed outcome from fellow farmers. Such attitudes were aimed at risks reduction. Membership participation in cooperative activities was statistically significant (χ^2 72.8, $d.f$ 3, and p<0.001), implying that farmers derived ample benefits in cooperative activities. Although participation in meetings was not mandatory in principle, notwithstanding, farmers actively participated in cooperative meetings, seminars and other activities.

Approach Necessary for Biotech Information Dissemination and Increased Level of Trust

The level of trust on information content and source is central to decision making. Every (normal and well-informed) individual makes rational choices. Adoption decision is a complex process and sometimes cyclic, it cannot be significantly explained and understood by a single concept. Reasons being that human beings are sometimes unpredictable as well as the environment they live in. When farmers adopt the position of 'seeing-is-believing', there is a modicum of trust principle. Majority of farmers noted that they became aware of some of the innovations they were using through cooperative activities. Opinion/ideas from cooperative leaders in some cases had more impact on members than the contrary. Farmers adhered to decision of the leaders because they (leaders) have been proved capable of representing members' interests. Extension agents (EAs) were in some instances regarded as representing government interests. Due to failed promises from government, farmers sometimes demonstrated less trust on EAs. Ostensibly, farmers' decisions were shaped by the ideologies of cooperative leaders. Farmers are more apt to believe and apply information content depending on the reliability of information sources over time. Trust is very necessary considering resource availability and optional usage. New technologies were sometimes tried on group farms to spread risks. When individual farmer however comes across an innovation, they are not allowed to try it on the group farm but in the farmer's personal field. The more the farmer possessed alternative resources to make allowance for risks, the more the willingness to try new products. Results indicated that 61% would be willing to adopt biotech if it is disseminated through cooperatives. Among these category, 51% were cooperative members, 10.1% were non-members.

However, 32.4% opted to seek further information before accepting the innovation. This was linked to low awareness of biotech/GMOs, 6% indicated that maybe they would accept it, only 0.9% were not sure if they would accept or not. The Chi-square test was highly statistically significant (χ^2 55.40, *d.f* 3, and $p<0.001$), indicating that disseminating biotechnology through cooperatives will receive wider coverage, more acceptance and trust rating than through other channels.

Making Sense of Biotechnology Information Dissemination

Studies have revealed that cooperative participation played significant roles in adoption process. Faturoti, Agwu, Igbokwe, and Tekouano (2008) and Nielsen (2001) have demonstrated how peer farmers' influence affected innovation adoption. When innovations have been adopted by a cooperative member and the knowledge shared with other members, it spreads more rapidly. Various information sources existed in the study areas. The major ones were cooperatives, extension agents, family members, marketing agents and research institutions. Among those who adopted recently recommended innovations, about two-third became aware of the innovation through cooperatives, 45% were through extension agents, 30% were through village leaders (some village leaders were also cooperative leaders), while 1.9% and 1.6% became aware through government agents and marketing agents respectively.

Farmers noted they will accept any sustainable innovation recommended to them by cooperative members. A correlation analysis between acceptance of innovation and awareness source of recently adopted innovations is illustrated in Table 6. The strong positive correlation between accepted/adopted innovations and awareness source of recently adopted innovation indicate that those who became aware of new technologies from cooperatives trusted the information as reliable (r 0.85, $p<0.001$, 2-tailed). A medium correlation existed between acceptance of recommended innovation and awareness from extension agents (r 0.37, $p<0.001$, 2-tailed). As envisaged, there was no correlation between acceptance of recommended innovation and awareness from government agents or marketing agents. The implication of these results is that farmers trusted information that emanated from cooperatives more than other sources. Biotechnology information disseminated through cooperatives will evolve higher level of trust than when such information is emanating from an entirely outside sources. Moreover, biotechnology information will also spread faster.

Table 6. Correlation analysis between acceptance and awareness sources (n=1120).

	Source of recently adopted innovation				
Adopted innovation	**1**	**2**	**3**	**4**	**5**
1	1.0				
2	$.85^{***}$				
3	$.04^{n.s}$	$.03^{n.s}$			
4	$.37^{***}$	$.31^{***}$	$.01^{*}$		
5	$-.03^{n.s}$	$.01^{n.s}$	$.09^{*}$	$.5^{n.s}$	1.00

*** = Significant at 1%, * = significant at 10% (2-tailed respectively), $^{n.s}$ = not significant

(Where 1 adopted recommended innovation, 2 cooperative members, 3 government agents, 4 extension agents, 5 marketing agents)

Conclusion

Adoption of biotechnology poses a lot of dilemma especially in developing countries due to the controversies it has garnered. Farmers face severe constraints and hence, would welcome any sustainable innovation capable of reducing production and marketing constraints. However, farmers are also cautious about which innovation to adopt based on risk factor and resource availability. Conversely, the intention(s) of foreign-based seed companies may not be fully understood by farmers. Such factors also increase risk and uncertainty perception, which consequently increases transaction cost based on diffusion time. This scenario is capable of lowering any perceived benefits of biotechnology. Farmers perceive information content differently because they may have already formed expectation and priority opinions. When expectations conflicts with information content of the new technology, farmers select which information to listen to or receive the information but decline actual implementation. Farmers do not always choose alone, hence the success or failure of neighbors or group members can shape the next action concerning an innovation. Cooperatives therefore can act as proxies. In the study areas, several innovations have been disseminated through cooperatives while cooperative membership and participation keeps increasing. Disseminating biotechnology information through cooperatives in the adoption process will tend to accomplish a wider coverage per time since majority of the cooperatives are operational in various states of the federation and cuts across religion, gender and ethnicity. Cooperatives will serve as innovators and early adopters, whose benefits will be observed by other farmers. The overall consequence is to eliminate fears and uncertainties capable of resulting into rejection of biotechnology based on wrong percep-

tion by local farmers. Finally, it will ensure that farmers in developing countries are partakers in decision making and implementation of the innovation in reasonable terms. This will evoke a sense of trust, sense of belonging and readiness to adopt biotechnology as information sharing will tend to lower risk perception.

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