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# Agricultural Technology Transfer in Nigeria: A Review of the Challenges and Prospects in the Contemporary Times

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## Abstract

*This paper examines the challenges and prospects associated with the transfer of agricultural technology transfer in Nigeria. Also explored are the relevance of technology transfer and the key roles of its key players along its value chain in Nigeria. Constraints to technology transfer in Nigerian agriculture such as problems related to the nature of the technology (i.e., the nature of the technology, how it functions, and how well it can be utilized by uneducated farmers), the technological transfer system (the procedures used in the technology transfer), socio-economic attributes of farmers (farmers personal characteristics and conditions that predisposes him to adopt any technology) and local peculiarities and differences (the technologies not conforming to farmers local differences and peculiarities) were also examined in the paper. The paper identified emerging advanced technologies like precision agriculture, weather tracking technologies, satellite imaging, agricultural robots and radio frequency identification as the major prospects of technology transfer that are capable of increased productivity and marketability in Nigerian agriculture. Among other recommendations is for government to create an enabling environment for an increased private-sector participation in effective multiplication and dissemination of acceptable production technologies that are affordable to farmers.*

**Keywords:** Technology development, Knowledge transfer, Agricultural research

## Introduction

In developing countries, agricultural technology plays important role in driving growth for smallholder farmers. A crucial component of improving the productivity of farmers and increasing food production is to develop, transfer, and utilize relevant agricultural technologies. There has been a decrease in agricultural productivity in Nigeria as a result of farmers not accessing developed agricultural technology (Farm Square, 2022).

Agricultural technology is an important aspect of modern farming practices in Nigeria, as it helps to improve crop yields, reduce production costs, and increase the overall efficiency of the agricultural sector. Agricultural technology includes a range of

materials, processes, and knowledge. To transfer agricultural technology to end users, different institutional arrangements are needed due to its complexity. Most small-scale farmers operate relatively complex farming systems in each agroecological zone (AEZ) in Nigeria. Consequently, farmers in the different AEZ need access to a wide variety of locally validated technologies if they are to increase their productivity.

Technology is the application of knowledge for practical purposes and it can be classified into two major categories which include material and knowledge-based technology. Material technology involves knowledge that is embodied in a technology product such as tools, equipment, agrochemicals, improved plant varieties or hybrids, and improved breeds of animals. The transfer process for material technology is simpler than training and disseminating technical knowledge and management skills to large numbers of farmers in the country. Knowledge-based technology includes technical knowledge, managerial skills, and other processes that farmers need to successfully grow crops or livestock management practices. (Umar, 2022).

To understand the different roles that research, extension, input supply and other systems actors should play in the technology development and transfer process, it is essential to differentiate between the different categories of technology. Each category follows a different channel as new technology is developed and transferred to farmers. They include crop technology, livestock technology, farming systems, soil and water management practices, farm mechanization, agro-forestry, post-harvest technology, and farm management. These technologies have both hardware and software components. For example, a new crop variety, as a type of material technology cannot be fully exploited without having a complimentary set of agronomic or crop management practices, including pest management. Likewise, improved breeds of livestock generally require higher levels of management, including improved nutrition, housing and preventive health services.

It is important, therefore, that the functional relationship or linkages, both within and across different categories of technology, must be carefully examined in identifying constraints that limit the flow of technology within an Agricultural Technology System (ATS) (UK Essays, 2018). This paper is conceived to review the following aspects of agricultural technology transfer in Nigeria: relevance of technology transfer in Nigeria's agriculture; key players in Nigeria's agricultural technology development & transfer; problems of technology transfer in Nigeria, and; prospects of agricultural technology transfer in Nigeria.

**Relevance of Technology Transfer in Nigeria's Agriculture**

The importance of technology transfer is justified by the fact that farmers are faced with many constraints and opportunities. In addition to being profitable, they need to meet environmental standards and regulations (Umar, 2022). According to Umar (2022), technology transfer remains an important factor in agriculture because of the following:

**i.** The need for technologies that target pests and diseases more precisely:

Technology advances in pest control are expected to continue to produce chemical control agents that are as effective as those released but are less toxic, less persistent and less mobile through the soil.

**ii.** The need for technologies that administer nutrients more efficiently:

Technology must be used to administer fertilizers at the right places, times and amounts to increase crop yields while reducing leaching and runoff of nutrients.

**iii.** The need for technologies that administer water more efficiently:

The technologies used for irrigating crops are old and do not lead to optimum utilization. They are wasteful and evaporate before reaching the root zone. Technical efficiency can be achieved by using accurate measurements of crop needs to deliver water more accurately and at more precise rates.

**iv.** The need for technologies that reduce post-harvest wastage:

The use of technologies to harvest, process, store, transport and distribute farm commodities is expected to reduce post-harvest losses, as every part of crops and animals can be recovered for commercial use. This will result in lower levels of wastage.

**v.** The need for technologies that disseminate information:

The internet provides further development in the dissemination of information on sustainable technologies and since agriculture has become so dynamic, the adoption of new technologies by farmers has become so challenging. Technologies will be needed to take information to the doorstep of farmers in rural areas, especially during times of awareness, emergency, pest infestation, or disease outbreak.

**vi.** The need for farmers to practice mechanized agriculture to produce more food for the growing population:

Farmers must use innovative technologies to produce more food to feed the world's growing population, which is projected to exceed nine billion by 2050 (George, 2018). To do this, farmers must use innovative technologies to produce more food.

**vii.** The need for climate-smart agriculture:

Agriculture is the most widely integrated sector of the economy, and when global warming and climatic conditions change, agriculture must deploy technologies that mitigate the effects of the climate. To do this, farmers' technological practices must continuously change to suit the needs of the times to mitigate or adapt to climate change.

## Key Players in Nigeria's Agricultural Technology Development and Transfer

The key players in Nigeria's agricultural technology development industry may be grouped into three broad categories:

i. technology developers;
ii. technology disseminators; and
iii. technology users

These three classes of players cut across the public and private sectors of the economy.

### Agricultural Technology Developers

Agricultural technology developers in the country fall into two sub-categories, namely:

i. The International Research Centres

Four international agricultural research centres have physical operational locations and a presence in Nigeria. These are the International Institute of Tropical Agriculture (IITA) with its headquarters in Ibadan and sub-stations in Kano and Onne (Port Harcourt); International Livestock Research Institute (ILRI) with sizable sub-stations in Ibadan and Kaduna but jointly head-quartered in Nairobi, and Addis Ababa; West African Rice Development Association (WARDA) with a national office within the IITA

complex in Ibadan; and International Crop Research Institute for Semi-arid Tropics (ICRISAT) in Kano.

ii. The National Agricultural Research Institutes

They make up what is commonly referred to as NARIs in collaboration with 26 universities across the nation that have agricultural faculties engaged in agriculture-related research. Through traditional plant/animal breeding, cultivar introduction and improvement, or the production of breeder seed, each of these national research centres is engaged in the development of new and improved agricultural technology (foundation and certified seed or livestock, and mechanical equipment for food processing). The partnership that exists between the country's national and international research centres is most appropriately characterized as collaborative.

Agricultural technology developers in the country are involved in the production of a number of desirable technologies such as:

a. Improved breeder and foundation crop and livestock varieties, (seeds, species, cultivars and/or germplasm) for directed biotechnology development;
b. Relevant small-holder hand tools;
c. Fertilizers;
d. post-harvest processing equipment (especially for cassava, maize and palm produce);
e. Cold storage equipment; and
f. Other simple equipment for household use.

**Agricultural Technology Disseminators**

This class is involved in testing, multiplying and releasing/distributing already approved and/or accepted new technologies to farmers. At other times, they engage in further cultivar development and improvement through variety purification and breeder seed production. This disseminator class consists of:

a. Private sector seed distributors; and
b. Public sector agencies and centres.

Unfortunately, existing practice shows that the public sector is more actively involved than the private sector in this component of the country’s technology system. As a result, the productivity of crops, livestock and fisheries remains largely underdeveloped. Fostering knowledge creation and transfer, particularly to farmers, entails re-organizing and strengthening agricultural research and training systems to effectively work with the private sector to help develop inputs and medium-scale technologies consistent with local needs (Federal Ministry of Agriculture and Rural Development, 2022).

Private operators in this sub-sector consider the profit margins on improved agricultural technology distribution to be low and unattractive despite the fact that prices charged for these seeds are relatively high compared to the almost free packages farmers receive from the ADPs and other interventions from other agencies and intergovernmental organizations. Given the high-interest rates (often over 25 percent on average) paid on funds borrowed from the banks, these low returns on their operations discourage further investment. With respect to livestock, there are no special designated disseminators for genetically improved small and large ruminants in the country. It is only in the case of poultry that we have two large-scale improved genetic (parent) stock producers and distributors in the country.

The private sector seed distributors may be broadly classified into two sub-categories: the formal or organized group, and the informal or unorganized group. The organized group are made up of operators in the country like Premier Seeds based in Zaria and UAC Seed Division also based in Zaria; while the unorganized group is made up of Community Seed Development Programs, and Small-scale Seed Enterprises usually owned by enterprising farmers. This class of seed distributors produce and distributes only certified and/or authorized seeds.

The public sector seed distributors are the state Agricultural Development Programs (ADPs), the Crop Variety Release Committee, the National Seed Council and the Plant Quarantine Services. The ADPs are state-based programs established primarily for carrying out extension services to farmers in their respective states. In addition to providing extension services, state ADPs produce and distribute certified and authorized seeds using appointed out-growers in their states, and also carry out seed promotional programs (Ishiak *et al.,* 2021).

**Agricultural Technology Users**

Farmers are the key users of agricultural technology for their sustenance and for national development. Institutional and governmental organs have been put in place to ensure farmers' awareness and adoption of agricultural innovations relevant to their situation e.g., National Agricultural Extension and Research Liaison Services (NAERLS), Agricultural Development Programmes (ADP), Ministries of Agriculture at both state and federal levels, specialized universities of agriculture and extension outreach units of the 18 agricultural research centres (Mgbenka and Mbah, 2016)

Some of the challenges being faced by farmers in accessing improved agricultural technologies to increase their agricultural productivity as highlighted by Farm Square (2022) include the following.

i. Access to technology: The ability of many farmers to benefit from agricultural technologies may be constrained by their lack of access to these technologies. It will be crucial to find ways to increase access to these technologies, such as through subsidies, training, or public-private partnerships, in order to ensure that the benefits of agricultural technology are more broadly disseminated.

ii. Capacity building: Farmers must possess the essential abilities and information in order to employ agricultural technology efficiently. Understanding how to utilize various forms of technology, maintain them, and evaluate and apply data and other information are all part of this. By strengthening their abilities through training, farmers and other agricultural stakeholders will be better equipped to utilize the technology at their disposal.

iii. Sustainability Issues: Agricultural technology has the potential to enhance the efficiency of farming practices and productivity, but it must be used sustainably and responsibly to avoid harming the environment or local communities. For instance, it is important to closely monitor the use of pesticides and herbicides to make sure that neither the environment nor people are being harmed.

**Problems of Technology Transfer in Nigeria**

Oyetoro (2022), identified the following constraints to the transfer of agricultural technologies in Nigeria as follows:

1. The complexity of the technology: The nature of the technology, how it functions, and how well it can be utilized by uneducated farmers are all factors in this category. Most technologies fail because they are difficult and complex for farmers to handle, not because they are bad in and of themselves. The characteristics of the innovations themselves determine how quickly they are adopted. The majority of technologies are expensive and inaccessible, even when technologies are available, in most cases, they are very costly.

These technologies are developed in a controlled setting and tailored to certain requirements so that they can perform at their best. In most cases, these details are not given to farmers and even when they are, they fail to meet the criteria, which leads to technical failure and worsens their situation.
2. Problems with the technological transfer system: This refers to the procedures used in technology transfer. Small-holder farmers find it challenging to adapt since most technological developments are top-down in nature, the build-up does not involve them in the development process. More worrisome is the fact that these technological inputs arrive late in the manufacturing process when the farmers would not benefit from them.
3. Socio-economic attributes of the farmers: This has to do with the farmers' personal characteristics and conditions that predispose them to adopt the technology. Some of these characteristics are;
i. Education: Farmers' literacy plays a vital role in the process of technological transfer. Education enhances behavioural changes; because it informs and leads to the understanding of complex material and values and the use of innovation. According to Kafando, Pelenguei and Gnedeka (2022), the likelihood of farmers adopting new agricultural technologies increases when they are educated. This therefore calls for the reappraisal of policy initiatives towards the educational needs of farmers for better results.
ii. Age: Farmers' age has a lot to do with their disposition to accept or reject a technology. While some technology adoption favours the young farmers, others favour the older ones.
iii. Level of experience: There is no gainsaying that the well-experienced farmer in a particular enterprise is always very much at home with technological adoption since they are better risk managers than the inexperienced farmers (Donkoh, Azumah and Awuni, 2019).
iv. Income and social status: The financial position or reputation of a farmer plays a vital role in his level of adoption of e-technology. This is because he is financially well-to-do to accommodate the risks associated with the transfer of technology.
v. Culture: It would be counter-productive to introduce a technology that is not compatible with the traditional norms of a society. Furthermore, placing the role of male in the hands of women and vice versa would be a taboo in most communities.
vi. Group membership. The more social organizations a farmer belong to, the more likely he will be disposed to adopt new farm technologies. Social group dynamics provides a person with ready access to others with similar interests and problems where opinions are shared and trustworthy as people are usually influenced by the decision of others. This is why it is necessary to help farmers to form cooperatives that will facilitate their levels of technological adoption.

Similarly, John *et. al. (*2022) reported that factors like age, household size, education, farm size, access to credit and extension agent visits have an influence on the transfer

of improved technologies to farmers. The age of farmers showed that younger farmers are more likely to adopt new technologies than older farmers. The farmer should be provided with adequate educational facilities since this will enhance their rate of adoption. Access to credit facilities has been found to be pivotal in the adoption of farming technologies implying that farmers should be granted access to more credit to enable them to increase the adoption of more technologies.

4. Local peculiarities and differences: Rural smallholder farmers find it very difficult to abandon their already established ways of doing things no matter how primitive, for a better technology except if the new technologies being introduced have been tried and found to be more advantageous and conforms to their local differences and peculiarities.

**Prospects of Agricultural Technology Transfer in Nigeria**

Technology advancements in agriculture are creating new opportunities and transforming how farming is done. This has led to more efficient methods of resource management and smallholder farmers are turning to new technologies to improve food production and marketability (Falodun, 2019).

According to Umar (2022), Nigeria's agricultural landscape is likely to change in the coming years as a result of the following emerging advanced technologies.

i. Precision Agriculture: Precision agriculture involves using GPS and other technological tools to collect data on crops and soil to optimize inputs based on specific conditions. By monitoring and responding to variability in factors like moisture levels, crop growth can be improved while also reducing wastage. Farmers who embrace precision farming see higher yields, better soil health, and improved environmental impact. For example, by using technology to monitor soil fertility, farmers can avoid over-fertilizing the soil, which can be wasteful and have severe effects on the crops.

ii. Weather Tracking Technology: Farmers can use this technology to get the information necessary to protect the plants and reduce crop losses. This technology can give farmers advanced notice on weather information for precautionary measures that will mitigate losses to a greater extent.

iii. Satellite Imaging: This technology provides real-time crop imagery which can be used by the farmers to control plant growth without necessarily visiting certain farm locations. This can save a farmer a considerable amount of time and money. Furthermore, this technology can be integrated with crop, soil and water resources for the farmers to receive a notification when danger thresholds emerge.

iv. Artificial Intelligence: In the modern agricultural industry, robotic innovations, drones, robotic harvesters, seeding robots or autonomous tractors are now widely used. These agricultural robots or so-called ag-bots simplify farm activities such as harvesting, fruit picking and soil maintenance.

v. Radio Frequency Identification (RFID) Technology: FRID is a technology that uses radio waves to identify a tagged object. The technology provides information that is associated with farming yields. For example, a bag of potatoes can have a tag or label that you can scan with a smartphone in order to access information about the soil that yielded the farm products.

**Conclusion and Recommendations**

The review clearly shows that the effectiveness of technology development and transfer strategy in Nigeria depends primarily on the key roles of technology

developers, technology disseminators and technology users along the value chains. The prospects of technology development and transfer in Nigeria in contemporary times are hinged on emerging advanced technologies like precision agriculture, weather tracking technologies, satellite imaging, agricultural robots and radio frequency identification. A more pragmatic and result-oriented strategy is needed that will place selected experts to work closely with farmers in the field on specific problems for a limited period of time. There should be increased private-sector participation in the multiplication and dissemination of acceptable production technologies that are affordable to farmers. There is need for pluralistic funding of agricultural extension activities by Federal, State and Local Government Areas with specific terms of reference and proportionate funding quotas.

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