

CHAPTER 8

Agricultural Extension Services & Seed Systems for Agricultural Technology Transfer in Nigeria

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List of Abbreviations

AATF	African Agricultural Technology Foundation
ADP	Agricultural Development Program
ARCN	Agricultural Research Council of Nigeria
DUS	Distinctiveness, uniformity, and stability
FDAE	Federal Department of Agricultural Extension
FMARD	Federal Ministry of Agriculture and Rural Development
IAR	Institute for Agricultural Research
IFPRI	International Food Policy Research Institute
IRM	Insect Resistance Management
NAERLS	National Agricultural Extension Research and Liaison Services
NARIs	National Agricultural Research Institutes
NASC	National Agricultural Seed Council
NBMA	The National Biosafety Management Agency
NOTAP	National Office for Technology Acquisition and Promotion
NRCRI	National Root Crops Research Institute
NVRC	National Committee on Naming, Registration and Release of Crop Varieties, Livestock Breeds/Fisheries
QMS	Quality Management Systems
REFILS	Research-Extension-Farmer-Input-Linkage System
SOP	standard operating procedures
VCU	Value for cultivation and utilization

Introduction

Agricultural systems globally have benefited from the application of innovative technologies leading to continuous improvement in the effectiveness and efficiency of food production (United Nations Conference on Trade and Development, 2005; Juma & Serageldin, 2007; Spielman & Pandya-Lorch, 2009; International Food Policy Research Institute [IFPRI], 2013). Africa, particularly the sub-Saharan Africa (SSA), has been significantly left out in this upward trend due to a number of factors that constrain access to these innovative technologies (United Nations Conference on Trade and Development, 2005; Juma & Serageldin, 2007) and the result has been a characteristic low productivity of agricultural resources in the region. Despite the fact that agriculture is central to the livelihood of millions of people in SSA, the region has not been able to reach its agricultural potential (Organization for Economic Cooperation and Development/Food and Agricultural Organization of the United Nations, 2016; Christiaensen, 2017; Tai, 2012), mainly due to low output of agricultural assets resulting in low yields (Alliance for Green Revolution in Africa [AGRA], 2016).

The low agricultural productivity in the SSA region is evidenced by huge yield gaps between landraces, local varieties, which are predominantly cultivated by farmers and their counterpart improved varieties (AGRA, 2016). Appropriate agricultural technologies are essential to reversing the low productivity and unlocking the agricultural potential of sub-Saharan African farmers who are mostly smallholders (African Agricultural Technology Foundation [AATF], 2017). Developing systems for agricultural technology transfer is key to accessing appropriate agricultural technologies including good quality seeds and planting materials.

Agricultural extension and seed systems are undoubtedly critical elements of technology transfer in agricultural systems and a vital determinant of agricultural productivity and competitiveness leading to increased food security and improved rural livelihoods. Agricultural extension is a major conduit for pro-poor economic growth through provision of critical support services, which can enable rural communities to confront new challenges of transforming into global food and agricultural systems occasioned by the rise of supermarkets and the growing importance of standards, labels, and food safety (Huber et al., 2017). Seed systems, on the other hand, represent a set of arrangements and processes that guarantee availability, access, and use of high-quality seeds of a wide range of crop varieties by farmers and other stakeholders. In Nigeria particularly, farmers have not been able to optimize the potentials of agricultural livelihoods due to inefficient agricultural extension services and poor seed delivery systems (Okojie, 2020). Challenges imposed by climate change and depletion of natural resources on agricultural productivity have intensified the need for functional extension services and seed systems in Nigeria and other sub-Saharan African countries. Yet, in Nigeria, there are profound challenges to achieving good extension services and seed systems that work for the smallholder farmers. With a focus on the cowpea seed delivery chain, this chapter provides a description of the Nigeria agricultural extension services and seed systems toward developing resilient systems for agricultural technology and knowledge transfer.

Agricultural Sector in Nigeria

Nigeria, with a population of over 200 million, is the most populous country among the 55 member countries of the African Union. Agriculture is an important sector of the Nigerian economy, providing livelihoods to nearly 70% of the population. The agricultural sector offers high potentials for employment generation, food and nutritional security, economic growth, and poverty reduction. Agriculture in Nigeria is dominated by smallholders. Large-scale agriculture is not common. Agriculture contributed 22% to the gross domestic product in 2019 (Statista, 2020). The Nigeria Agricultural Policy has provided the framework for implementation of programs and guidelines for agricultural development. The broad objective has been to attain self-sustaining growth in all the subsectors of agriculture and realization of the structural transformation relevant for overall socio-economic development of rural areas (Huber et al., 2017).

In spite of existing infrastructure for extension services, Nigeria's agricultural extension and advisory services are proving to be the weak link in the country's plan of revolutionizing the agriculture sector. Nigerian smallholder farmers have continued to lag behind their peers in the region, owing to their inability to raise productivity due to the weakness of the country's agricultural extension and advisory services. The inability of farmers to access vital information and dissemination of that information by extension agents have reduced agricultural productivity in the country for decades.

Agricultural Extension & Technology Transfer Services in Nigeria

Policies of agricultural extension in Nigeria have not been strategically documented over the years. It has been operated within government programs. The Nigerian agricultural extension system has evolved over several decades. It started during the colonial era where it was operated from the regional ministries of agriculture (Naswem & Ejembi, 2017). Historically, the theory and practice of agricultural extension services in Nigeria is as old as the country itself. The establishment of the School of Agriculture at Moor Plantation in 1921 marked the formal beginning of extension work. Its main objectives included carrying out experiments on the production of export crops, improving soil fertility, marketing agricultural produce, and offering rudimentary extension services (Adejobi et al., 2008). Fadiji and Adeniji (2011) emphasized that the 1950s was a period of substantial progress in the development and organization of agriculture and extension in Nigeria. Through constitutional changes, the Regional Ministries of Agriculture were created. Hence, an extension or Field Service Division was created in each of the Regional Ministries of Agriculture, thus setting a pace in the modern organization of agricultural extension. The extension system in Nigeria has evolved through many policies and actions and arrived at the current practice.

Nigeria has 36 states, which are governed independently. The federal government gives guidance and coordination support to the states in terms of agricultural programs and implements some agricultural projects. Each state has a network of Agriculture Development Programs (ADPs) with several extension agents, which provide extension services across the country. This system of extension was established in the 1980s and 1990s. As a part of the agricultural development reforms, in 2012, a Department of Agricultural Extension and a national extension policy was established, which replaced the Federal Agriculture Coordinating Unit (Federal Ministry of Agriculture and Rural Development [FMARD], 2019). Under the current system, the federal government provides most of the funding for agricultural extension, and state governments do most of the implementation through ADPs.

There is a growing involvement of the private sector in extension and advisory services.

The Agricultural Transformation Agenda Policy on Extension

In 2011, the government of Nigeria launched an agricultural transformation agenda under the FMARD to promote agriculture as a business, integrate the agricultural value chain, and make agriculture a key driver of the economic growth in Nigeria (Ojo, 2019). The aim of this agenda has been to change the perception about agriculture as a development. The agriculture transformation vision and strategy aim at a hunger-free Nigeria. This can be obtained through a transformed agricultural sector that enhances income growth, and food and nutritional security as well as generates employment opportunities (Ajani & Igbokwe, 2014).

To achieve this vision, the value chain approach has been in use. Fertilizer procurement and distribution, marketing institutions, financial value chains, and agricultural investment framework are poised for a change using this approach.

E.N. Ajani and E.M. Igbokwe published the following ideas for driving agricultural transformation.

To effectively drive the agricultural transformation agenda, an agricultural extension transformation agenda was articulated. The objectives of this agenda are to:

- Establish a Federal Department of Agricultural Extension (FDAE) which will oversee, monitor and provide the leadership needed for an efficient and effective agricultural extension and advisory service delivery in Nigeria;
- Review the agricultural extension policies within the subsisting agricultural policies and recommend appropriate policies that will ensure the effective participation of all stakeholders in a stable policy environment and adequate funding for the delivery efficient and effective agricultural extension and advisory services;
- Recommend appropriate institutional structures and arrangements for the delivery of effective and efficient multi-plural agricultural extension and advisory services in Nigeria, using the value chain approach; and

- Recommend demand-responsive extension systems/approaches and tools that will ensure the delivery of efficient and effective agricultural extension and advisory services for all the multi-actors in the targeted commodity value chains of interest to government (FMARD, 2011, as cited in Ajani & Igbokwe, 2014, p. 239).

The report of the agricultural extension transformation agenda has provided a clear road map to address the critical challenges of agricultural extension and advisory services to transform it into a participatory, demand-response, market-oriented and ICT driven service that will provide for extension needs of all actors along the targeted commodity value chains of interest to the present administration, starting with the review and articulation of a functional, all-encompassing and friendly agricultural extension policy with inputs from all the key stakeholders in the agricultural and rural development sector (FMARD, 2011, as cited in Ajani & Igbokwe, 2014, p. 239).

The strategy was well thought out but was truncated with a change of administration before it became a legalized policy.

Agriculture Research System & Its Linkage to Extension Services in Agriculture

The agricultural research system in Nigeria is coordinated by the Agricultural Research Council of Nigeria (ARC�) with a mandate to support, promote, and guide sector development programs. The ARC� supports the agricultural research system through establishing policy options to promote innovation, establish a knowledge management capacity, and strengthen Nigeria's agricultural research system. The council coordinates 15 National Agricultural Research Institutes (NARIs) and 10 Federal Colleges of Agriculture in Nigeria. Each of the institutes under the council have their specific mandate commodities, which keep each institute focused on a specific commodity. For instance, the Institute for Agricultural Research (IAR) has a mandate for cowpea research in Nigeria in addition to some other commodities, and the National Root Crops Research Institute (NRCRI) supports cassava research. The FDAE is responsible for the agricultural extension policy, while the National Agricultural Extension and Research Liaison Services (NAERLS) is responsible for extension research and has linkage with the State Agricultural Development Programs (ADPs). The ADPs are the direct links to the farmers. Furthermore, all the institutes have extension units, which also liaise with the NAERLS. The NAERLS has a mandate to promote agricultural technologies developed at any of the institutes through their ADPs linkages. Extension data generated by the NAERLS through linkages with ADPs and other NARIs often inform policy decision by the FDAE. All these make NAERLS/ARC� to be central to agricultural extension activities in Nigeria.

Seed Production System: Breeder, Foundation & Certified Seed

Nigeria has a three-tier system of seed production and multiplication: breeder seed, foundation seed, and commercial (or certified) seed. The NARIs are responsible for breeder seed production. Private seed companies and seed production units of many of the NARIs produce foundation seed. Private seed companies can produce both foundation and certified seeds but under separate trade names. The National Agricultural Seed Council (NASC) is a regulatory agency that controls all activities in the seed industry including licensing of private seed operators and process-based certification of all classes of seeds.

Figure 8-1. Cowpea at flowering stage in Bakura Zamfara State of Nigeria. (Photo by Francis Onyekachi)



The Bt-cowpea and cassava provide a classic example in understanding the functioning of the seed production system in Nigeria. The IAR, having the national mandate for cowpea research, collaborated with the AATF and other partners to develop the Bt-cowpea, which was approved for commercial release in Nigeria by the National Biosafety Management Agency (NBMA) in 2019. The breeder seed of Bt-cowpea was produced by the research team at IAR, which also maintains the breeder seed. IAR Seed Unit is a commercial business entity owned by IAR, which specializes in early generation seeds (foundation seeds) and has been issued a sub-license to produce Bt-cowpea foundation seeds. Commercial certified Bt-cowpea seed production is by private seed companies under a non-exclusive license agreement.

Seed Varietal Registration & Certification

Seed varietal naming, registration, release, and certification are regulatory activities performed by two different and distinct bodies in Nigeria. The National Committee on Naming, Registration and Release of Crop Varieties, Livestock Breeds/Fisheries (NVRC) is responsible for naming, registration, and release of new crop varieties for commercial cultivation by growers,

while the NASC is responsible for seed certification. Every crop variety from a breeding line that will be cultivated in Nigeria must go through the NVRC to ascertain its distinctiveness, uniformity, and stability (DUS) as a new crop variety. The NVRC also looks out for value for cultivation and utilization (VCU) as criteria for variety naming, registration, and release. Once the variety is released for cultivation, the NASC steps in through the seed certification program to ensure that pure and good quality seeds are delivered to the farmers. Specifically, the NASC takes a process-based approach to ensure that the planting material (1) must be of acceptable variety and genetic purity, (2) must be of prescribed physiological and health status (disease and pest free), and (3) must have undergone the certification process.

Certification is compulsory for all classes of seeds (breeder, foundation, and certified seeds) as well as all stages of production, which also includes transportation and storage of all planting materials. Anyone with the desire to produce or multiply seeds or be a seed entrepreneur must be registered with NASC. For example, Bt-cowpea was named, registered, and released as Sampea 20-T in Nigeria in December 2019, having satisfied the requirement for DUS and VCU by the NVRC. Thereafter, the NASC certified the various classes of Bt-cowpea seeds for the 2020 cropping season.

Transfer of Agricultural Innovations to Farmer Fields & Use of Demonstration (On-Farm) Centers

As in most countries in Africa, the transfer of new technology and innovation from research to farmers in Nigeria is mainly carried out by the public agricultural extension services and scarcely by the private sector. With insufficient funds for extension and restructuring of public extension services, there has been a decline in the delivery of agricultural information and technologies as well as widening gaps between the extension agents to farmer ratio, thereby causing constraints in the delivery of extension services. The private sector has not responded adequately to fill the gap in service provision to smallholder farmers created by the withdrawal of the state. This is due to lack of enough trained personnel, unprofitability of providing services, the complex farming systems, and inability by farmers to pay for the services (Kormawa et al., 2001, 2004).

For circulation of information, traditional dissemination methods coupled with the use of social media have been found to be vital in the transfer of technology to farmers especially for seed varieties that are usually introduced by the public or private sector (Babu et al., 2020; Faure et al., 2016; Huber et al., 2017). Within the process of participatory technology development, attempts have been made to build on farmer-based knowledge. These include the design of extension methods that would have greater impact on the technology dissemination and transfer of new production inputs and methods. Communication among farmers is still an important factor as farmers prefer their fellow farmers as the primary

information source. This is the basis for farmer demonstrations, which has often worked well at increasing adoption.

According to Koyenikan (2008), Nigerian extension is the decentralized type, but the Federal States coordinate agricultural extension-related programs. The Federal States carry out extension programs, and manage and control activities and resources. This was also corroborated by Contado (1997), who opined that the pluralistic type of extension organization is emerging in many countries, and this is true for Nigeria. This has been reflected in the agricultural extension policy because the need for extension service is high. Public, private, and nongovernmental organizations are supporting and implementing agricultural extension programs. For example, the oil companies such as Shell Petroleum Development Company in the Niger Delta Region, universities, agro-business firms, and religious and farmers' organizations such as the Farmers Development Union are among the organizations supporting extension programs in Nigeria.

The Research-Extension-Farmer-Input Linkage System (REFILS) has been identified as an exciting and viable extension instrument for effective technology transfer and provides a sustainable approach to linking research to policy and development in the agricultural sector (Nnadozie et al., 2015). The NAERLS is central to the implementation of REFILS in Nigeria. NAERLS has a mandate to (1) advance the frontiers of extension research and services; (2) conduct agricultural performance assessment and provide feedback; (3) build the capacity and skill of key actors for effective extension service; (4) plan, coordinate, mentor, and evaluate REFILS activities; and (5) package and disseminate improved agricultural innovations in Nigeria (NAERLS, 2020). The NAERLS work closely with the National Office for Technology Acquisition and Promotion (NOTAP) to ensure technology licensing, which is a critical aspect of technology transfer. (NOTAP was established by Decree No. 70 of 1979, amended by Decree No. 82 of 1992 now referred to as NOTAP Act Cap N68 LFN 2004 Laws of the Federation of Nigeria.) The mission of NOTAP is to ensure the acceleration of Nigeria's drive toward a rapid technological revolution by an efficient acquisition and absorption of foreign technology and a concerted development of indigenous technological capability through a proactive promotion of innovation and commercialization of technology (NOTAP, 2020).

The functions of NOTAP include but are not limited to the commercialization of viable research and development (R&D) results emanating from both private and public research institutions, promotion of intellectual property rights, and encouragement of innovation among Nigerian scientists, researchers, and inventors, as well as establishment of a network of linkages among researchers, inventors, industry, and research institutions. NAERLS and the entire ARCN must build synergy with the NOTAP to have a wholistic approach to technology transfer that adequately caters for technology licensing thereby achieving desired results in Nigeria agricultural space.

Research-Extension-Farmer Linkages & Stewardship

Commodity Case Study: Bt-Cowpea

The government of Nigeria has taken positive steps toward harnessing modern biotechnology for enhancing agricultural productivity and food security. Last year, the government gave approval for the commercialization of insect-resistant cowpea varieties developed in collaboration with the AATF. The successful deployment, use, and management of biotechnology-derived crops will require appropriate extension education services to empower farmers on technology stewardship aspects.

Figure 8-2. Transgenic cowpea. (Photo by Francis Onyekachi)



The Bt-cowpea stewardship requirement provides a practical platform to strengthen linkages between research, extension, farmers, and all stakeholders along the seed value chain. The stewardship program of Bt-cowpea aims to ensure the product quality and integrity, provide sustainable access of good quality seeds for farmers, promote adoption, and enhance regulatory compliance for biotechnology crops as well as enhance consumer confidence. The components of this stewardship program include identity preservation, trait performance, insect resistance management (IRM), integrated pest management (IPM), good agricultural and agronomic practices, high-quality seeds, consumer acceptance, marketing, labeling, and intellectual property management. A life cycle approach to product management primarily through the technology developers, seed producers and distributors, and users has been established as follows:

- **Standard operating procedures (SOPs) and quality management systems (QMS):** To support a comprehensive stewardship program, the technology developer (AATF/IAR) is collaborating with NASC and NAERLS to review and optimize the existing SOPs and QMSs to ensure proper documentation, effective seed testing, proper seed packaging and labeling, traceability, and proper recordkeeping that meets stewardship audits at each stage of product development, seed production, and distribution as

well as rapid and effective communication between different teams on emerging issues. Farmers are also encouraged and supported on recordkeeping and stewardship compliance procedures.

- **Insect resistance management:** The evolution of resistance to the Bt (*Bacillus thuringiensis*) toxins by insect pests is a major concern in application of Bt-cowpea like other Bt-based technologies. The rate of evolution of resistance can be delayed or prevented using appropriate insect resistance management (IRM) and integrated pest management (IPM) strategies to reduce the selection pressure on target pests. The IRM/IPM plan has been deployed in adherence to existing agroecosystems, cropping, and other local agricultural practices and implemented in line with local conditions for social acceptability and economic viability of smallholder farmers in Nigeria. The AATF/IAR/NAERLS are working together to ensure that the IRM plan is appropriately supported and implemented by farmers and other stakeholders through education and compliance monitoring programs to prevent the development of resistance, thereby extending the efficacy and durability of Bt-cowpea technology for a long-term period.
- **Anti-counterfeiting and adulteration of seeds:** With the success of Bt-cowpea, it is expected that counterfeit and adulterated seeds will become a major threat that can destroy the farmers confidence in the product. To combat this threat, methods of detecting counterfeit seed are being tested. The first one is the Seed Assure technology, which has not been introduced in Nigeria yet. The second method is the Mobile Authentication Service (MAS) method, which has been in use in Nigeria by the National Agency for Food and Drug Administration and Control since 2012 to detect fake anti-malarial drugs and antibiotics. This method uses scratch codes and Short Messaging Service (SMS) to enable buyers to verify the authenticity of the medicine at the point of purchase. The buyer scratches a panel on the product, which then reveals a unique, one-time-use PIN (personal identification number). The PIN is sent toll-free to a short code using any of the GSM (Global System for Mobile communications) operators and the consumer receives a response in form of a text message (SMS) stating that the product is either genuine or suspected fake. Many smallholder farmers in Nigeria are conversant with the use of mobile phones for agricultural services through the E-Wallet program and this gives credence to a successful implementation of MAS for Bt-cowpea farmers.
- **Stewardship Sustainability Framework:** A multi-prong approach is being taken to ensure sustainability of a stewardship program for Bt-cowpea. First, is the stewardship obligation given to seed companies through the license agreement. Second, the cost of stewardship will be included in the seed cost to the seed companies while a sustainable model of administering the funds will be worked out by AATF/IAR/NASC and the seed industry stakeholders. Third, the project will collaborate with the extension services to mainstream Bt-cowpea stewardship programs into the routine activities of extension agents across cowpea producing areas of the country. This is ongoing in Nigeria and will be replicated in other project countries. It will involve training of field extension agents as well as subject matter specialists who manage the NAERLS E-extension services and Farmer Help Line.
- **Farmers and Stakeholders Training:** In Nigeria, sustainable use and success of the Bt-cowpea technology will require training of various stakeholders along the value chain including researchers, seed regulators, private seed companies and seed production companies, multiplication

and distribution experts, extension professionals, and farmers. Training will include seed production, multiplication and distribution channels on specific stewardship SOPs, QMS, IRM, incidence management, and anti-counterfeiting approaches. The Training of Trainers Internship program is ongoing. This will help to create a team of “product stewardship champions” in Nigeria. Training programs in stewardship program implementation will be conducted for local stakeholders including farmers through in-country national and regional workshops. Key elements of the training will be seed quality control and assurance, implementation of on-farm and community refugia for insect resistance management, and overall stewardship program planning and implementation.

Private Sector Participation in Agricultural Extension

Privatization of extension service delivery has been considered lately as the only option to remedy the decline in both the funding and overall organization and administration of extension due to so many challenges facing the effectiveness of publicly funded extension delivery, particularly since the withdrawal of the World Bank sponsorship of agricultural programs in Nigeria (Babalola, 2015). The development of Bt-cowpea technology demonstrates a successful public-private sector partnership. Facilitated by the AATF, the technology was donated by a private company and the technology testing and development was performed by the public research institution in Nigeria with the technology commercialization and deployment to be carried out through partnership with local seed companies. The government-supported extension services will conduct the farmers’ education and outreach. The AATF provides the overall coordination of the project, including in-house expertise on intellectual property management, business development, regulatory compliance, communication and outreach, seed delivery, and stewardship.

Another example is the cassava seed system, one of the few emerging seed systems as cassava has been classified as one of the “orphan crops.” A project funded by the Bill and Melinda Gates Foundation was initiated to establish the cassava seed system as an economically sustainable integrated seed system. The project created a new paradigm for the development of cassava seed systems. One of the components for this program was the creation of a cadre of seed entrepreneurs in rural villages to produce certified cassava seeds within their locality. The Catholic Relief Services involved with the project created a quasi-extension system to teach and extend information to all the village extension service units to ensure proper maintenance of their seed production fields. This corroborates the thinking of Adebayo (2004) that information and advice are not necessarily public goods: they can fall into different categories within the public-private goods matrix. Advice tailored to the specific circumstances of an individual farmer, who will, in principle, be prepared to pay for it, should therefore be supplied at an appropriate level by the private sector.

Conclusion & Way Forward

As an integral component of the agricultural transformation agenda, the government of Nigeria has taken positive steps and made a strong commitment to enhance agricultural extension and advisory services to better serve millions of smallholder farmers. The agriculture sector is rapidly changing all over Nigeria and across the African continent from a production-driven to a market-driven enterprise. The private sector is playing an increasing role and joining the efforts of the government to accelerate this process. The improved varieties of crops such as cowpea, cassava, and maize, developed through public-private partnerships, are serving as an excellent platform to enhance national agricultural extension and advisory systems. The emerging tools of ICTs are providing unique opportunities to enhance real-time and rapid information delivery to local farmers and stakeholders.

The role of the NASC as a foremost seed regulator in SSA has been very instructive. The council has used pragmatic measures to ensure sanity and quality assurance in the seed industry especially in partnership to develop seed systems for orphan crops such as cassava. Despite the huge challenges and institutional lapses in the agricultural extension systems in Nigeria, the technical information dissemination within its cassava program has yielded great impacts and as such, can be further developed for cascading into other crops. Furthermore, NASC has reinforced the fact that the private sector takes the lead in the seed industry. This has helped in the rapid transformation of the seed sector to a business- and income-generating sector, which in essence affirms that:

- Private extension should be encouraged to ensure stakeholders get their specialized information without the technical hitches of the public extension system.
- Public-private collaboration in extension should be strengthened and more coordinated. This will eradicate the duplication and conflicting channels of information dissemination to stakeholders.
- Specialized seed extension programs should be introduced and institutionalized. This is to engender the robust development of seed information channels among seed stakeholders.
- Seed tracker developed by the seed council should be further explored as a tool for extension service delivery.
- There is a need to unbundle the extension system and be recognized as a key sector of the agricultural system that is cross-cutting along all the value chains with active engagement of all the key stakeholders.

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