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Issues and Prospects of Agricultural Technology Development and Dissemination Systems in Nigeria

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ABSTRACT
The issues and prospects of agricultural technology development and transfer systems in Nigeria continue to raise attention of consumers and users of agricultural innovations in the country. It is believed that the development, transfer and utilization of relevant agricultural technologies are very important and sustainable ways of improving the productivity of farmers and increasing food production. However, it has been observed that there is low agricultural productivity in the country which has been attributed to low or non-adoption of developed agricultural technologies by famers in the country. Nigeria agricultural technology development/transfer system is still rudimentary in character and traditional in expected accomplishments and observers see this as largely due to poor funding of agricultural research. Current levels of agricultural production and agricultural resource productivity in Nigeria show that there is a large need for improvement, *This paper, therefore, examined some different agricultural strategies or approaches the agricultural sector in Nigeria has used in technology development and transfer to increase production. The process is still top-down, which has resulted in development of technologies that neither meet the farmers' needs nor address their production constraints. It was recommended that the farmers should be involved at every stage of technology development for increased production.*

Keywords: Prospects, agricultural technology, development, dissemination systems.

INTRODUCTION

Agricultural technology may be defined as the application of technology for development and promotion of agriculture. Research. institutes are the sources of technical innovations, whereas extension body transfers these innovations/ technologies to the farmers for adoption to take place. The adoption and utilization of the technologies proved the appropriateness of the technologies (Enin (2011, Ironkwe, 2011). The population pressure in Nigeria, accompanied by high demand for food and agricultural products, has necessitated the need for increased and sustainable agricultural production to meet the demand for local consumption and export

market. The foundation for sustainable agriculture is enhancement and maintenance of productive potentials of the farmers, and the development and diffusion of appropriate or relevant agricultural technologies that meet the farmers needs and also suitable for their environments. Hence, sustainable agriculture depends on availability of appropriate technologies generated and promoted by research in collaboration with extension and farmers to improve productivity with emphasis on increased food supply at the rural level (Chukwu, 2007). Adoption and utilization of appropriate agricultural technologies by farmers are also necessary requirements for sustainable agricultural development. Therefore, technology development, transfer and utilization become important factors that should be considered if agricultural production is to be enhanced and sustained to combat the recent global food crisis.

The concept of Agricultural technology or Innovation

Agricultural technology and innovation are almost the same and they are always used interchangeably but for clarity and proper understanding, the following definitions and descriptions are given on both in this context. Technology is globally recognized as a power key and major ingredient for socio-economic development of any nation. It encompassed all skill, knowledge, processes, procedures or methods used to carry out man's activities. Technology is also the basis of development, a product of research, which can emanate from any knowledge area, be it physical, biological, social or economical. Technology being a means to material self-improvement is a critical factor in the growth and development of national agricultural sector. This explains why the technology meant for increased production should be based on the needs and problems of all the clients involved in the production process. It is also expected to be economically viable, affordable, practicable, feasible and available to all the end users for it to be easily adopted to increase production (Unamma, *et al*., 2004). Based on this fact, the purpose of technology development and transfer, which is to improve living conditions, would be accomplished. In the same manner, it would also generate opportunities for people to make a livelihood and improve their standard of living.

An innovation may be defined as a new idea, practice, method or technique which provides the means of achieving sustainable increase in farm productivity and income. It is also an idea, practice or object perceived as new by an individual. These innovations or technologies are mostly developed in research institutes and then transferred by the extension agents to the farmers for adoption to increase production. It is the perceived or subjective newness of the idea for the individual that determine his/her reaction to it. Therefore, the characteristics of innovations as sensed by the receivers (farmers) contribute to their different rate of adoption and sustainability. pointed out that the innovations that are usually adopted most rapidly are the ones with the following characteristics:

- have a high relative advantage for the farmer,
- are compatible with his values, experience and needs
- are not complex
- can be tried first on small scale and
- are easy to observe

In addition, the appropriateness of the technology has a lot of influence in determining its adoption. The technology has to be timely to address the needs and problems of the farmers for easy adoption. These characteristics are better determined by the farmers themselves if they are involved in the technology development process to make adoption easy and sustainability possible for increased productivity.

Technology development and Transfer Processes

Technology development is regarded as the result of aggregated knowledge that accumulates over a period of time and sieved for the substance, which eventually is used to solve problems of basic needs that will make life better for the users (Chukwu, 2007). The purpose of technology development is to improve living conditions and in the process generate opportunities for people to make a livelihood and improve their standard of living. Therefore, technology development

and transfer processes are considered to be primary driving forces for growth and welfare in developing countries (Balakrishnan, 2004). However, in any given economy.

Nigeria presently, agricultural research institutes and universities of agriculture are responsible for generation and development of improved and relevant agricultural technologies/ innovations on various crops grown, and animals reared in the country to increase food production and income of the farmers. The extension agencies, on the other hand, help in transferring developed technologies to the farmers for adoption. The input agencies act as supporting system by providing inputs and marketing channels to the farmers. The active participation of the farmers in the whole process is very important. This will give room for adequate consideration of the farmers' concerns and their environments, provide opportunity for exchange of ideals and contributions and offer the farmers the sense of belonging. This will help to make the outcome relevant for the farmers to adopt for increased productivity.

Often time, the specific steps of technology development depend on the underlying technology while the developed technology must be appropriate and relevant to the end users for it to be easily adopted. However, in Nigeria the generation and development of new and improved technologies are the combine responsibilities of the research and extension agencies both national and international. The development of technologies is supposed to be based on the identified farmers' production needs and constraints for it to be appropriate and relevant. An appropriate technology developed is then made available to the end users for adoption and utilization through the transfer process. Therefore, the development of appropriate technology requires the cooperation and collaboration of the research and extension agencies for dissemination to the end users who are generally resources-constrained farmers Ekwe (2004)

On the other hand, technology transfer is a process encompassing various elements such as hard ware, technique, human ware organization and the final output. It is the stage in development of a technology or process in which operational personnel learn about the technology, commit to it, and develop procedures for operational-scale application. Transfer of agricultural technology is therefore, an expression that suggests a whole range of forms through which technology knowledge is transmitted from suppliers to recipients. Technology transfer implies that the recipients of the transfer acquire technical knowledge that underlies formulae, design and production systems Agricultural technology transfer is therefore a process with multiple functions which include information, teaching, technology supply and technology service (Madukwe *et al.,* 2000).

It is the entire process of moving an agricultural technology from source to the farmers. Transferring implies conveying information and advice regarding the adoption of technologies and practices. Four major elements are critical in an agricultural technology transfer process. First is the identification of the problems and needs of potential end users. Second, is the testing and adaptation of new technologies to the local environment of the end users. Third is the existence of government or official regulations to provide a decision mechanism for the approval and release of new technologies to users. Fourth is the effective operation of the communication process for ensuring that approved technology are passed on the users, where applicable, through the extension services system. These steps are good in technology development if well managed but the critical question is, are the farmers, whose interests are said to be targeted, involved in the process?

A proper examination of the above mentioned steps clearly revealed that the technologies are being developed outside the farmers' environment, without their contributions, and then taken to them for adoption to increase their production. The exact process of transferring technologies from the developer to the end user is demonstrated in Figure 1.

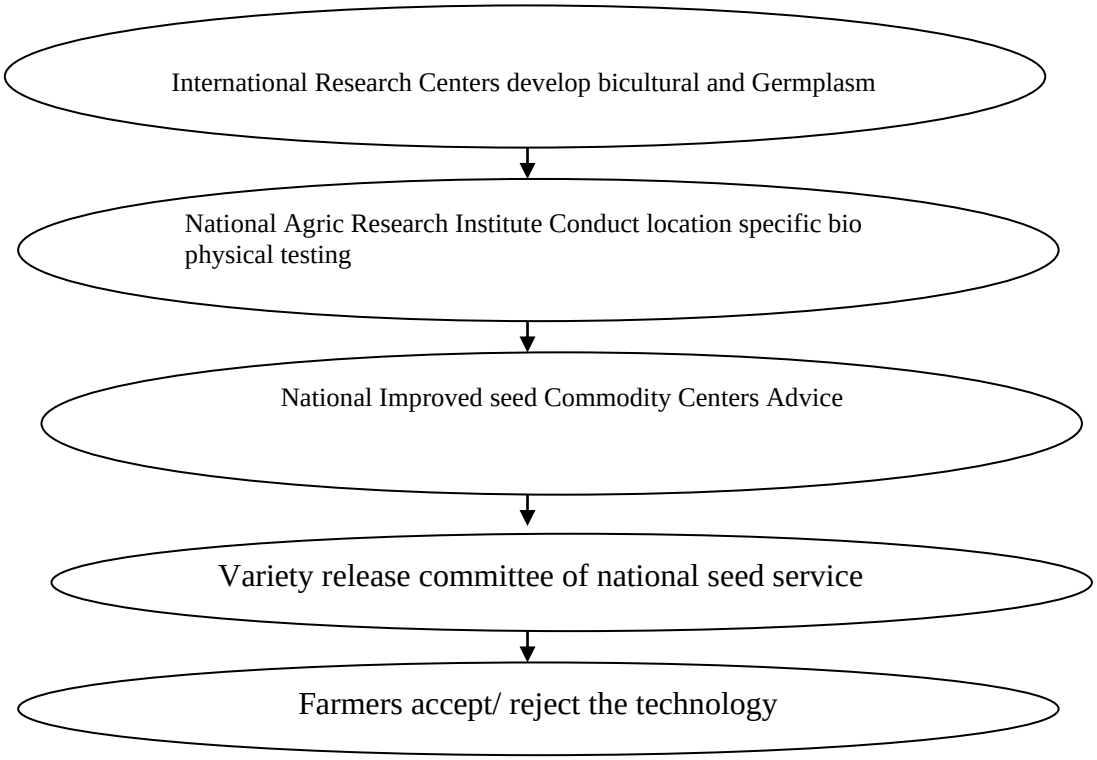

Fig 1: Process of Agricultural Technology Transfer From developers to Farmers in Nigeria source: Ikpi (2002)

According to Madukwe *et al* (2000), Agricultural Development Programme (ADP) is the extension agency with the major responsibility for agricultural technology transfer in Nigeria. The transfer of developed technologies and technical information to farmers is therefore the major role of the extension agencies. These agencies carry out their role by receiving technologies from the research institutes and sending them to farmers for adoption and then bring to the research institutes the farmers' responses. Therefore, the extension agencies perform three basic functions of informing, teaching and advising the farmers on the uses of new technologies. The farmers, on their own sides act as clients in using the developed technologies transferred to them. The relevance of developed agricultural technologies can be determined when they are properly adopted by end-users to increase their productivities. The input/marketing agencies, on their own part act as a support system in producing the necessary inputs and providing appropriate marketing channels to help the farmers avail themselves of the opportunity of adopting the new improved technologies to increase their production and income. Actually, adoption of improved technologies would eventually leads to increased agricultural productivity and higher income to the farmers. Such adoption could lower the prices paid by consumers for agricultural products and generate greater economic efficiency and overall growth in the national economy. However, the effectiveness of this system and the sustainability of the outcome is dependent on the technology development model or approaches being used.

Technology development models/strategies or approaches

The low productivity resulting from low or non-adoption of developed agricultural technologies by farmers is one of the issues that has been of great concern in the last two decades to government and agricultural scientists in Nigeria. The reason for the low adoption of agricultural technologies has been attributed to non involvement of farmers of all categories in the development and transfer of these technologies. Over the years, several technology development and transfer approaches have been adopted to find a way of bringing the farmers closer to research to enhance adoption to increase agricultural production in Nigeria. Among these are:

a) Tradition linear

b) Participatory and development

Some models have also been employed in the past to address the same problem. Unamma *et al.,* (2004) identified various technology generation models or strategies with a new proposal for a new model to focus on the farmers' participation in technology development and transfer. Such models as Technology demonstrate model, Research - farmer linkage model, FSR&E model and REFILS model. All these approaches and models are discussed below accordingly, but the differences depend on levels of farmers' involvement in the process and the success recorded to increase adoption.

Traditional linear approach

This approach to technology generation, transfer and adoption was top-down in nature in that the information flowed from top to down. Here researchers from research institutes, identified and prioritized production constraints, independent of the farmers, and subsequently developed solutions to those constraints (Schluz, 2000). Hence, research was largely initiated and conducted without farmers' participation and due consideration of their environments. The developed solutions were then handed over to extension services for dissemination to farmers, who either used or rejected the technologies. Here, there was no interaction between farmers, research and extension. The farmers could not influence the process of problem identification and technology generation. This approach therefore was unsuitable as the researchers did not know or consider the conditions and environments of the farmers (Unamma *et al.,* 2004). Even though the approach made research procedures easier and less expensive, the technologies developed were not relevant to the needs of the farmers and were unacceptable to them, hence the low adoption and persistent low productivity observed in the farmers fields. The short coming of the traditional approach required new client-oriented approaches, for agricultural research and development. Therefore, from the early 1980s on-ward farmer centered participatory approaches were advocated for, with the aim of increasing adoption and improving the livelihood of resource poor farmers (Schluz, 2000).

Participatory research and development approach

In this approach, there was a direct link between research, extension and farmers. The process was client-oriented and centered on identifying and solving farmers' problems (Unamma, 2002). The objective of this approach was to have research work with the extension to identify, incorporate with farmers, acceptable new farming practices and materials that would improve the farmers' systems and raise their productivity in a sustainable way (Unamma *et al.,* 2004). The farmers participated in the research processes starting from problem identification to adoption and evaluation (Schluz, 2000). Nevertheless, the farmers had problem with input supply. This situation made adoption of most of the relevant technologies difficult, resulting in the amalgamation of farming systems research and training and visit (T&V) (Unamma, 2002).

Technology Demonstration System (TDS)

Here the research sub-system conducted research and reported, published or presented their findings. It did not matter to them whether or not the clientele benefit from the findings. The assumption was that the transfer sub-system would collect such publications or reports, interpret the results, reduce the content to a level that they felt was suitable for the farmer and then take them to the farmers for adoption. In some cases, they would train the farmers on the technologies through result demonstration approach. Generally the technologies offered to the farmers came from a top-down approach. Farmers were not involved in the development and transfer process. The technologies developed were unsuitable because the researchers did not know or consider the conditions and the environment of the farmers. Hence, there was non-adoption of these technologies because they were neither relevant to the needs and problems of the farmers nor suitable to their farming system, consequently agricultural productivity remained low and income of the farmers was minimal (Unamma *et al.,* 2004). The solution then was to develop an efficient technology development and transfer model that would involve the farmers in the process to increase adoption and this led to the development of Research-Farmer Linkage model.

Research-Farmer Linkage model

Here attempt was made to take research closer to the farmers as a way of improving upon the linkage system and addressing the problem of limited adoption of research findings. In this approach, research was designed at research institutes and taken to the farmers' fields without considering farmers' farming system, environment and farmers' opinions. This approach was still top–down as the farmers were involved to some extent while extension was in adequately involved. This resulted to the formation of farming System Research and Extension model (FSR&E) (Unamma *et al*., 2004).

Farming System Research and Extension model (FSR&E)

Research must begin and end with the farmer, the model involves diagnosis to define problems. Interdisciplinary team research to develop potential solutions through on farm and experiments, testing and adaptation of proposed solution to farmers conditions, and farmer evaluation and adaptation of the technology and monitoring of its adoption. The degree of farmer participation and integration between on station is high in this model. The objective of this model was to have research work with extension to identify, in collaboration with farmers, acceptable new farming practices and materials that would improve the farmers' system and raise their productivity in a sustainable way. The approach required testing of innovations under farmers' condition with close monitoring of their profitability and acceptability, rejection of what was not appropriate, modification of what was modifiable (Unamma *et al*., 2004). This approach was to harness resources, men and materials to help farmers identify their production constraints, and find out opportunities for resolving them. By so doing appropriate agricultural production technologies would be generated and effectively diffused among the farming population to facilitate adoption and increase their agricultural productivity and income on a sustainable base (Unamma *et al.,* 2004). This model would be enhanced through organizational development of the human resources of the Research, Extension, Utilization and Supporting Systems with a string articulated and relevant technological backing to provide substantially high quality and relevant services to farmers in a regular and systematic manner.

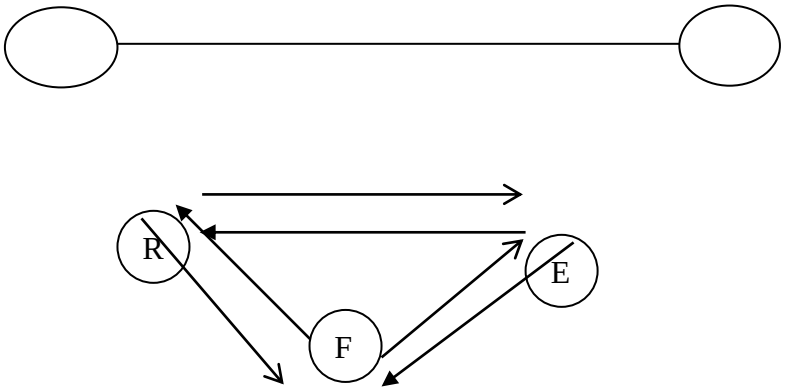

Fig 2: Triangular system of collaboration with institutions

Research, Extension, Farmers, Input Linkage System (REFILS)

This approach is the one currently being used in Nigeria. The process, according to Unamma, *et al.,* (2004), starts and ends with the farmers. This model integrates the efforts of Research, Extension and Farmers in collaboration with input and marketing agencies in the identification of major agricultural production constraints to develop sustainable, technically feasible, economically viable, and socio-culturally acceptable alternative production technologies, which could meet the needs and capabilities of the resource poor farmers without destroying the natural resource base (Unamma *et al.*, 2004). Here, there is a close link between research, extension,

farmers and input/market agencies. The farmers are supposed to have active participation in the research processes starting from problem identification to adoption and evaluation. Because of the close-link that exists among the parties involved in the system, there is room for proper interaction and exchange of ideas and information, active participation and collective responsibility. Unamma regarded this system as an important part of the economic development strategy for countries with large agricultural sector like Nigeria. According to him, it accelerates development by ensuring appropriate technology generation, development, transfer, adoption and utilization. Thus, increased productivity is certain with this type of approach if well organized and managed. The farmers' involvement during some key activities in REFILS model emphases the participatory nature of the strategy and could be summarized as follows:

1. *Exploration and Diagnostic Surveys*: The farmers participate in the identification of their problems and priorities through interacting with the research and extension staff that they conduct around their farms and homes to observe and record what, why, when, how the farmers do what they do and who does what. Thus, the farmers provide the basis for defining research priorities (Unamma *et al*., 2004).
2. *On-farm Applied Research*: A few representative co-operating farmers execute researcher managed, replicated trials to develop prototype technologies by providing plots and labour. They also participate in the selection of the best treatment.
3. **On-farm Adaptive Research**: Several representative contact farmers execute extension-guided, non-replicated trials to adapt the selected prototype technologies using their own inputs.
4. *Mass Diffusion (Using SPAT).* Here a large number of contact groups of farm families spread over large areas, demonstrate the adopted technologies by practicing them with the help of village extension agents in small area or units to decide whether to adopt them or not. They also provide reactions for their decision to help adjust research and extension provide to local condition.

   However, that the assessment of the average yields at farmers' level currently indicated limited adoption of improved technologies as observed by Ekop (2001) meant that there are some problems or lapses with the system, either it is no more being operated as originally planned or there is a gap in the linkage system. These problems might not be unconnected with the non functional performance of the ADPs in the country presently due to lack or poor funding, consequently, the farmers and their environment are no more being properly considered in technology development and transfer processes. Hence, the farmers found it difficult to accept the outcome of such technology development, and this action has resulted to low agricultural productivity observed in the country.

   A lot of factors hindered the process of technology development and transfer systems in Nigeria.. Put together, the major challenges to effective agricultural technology generation in Nigeria relates to inadequate or late release of funds, unfavorable condition of service for staff and inadequate research equipment and facilities (*Nwakor et al, 2015)*

CONCLUSION AND RECOMMENDATIONS

The most obvious role of agricultural research institutes is to generate agricultural innovations that can lead to increased production in farmer's field, and which consequently lead to increased national production, the utilization of these technologies by farmers and other end users is meant to reduce food insecurity and poverty in Nigeria (*Nwakor et al 2016*). From observations so far made, it should be inferred that the technology development and transfer system presently being used in Nigeria is not participatory in nature as the farmers are not being involved at all levels of technology development and transfer processes as to enhance utilization for increased agricultural production in Nigeria. Most of the technologies developed in the country are based on assumption on what should be but not on reality of what exists at the farmers' end. The process is still top-down in nature, which has resulted in development of technologies that neither meet the farmers' needs nor address their production constraints. The REFILS approach/model would have been a better alternative but because of some problems encountered along the way after the withdrawal of the World Bank, made it difficult to operate the system

effectively and efficiently. These problems came as a result of institutional, management, economic and social factors emanating both from the Federal and State governments. The research institutes that are involved in technology development are separate organization under federal government and with different mandates from that of the ADPs that are responsible for technology transfer and which are under the state ministry of agriculture. This makes the system difficult to be run as the former have no control over the latter and the farmers on the other hand have no direct link with the research institutes as to continue in the process. Social system theo**ry** which was advocated by Hawthorn (1981) in Olatunji (2005) stated that the social system is a set of articulated sub-unit linked together to obtain the overall objectives of the system. The theory emphasizes interrelationships among the parts rather than the parts in isolation to each other. This is because each sub-unit cannot have a complete isolation, the emphasis of proponents of social process theory is on the interrelationship among the parts and the need for effective collaboration and participation among parts. The theory insists that it is only when units are properly integrated that organizational goals can be achieved. It is on this premise that the REFILS approach was created for development, transfer and utilization of appropriate agricultural technologies. It advocates for farmers' participatory technology development strategy to enhance adoption and increase production and income of the farmers.

Appropriate or relevant technology therefore, should essentially be a product of combined research efforts of all the stakeholders on participatory basis, involving all the actors in technology development and implementation especially those on the receiving end (farmers) is likely to assure the most efficient allocation of scarce resources and the early identification of inefficient or wasteful use of resources. The inclusion of all the stakeholders particularly farmers in all the processes in technology development would also show them that they are regarded as responsible and capable individuals. In the same vein, without effective participation of all concerned in technology development and implementation, sustainable agriculture might be impossible. Collaborative participation could speed implementation where participants take greater ownership of effort. Based on the above argument, Research suggested a client participatory approach to the generation, evaluation and transfer of technology as this would ensure relevance of technology developed. Ekwe (2004) therefore, added that farmers' participatory technology development enhances involvement, motivation and commitment, the result of which would show high degree of acceptability, ecological appropriateness and sustainability. Unamma (2001) affirmed that adequate and appropriate technologies would enhance rapid utilization by farmers and consequently, empower them to produce more and better quality food and to earn more money. Hence, there is need for participation of the end users in the development and transfer of any agricultural technology for sustainable food production in the country. This could be done by empowering the research institutes in the country to strengthen their extension departments to have direct link with the farmers thereby making their participation in technology development possible and effective. It will also help to make research efforts demand driven and the outcome relevant to increase food production on sustainable manner. Therefore farming system research with the REFILS models should be taken more serious for increased agricultural productivity in Nigeria.

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