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Growing Capacity for Agricultural Biotechnology: Role of Traditional ICT Tools in Nigerian Agricultural Research System

Dr. Thomas ADISA[1], Toluwani IBITOLA[2] & Jacob HUNDU[3]

FCAHPT, National Veterinary Research Institute, Vom

Abstract

Purpose: *The study investigated the role of traditional information and communication technologies in the development of national capacity for agricultural biotechnology.*

Design/Methodology/Approach: *The population of the study was 148 scientists in National Agricultural Research Institutions who use biotechnology applications for research. Multistage sampling was used to select 148 scientists. Both primary and secondary data were utilized in the study. A structured questionnaire was administered to the respondents containing a standard list of traditional information sources and a list of biotechnology related activities. Scientists indicated the sources of information they utilized for research and the kinds of activities they participated in.*

Findings: *Results from the survey showed that journals (55.3%) were the most frequently used source of biotechnology information followed by technical reports (35.3%) while telephones (30.4%) and radios (15.5%) were the least consulted. Regression analysis results showed that sourcing information from seminars ($p<0.05$), workshops ($p<0.05$) and magazines ($p<0.05$) contributed significantly to scientists participation in agricultural biotechnology research and related activities.*

Implication: *The study concluded that Nigeria and other peer developing systems can maximize the benefits of biotechnology in ensuring and securing food for their growing populations through sustained investment in traditional and modern information and communication infrastructure.*

Originality/Value: The study recommends a sustained investment in traditional and modern information and communication infrastructure.

Key words: Capacity, information, biotechnology, communication, traditional

Paper type*: Empirical research*

Introduction

Within this century the world is faced with more and more complex challenges of feeding its rising population, while assuring an equitable and sustainable development. Scientific and technological advancement is generating the knowledge and tools to make this possible (Saidu, Clarkson, Adamu, Mohammed and Jibo, 2017) The recent scientific revolution that is taking place at the turn of the century based on the emergence of the latest areas of science, namely in molecular

production and information and communication technology, is most important to the growing significance of knowledge in present day agriculture and natural resource management. Knowledge has turned out to be the most important factor of the production, and it plays a critical part in our capacity to respond to the challenges of the food security, poverty eradication, weather patterns and soil conditions change. Current information allows farmers to deal with and even benefit from these changes. The appearance of Information and Communication Technologies (ICT) in the last decade has opened new avenues in knowledge management that could play significant roles in meeting the prevailing challenges related to sharing, exchanging, and disseminating knowledge and technologies. ICT allows capitalizing to a great degree on the wealth of information and knowledge available for agricultural technology. The main intents of agricultural innovation systems are to come up with outcomes that can advance research in critical areas, and engender technologies that stakeholders can make use of

to increase production while conserving the environment.

According to ADB cited in Abdulsalam, Olaifa and Frederick (2016), ICT has turned out to be a powerful tool in providing developing countries with unprecedented opportunities to meet very important goals far more effectively than before. ICT has also helped in giving farmers access to a variety of information sources, which are accessible, affordable, relevant and effective. This development reflects a need for alternative sources of information rather than a face- to-face, technology-driven donor promoted information service. ICT is known for attaining and transferring information more effectively than other communication methods in extension. This is evident in its impact in extension, especially in developing countries in Africa, South Africa and Latin America. Traditional ICT's can provide the much needed backbone to modern communication tools in ensuring stability in both generation and dissemination of agricultural biotechnologies hence intensifying and sustaining such impact.

The sustainable development of agricultural biotechnology is a function of the efficiency with which accurate and timely information is available to key actors in its evolution and deployment. Indications are that accurate and timely information is not adequately available among stakeholders. For example information on how much agricultural biotechnology research is conducted around the world is very limited (Brinkerhoff, 2000). The mechanism for effective dissemination of agricultural biotechnology information must be an integral component in overall agricultural biotechnology research and development process. The assertion by BIO–EARN, (2002) is that successful biotechnology transfer and application will depend on access to information. The strategy should be to create awareness on benefits of biotechnology before public opinion is captured by negative information from other sources.

Apart from the necessity of information as a tool for shaping public opinion about agricultural biotechnology, it is the engine that will drive and direct the adoption process of end product of research. In the opinion of Adekoya and Oladele, (2008), information, from which ever source often marks the beginning of a train of thoughts which build upon the capacity and tendency of the target audience. While it may not be sufficient enough to motivate adoption, especially in situations where the motivation touches on belief and value system (as is the case with biotechnology), information delivery stands out as the vehicle through which findings can get to interested groups such a policy makers, end users and development planners.

ICT's in agricultural biotechnology information dissemination

Information and Communication Technologies (ICTS's) have been identified as very important sources of agricultural biotechnology information. FARA (2006) however reported that while most of the National Agricultural Research Institutions (NARI's) have some ICT and Science and Technology Information (STI) capabilities and the majority of scientists claim to be able to access technical information from electronic sources (including the internet), the efficiency of connectivity is seriously constrained by several problems. Some of the easily identifiable connectivity challenges include the following:

Agricultural biotechnology research information

i. Internet at the NARI's is generally unreliable due to poor services from local internet providers.

ii. Narrow bandwidth, making access slow and tedious.

iii. Insufficient numbers of scientist having direct access to internet services at their working desks. Most scientists depend on cyber-café to search the internet for information.

iv. Inadequate supply of up-to-date computers for research scientists.

Information is the key element in determining perceptions about agricultural biotechnology. Oladele and Akinsorotan (2007) found out that a significant relationship exists between sources from which such information is obtained and perceptions about the technology. This position is corroborated by Aerni, (2001) who pointed out that an individual's perception of the risks and benefits of a new technology is a very complex process, determined by the selected sources of information, interest and personal experiences. In the case of agricultural biotechnology, most people cannot count on personal experience, but must rely entirely on information they receive. Their sources of information can be rumors, experience of experts in the field, statements by industry, government, public interest groups or the academia and most importantly, media reports.

Alhassan (2003) places the responsibility for accurate perception of agricultural biotechnology on adequate public awareness about the technology, proposing the following options:

i. Assisting the media through contribution of feature articles

ii. Organizing special biotechnology and biosafety workshop

iii. Sponsoring programmes on radio, television,

iv. Writing texts of documentaries for filming by the media.

v. Sponsoring documentaries through cash payment or provision of equipment.

vi. NGO's that play advocacy role for biotechnology should be encouraged through sponsorship for their activities

In addition to the circulation of information within research circles, Mathews-Njoku and Adesope (2008) underscored the need for extension to assume a pivotal role in the proper dissemination of information about agricultural biotechnology and educating farmers to adopt research products for more farm output, further stating that there is need for both public and private investments into research for the dissemination of biotechnology information.

The potentials for the ease of dissemination of biotechnology information as identified by Pray and Naseem (2003) is in the fact that new information resulting from research is typically endowed with the attributes of a public good, characterized by *non-rivalness* or *jointness* in supply and use and non-excludability. An important exception as identified by Bientema and Stads, (2004), is in the case of private actors in agricultural biotechnology research who are reluctant to provide information on their activities.

Information and capacity building in National Agricultural Research Systems

Capacity building in an organization is not a spontaneous thing. It has to be an integral component of the policies that underpin mechanisms for attaining organizational objectives and it has a dynamic flow of information at its core. According to FARA, (2006), five major areas of need to be targeted to significantly improve the capacity and efficiency of NARI's:

vii. NARI's activities in biotechnology should organize periodical tour of schools to sensitize and demystify the technology

viii. Farmer organizations should benefit from public enlightenment activities.

v. Extension services have been identified as an integral element in shaping public perception about agricultural biotechnology.

Information access through formal and informal networks

A rather vital source of research information identified by Sheridan, (1998) is informal networks. Participation in these networks influences access to cutting edge information, resources, opportunities to publish and collaborate, and forum for decision making on important matters like hiring, research directions and resources allocation for research. This is particularly important for agricultural biotechnology research in view of its novel status in the world of life sciences.

i. Developing NARI's capacity for priority setting and linking resource allocation to priority research;

ii. Upgrading the technical skills and human-resource management of NARI's through sustained training programme, severing NARI's from civil service policies and procedures, and introducing performance based human resources incentive and management systems;

iii. Developing information technology to link NARI's to external scientific information networks;

iv. Establishing efficient internal management information systems;

v. Introducing systematic scientific external reviews and evaluation, and strengthening monitoring and evaluation systems to track the efficiency of outputs and impacts.

Of the five elements in the capacity building recipe for NARI's, three of them focus majorly on strengthening the framework for effective information management. This underscores the central role of information and communication in building an effective research system. Having established this pivotal role that information and communication play in the development of a virile research sector, it becomes important to explicitly identify some of the traditional sources and examine how important they are in the dynamics of evolving an effective research system. This study therefore looked at role traditional information and

communication sources in the Nigeria National Agricultural Research System (NARS). The following specific objectives guided the research:

i. Identification of biotechnology research activities in the NARS

ii. Identification of information sources for biotechnology in the NARS

iii. Determining the effect of sources of information on the research activities of scientists.

Methodology

The population of the study is scientists in National Agricultural Research Institutes (NARI's), Faculties of Agriculture, and Faculties of Veterinary Medicine in Nigerian universities who are participating in the use of agricultural biotechnology applications for research. These are individuals in the employ of these institutions with responsibility for research activities that utilize agricultural biotechnology applications.

Multistage sampling was used to draw samples from both Universities and National Agricultural Research Institutes. Two Federal universities, two state universities, A Federal University of Agriculture and a Federal University of Technology were selected from a list universities. Forty three scientists were purposively selected from the faculties of agriculture and veterinary medicine in these universities, based on participation in agricultural biotechnology research. Nine research institutes were purposively selected based on their mandate. A total of 105 scientists were purposively selected from the research institutes, based on their participation in agricultural biotechnology research. The total number of respondents from the selected both universities and research institutes amounted to 148 scientists.

Both primary and secondary data were utilized in the study. To obtain primary data on information sources for biotechnology research, a structured questionnaire was administered to the respondents containing a list of traditional information sources (adopted and adapted from Alhassan (2001)). Some important of the sources of agricultural research information included journals, newsletters, magazines textbooks, internet, workshops, conferences, and seminars. A list of these sources of information was presented to scientists and they were asked to indicate their frequency of utilization of these information sources for agricultural biotechnology research. The results were classified into electronic sources, consisting internet, TV, Radio and telephone; printed sources, consisting journals, newsletters, technical reports, newspaper, magazines and textbooks, and technical forums consisting workshops, conference and seminars. A list of biotechnology applications was also provided and scientist were required to indicate procedures or applications they utilized for research. Secondary data were obtained from books, journal and other documented sources. Data were analyzed using descriptive and inferential statistics, which included frequencies, percentages and simple regression.

Results and discussion

Electronic sources of Information

Researchers and other developers of new technologies in agriculture face the issue of how to promote uptake of their innovations (Sousa, Nicolay and Homes, 2016) Electronic sources constitute a vital resource for information sourcing and dissemination on agricultural biotechnology. Table 1 shows that researchers frequently used the internet (38.7%), radio (24.0%) and Television (19.3%). Apart from the internet, which provided access to technical information and scientific report on agricultural biotechnology, radio and television are sources of reports and updates about breakthroughs in the field of biotechnology. The International Bank for Reconstruction and Development (2000) had observed that Africa missed out on industrial expansion and now risks being excluded from the global information revolution. While the radio and television have developed considerably in Nigeria, the internet is still being developed. The versatility of the internet and its universal content and reach makes its development an unavoidable condition for growing a strong information backbone for national agricultural research.

Printed sources of Information

Formal, technical sources of information for scientists in agricultural biotechnology research included journals, often used by 55.3% of scientist and occasionally use by 40.7%. technical reports, often used by 35.3% of respondents and occasionally by 52.6%, newsletters often used by 30.7% and occasionally by 62.7% ,textbooks, often used by 56.7 and occasionally by 32.0%. This category of sources of information can be considered as traditional. Information has received a wide range of acceptance as an essential resource of this century. It has been described as a simulating creativity, resulting in new outcomes and processes (Adio, Abu, Yusuf and Nansoh 2016) These identified

sources are relevant for performance of scientists and are often used as basis for comparison or further research work. Other rather non-technical print media for agricultural biotechnology information included newspapers, often used by 30.7% and occasionally by 56.7% and magazines often used by 30.7% and occasionally by 59.4% of scientists. Oladele and Akinsorotan (2007) established significant correlation between scientists awareness about GMO`s and their patronage of newspapers for agricultural biotechnology information. While these sources may not contain information with depth in terms of technicality they serve as media for disseminating research results and stimulating interest for further research. Newspapers also provide a forum for advocacy activities in agricultural biotechnology research and development.

Table 1: Sources of information for agricultural biotechnology research

Sources of information	Frequency/ percentages		
	Often	**Occasionally**	**Never**
Journals	83(55.3)	61(40.7)	4(2.7)
Newsletters	46(30.7)	94(62.7)	8(5.4)
Technical reports	53(35.3)	79(52.6)	16(10.8)
Newspaper	46(30.7)	85(56.7)	17(11.5)
Magazines	46(30.7)	89(59.4)	13(8.8)
Textbooks	85(56.7)	48(32.0)	15(10.1)
Telephones	21(14.0)	82(54.7)	45(30.4)
Internet	58(38.7)	67(44.7)	23(15.5)
TV	29(19.3)	100(66.7)	19(12.8)
Radio	36(24.0)	87(58.0)	25(16.9)
Workshops	32(21.3)	102(68.0)	14(9.5)
Conferences	37(24.7)	97(64.7)	14(9.5)
Seminars	50(33.8)	88(58.7)	10(6.8)

Technical Forums

Workshops, Conferences and seminars provide fora where scientists, whether from the National Agricultural Research Institutes or universities can meet to exchange notes and information on agricultural biotechnology. Table 5.15 shows that 21.3%, 24.7% and 33.8% of respondents often use workshops, conferences and seminars as regular fora to source information about agricultural biotechnology respectively. In addition to being, sources of information, these fora provide a platform for scientists to also publicize their research activities. Michelsen, *et al* (2003) suggested that opening up seminars and workshops in universities and NARIs to a much wider public participation will allow for better participation. Such participatory approach in sharing of information in agricultural biotechnology will promote problem solving and enhance the adoption and use of the products of research. Lee (2017) took it further by observing that levels of stakeholders' endowment of accessible information and resources discriminate their participation and this could be an important factor to their output.

Table 2: Agricultural biotechnology applications and related research activities

Activities	Frequency	Percentage
Fermentation	74	50.2
Artificial insemination	37	25
Development of biofertilizers (pulses and cereals)	47	31.8
Tissue culture	62	48.6
Application of In-vitro techniques for breeding	47	31.8
Ethnoveterinary vaccines	34	23
Application of DNA maker techniques	48	32.5
multiplication of livestock/plant materials	82	54.9

Field trials of biotechnology products	73	49.3
Genetic modification	52	35.3
Journal paper article on agrobiotechnology	97	65.5
Newsletter publication	84	56.7
Extension bulletin on agrobiotechnology	74	50.1
Advocacy/opinion article in Newspaper/magazine	76	51.4
Participation in exhibition of biotechnology products	70	46.9
Radio/Television programmes on agrobiotechnology	70	46.9
Field demonstrations on agrobiotechnology	66	44.7
Conferences/Workshops on biotechnology	100	67.6
Seminars	115	77.7
Special courses in biotechnology	65	44
Securing of patent rights	40	26.8
Grant aided projects in biotechnology	41	27.7
Input in national planning on agrobiotechnology	44	29.8

N=148

Regression analysis showed that only participation in biotechnology related workshops ($p<.05$) seminars ($p<.05$) and use of biotechnology magazines ($p<.05$) significantly influenced participation in the use of applications and related activities. The active and engaging nature of workshops and seminars could be the likely reasons for their effect on the scientists. Magazines on the other hand are characterized by current and topical content. This it is expected could stimulate participation.

Table 3: Regression analysis of sources of information and scientist's participation in agricultural biotechnology

Model	Unstandardized coefficients B	Std. Error	Standardized coefficients Beta	T	Sig.
(Constant)	55.501	3.098		17.914	.000
Journals	-.018	1.801	-.001	-.010	.992
Newsletters	1.495	1.653	.094	.904	.368
technical reports	-1.176	1.121	-.097	-1.049	.296
Newspaper	.241	1.282	.019	.188	.851
Magazines	-2.759	1.355	-.190	-2.037	.044*
Textbooks	-1.022	.996	-.087	-1.026	.307
Telephones	-1.358	.845	-.145	-1.608	.110
Emails	.367	.979	.036	.375	.708
TV	2.249	1.541	.173	1.460	.147
Radio	-1.853	1.243	-.169	-1.490	.139
Workshops	-3.841	1.864	-.266	-2.060	.041*
Conferences	.121	1.958	.009	.062	.951
Seminars	-2.643	1.235	-.221	-2.141	.034*

$p< 0.05$

Conclusion

Agricultural biotechnology is as dynamic as it is versatile. The demand for accurate and timely information is *sine qua non* to developing adequate national capacity for scientists to be active players in its utilization. While traditional information and communication tools were found to contribute significantly to it development, a virile national capacity can only come about through investment in strengthening these sources alongside modern communication options like enhanced access to the internet. Nigeria and other peer developing systems can maximize the benefits of biotechnology in ensuring and securing food for their growing populations through sustained investment in traditional and modern information and communication infrastructure. Researchers on the other hand can leverage on the availability of formal

scientific communication platforms like seminars, scientific conferences and workshops to access information on emerging trends in the field of agricultural biotechnology.

Recommendations

The study recommends that Sustainability as a key requirement for the successful use of ICT should be encouraged by providing adequate ICT infrastructure, qualified personnel, and constant/adequate power supply at all levels. Additionally, adequate bandwidth for internet service should be provided from a reliable Internet Service Providers. Moreover, harmonized information and Communication Technology curriculum should be introduced at all level of education. This can be achieved through production of handbooks on different communication tools.

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