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Research Report

Building Skills and Research-Extension Linkages for Sustainable Agricultural Transformation: Insights from Nigeria.

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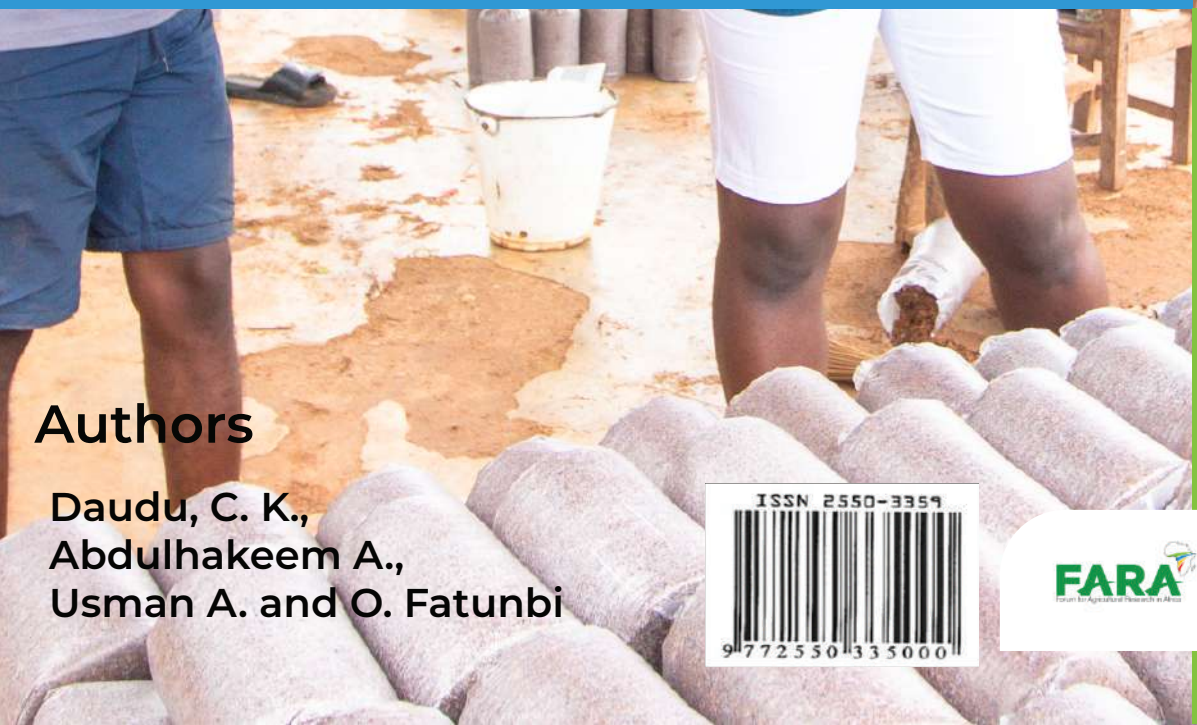

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The Forum for Agricultural Research in Africa (FARA) is the apex continental organisation responsible for coordinating and advocating for agricultural research-for-development. (AR4D). It serves as the entry point for agricultural research initiatives designed to have a continental reach or a sub-continental reach spanning more than one sub-region.

FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).

FARA's vision is; "Reduced poverty in Africa as a result of sustainable broad-based agricultural growth and improved livelihoods, particularly of smallholder and pastoral enterprises" its **mission is the** "Creation of broad-based improvements in agricultural productivity, competitiveness and markets by strengthening the capacity for agricultural innovation at the continental-level"; its **Value Proposition is the** "Strengthening Africa's capacity for innovation and transformation by visioning its strategic direction, integrating its capacities for change and creating an enabling policy environment for implementation". FARA's strategic direction is derived from and aligned to the Science Agenda for Agriculture in Africa (S3A), which is in turn designed to support the realization of the CAADP vision.

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List of Acronyms and Abbreviations

A.B.U.: Ahmadu Bello University, Samaru, Zaria

AREE: Agricultural Research, Extension, and Education

ADP: Agricultural Development Programme

ARCN: Agricultural Research Council of Nigeria

BBC: British Broadcasting Corporation

CEOs: Chief Executive Officers

CGIAR: Consultative Group on International Agricultural Research

DAC: Division of Agricultural Colleges

EAS: Agricultural Extension and Advisory Services

FARA Forum for Agricultural Research in Africa

FCAs: Federal Colleges of Agriculture

FCAIB: Federal College of Agriculture, Ibadan.

FGN: Federal Government of Nigeria

FTE: Full-Time Equivalents

FMARD: Federal Ministry of Agriculture and Rural Development

GPS: Global Positioning System

IAR: Institute for Agricultural Research, Zaria;

IAR&T: Institute of Agricultural Research and Training, Ibadan;

IITA: International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State;

KADA: Kaduna State Agricultural Development Agency

KADPOLY: Federal (Kaduna) Polytechnic, Kaduna

KNARDA: Kano State Agricultural and Rural Development Authority

NAERLS: National Agricultural Extension and Liaison Services

NARIs: National Agricultural Research Institutes

NARS: National Agricultural Research Systems

NGO: Non-Government Organization

NIFU: Nordic Institute for Studies in Innovation, Research and Education

OSADP: Osun State Agricultural Development Program

OYSCATECH: Oyo State College of Agriculture and Technology, Igbo Ora;

OSSADEP Osun State Agricultural Development Programme, Iwo, Osun State

OYSADEP: Oyo State Agricultural Development Programme, Ibadan

PARI: Program of Accompanying Research for Agricultural Innovation

PPP: Purchasing Power Parity

REFILS: Research-Extension-Farmer-Input-Linkage-System

SCA: Samaru College of Agriculture, Zaria

SSA: Sub-Saharan Africa

SDGs: Sustainable Development Goals

ATVET: Agricultural Technical and Vocational Education and Training

UI: University of Ibadan, Ibadan

USD: United States Dollar

ZEF: Center of Development Research

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Chapter 1 Introduction

Feeding a growing world population and achieving the Sustainable Development Goals (SDGs) necessitate a profound shift in agricultural practices. This transformation demands not only increased productivity but also innovations that enhance environmental resilience, conserve agrobiodiversity, and promote social inclusivity. Governments play a crucial role in this process by fostering skill development and supporting efficient research-extension linkages within the agricultural innovation system. Investing in agricultural research, extension, and education is a crucial strategy, with the "agricultural innovation system" emerging as a guiding framework for public investments in these domains over the past two decades (Spielman & Birner, 2008; World Bank, 2012). However, agricultural innovation systems have traditionally focused on increasing agricultural land and labor productivity, which may not be sufficient to meet the SDGs. Agricultural innovation systems must now evolve to address broader environmental and social goals such as climate resilience, agrobiodiversity conservation, and inclusiveness to meet the comprehensive demands of the SDGs.

Traditionally, agricultural innovation systems have prioritized boosting land and labor productivity. Recent efforts in African countries, including Nigeria, demonstrate a broader shift in focus through NARS research projects and advisory services promoting sustainable practices. Examples include research projects within the National Agricultural Research Systems (NARS) or projects within agricultural advisory services that focus on developing farmers' skills for sustainable agricultural practices. However, knowledge gaps persist, particularly regarding how these initiatives move beyond productivity and address multiple sustainability goals. Additionally, existing studies often overlook the diverse skillsets farmers need to navigate multifunctional livelihoods and maximize rural development benefits. One reason for this knowledge gap is the fact that past studies have mostly focused on the roles of these institutions in improving agricultural productivity without considering other sustainability goals (Fuglie ***et al***., 2020; Fuglie, 2021; Seck ***et al***., 2013). Consequently, there is a scarcity of empirical evidence on transitioning from a productivity-centric focus to addressing diverse sustainability goals within research, extension, and education institutions. Moreover, there is a limited understanding of how these institutions can respond to the diverse and changing skill needs of farmers, who may engage in multifunctional livelihoods based on the combination of crop, livestock, and horticulture, among others, and who may benefit differently from rural agricultural development processes.
This report aims to support the sustainability transition of the agricultural innovation system in Nigeria by analyzing the strategies and challenges of agricultural research, extension, and education institutions in meeting multiple sustainability goals and exploiting the potential of digital solutions. The report focuses on three types of institutions: (a) National Agricultural Research Systems (NARS), (b) agricultural advisory services, and (c) Agricultural Technical and Vocational Education and Training (ATVET) institutions. These institutions will be collectively referred to as AREE (agricultural research, extension, and education) institutions.
The report explores the following research questions:

- What types of synergies and trade-offs between productivity and other sustainability goals do managers and staff members of AREE institutions encounter and address in their efforts to generate and promote agricultural innovations and skill development?
- What is the general status of AREE institutions in terms of digitalization, working environment, and staff satisfaction?
- How are AREE institutions linked with each other (e.g. between NARS and agricultural advisory services) and with international research partners (e.g. CGIAR)?
- How can AREE institutions be strengthened and supported to promote agricultural development efforts that embrace all dimensions of sustainability in Nigeria and elsewhere?

The overarching objective is to provide vital insights and recommendations for AREE institutions, equipping them to foster agricultural development efforts that prioritize all dimensions of sustainability. By bridging the knowledge gap and offering practical solutions, we hope to guide policymakers, AREE stakeholders, and development partners in driving a successful transition towards a sustainable and equitable agricultural future for all.

Chapter 2: Insights from Existing Literature and Data

Achieving sustainable transformation in the agricultural sector necessitates the adoption of strategies capable of addressing key challenges to agricultural development in ways that are both sustainable and transformative. One such imperative strategy involves consistent investment in innovation. Agricultural innovation emerges as a critical driver of economic transformation in numerous countries, serving as a cornerstone for enhanced productivity, competitiveness, economic growth, job creation, income generation, poverty alleviation, and social development (World Bank, 2012). Governments play a pivotal role in supporting agricultural transformation by fostering innovation and skills development, with particular emphasis on investing in agricultural research, extension, and education. Beintema and Stads (2008, 2011) underscore the significance of efficient, effective, and well-funded agricultural research and advisory systems, equipped with appropriate research capacity and infrastructure, as catalysts for effective and transformative innovation in agriculture.

***Agricultural Research Institutions*:** Despite overwhelming evidence of improved economic growth, agricultural development, and poverty reduction in developing regions as a result of agricultural research, extension, and education investments over the last six decades (McIntyre, 2009; Cervantes-Godoy & Dewbre, 2010; Wesley & Faminow, 2014; Danso-

Abbeam *et al., 2018*), sadly the Nigerian government failed to prioritize these areas. Based on 2011 purchasing power parity (PPP), total spending on agricultural research increased from 245.9 million dollars in 2000 to 433.5 million dollars in 2014 (Figure 1). The spending trajectory throughout this time period followed an unpredictable pattern, with a dramatic fall in 2005 followed by a steady climb until 2009–2010, at which point spending fell, surged again in 2011, and then progressively reduced from 2012 onwards. The rise and fall in the pattern of spending could be attributed to a combination of low donor funding for agricultural research and declining government support for such research. Donors and other funding sources make up a very small portion of the overall funding for agricultural research in Nigeria, accounting for only 1.2 percent annually on average between 2009 and 2014 (Beintema e*t al*., 2017).

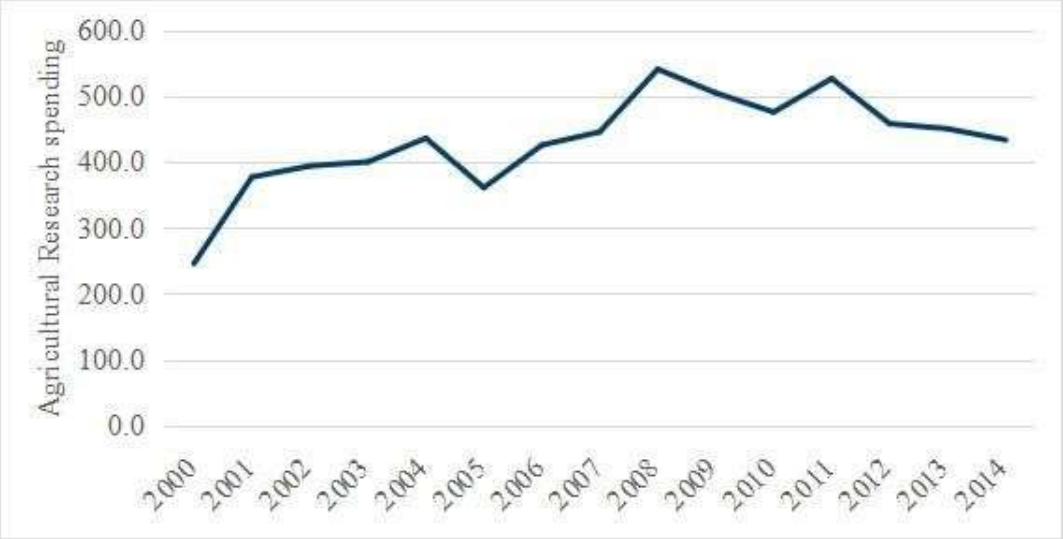

Figure 1: Agricultural research spending in million 2011 Purchasing Power Parities (PPP) dollars, 2000-2014

Source: ASTI/IFPRI

Similarly, the spending intensity (as measured by agricultural research spending as a % of AgGDP) declined from 0.41 percent in 2000 to 0.22 percent in 2014. Also, agricultural research intensity ratios reveal an average of 0.30 percent agricultural spending to AgGDP between 2000 and 2014. The full-time equivalents (FTE) researchers per 100,000 farmers average was 15.8 for the same period (Figure 2).

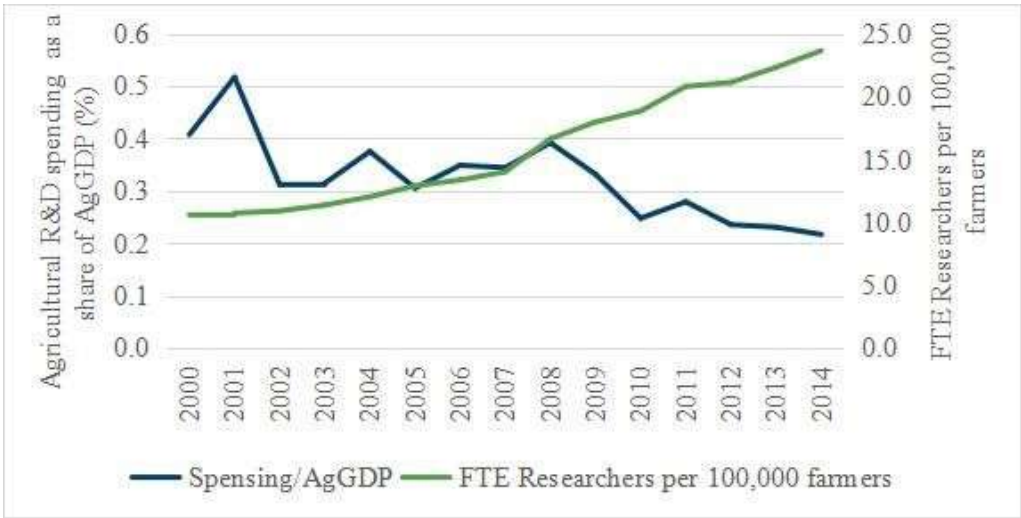

Figure 2: Agricultural research intensity ratios, 2000-2014

Source: ASTI/IFPRI

The NARS in Nigeria is composed of the Agricultural Research Council of Nigeria (ARCN), which is the apex body that coordinates the activities of 16 National Agricultural Research Institutes (NARIs) and 16 Federal Colleges of Agriculture (FCAs). The NARIs are specialized in different crops, livestock, fisheries, forestry, and natural resources, while the FCAs are involved in training and extension services. The ARCN also oversees the implementation of the National Agricultural Research Policy and ensures collaboration among diverse member institutions. This decentralized coordination involves stakeholders such as policymakers, researchers, farmers, civil society organizations, and development partners. NARS in Nigeria embraces a participatory approach that engages a wide array of agricultural research stakeholders. Policymakers, researchers, farmers, civil society organizations, and development partners actively contribute to the planning, implementation, and evaluation of agricultural research activities. This inclusive model ensures that research outcomes directly inform policy decisions, guide agricultural development strategies, and enhance on-the-ground agricultural practices.

The trend of agricultural researchers also demonstrates that there were 1,309 FTE researchers in Nigeria in 2000 and 2,975 in 2014 (Figure 3). The rise in the number and size of public and private universities may be responsible for this observed increase in the number of agricultural researchers. Almost half of the nation's agricultural researchers were thought to be employed by more than 100 higher education institutions as of 2014 (Beintema ***et al***., 2017). The Agricultural Research Council of Nigeria (ARCN), higher education institutions, and other government research institutes all play complementary roles in the institutional makeup of national agricultural research, adding to the total number of agricultural researchers.

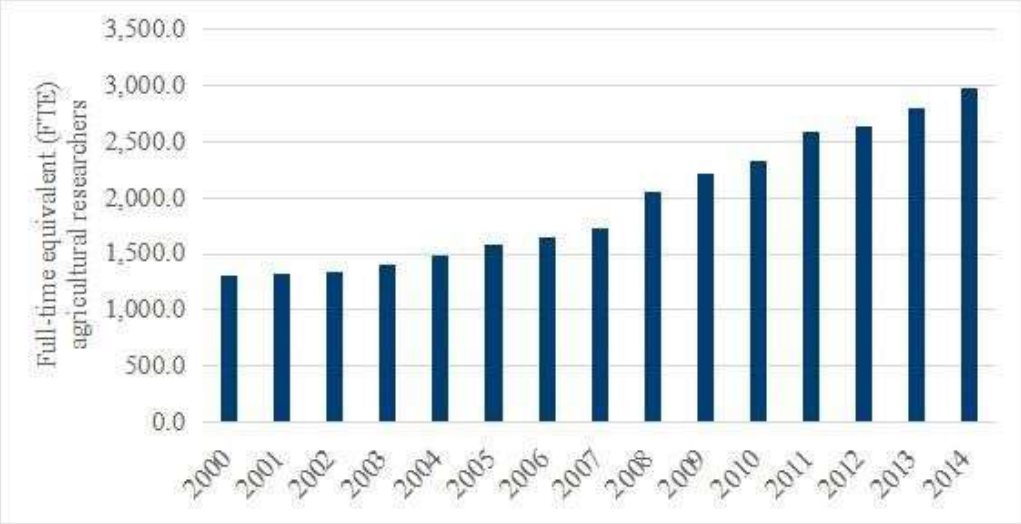

Figure 3: FTE agricultural researchers, 2000-2014

Source: ASTI/IFPRI

The NARS has several strengths and opportunities that contribute to its potential for effective and sustainable agricultural transformation. The NARS has a long history of agricultural research and development, dating back to the colonial era, and has generated many technologies and innovations that have improved agricultural productivity and livelihoods in Nigeria. The NARS has a large pool of researchers, with about 3,000 full-time equivalent researchers in 2014, of which 44 percent had PhD degrees. The NARS has a wide network of research stations and facilities across the country, covering different agroecological zones and farming systems. The NARS has a strong collaboration with international research centers and partners, such as the CGIAR, which provides access to global knowledge and technologies, capacity building, and funding support. The NARS has a mandate to implement the National Agricultural Research Policy (NARP), which provides a framework for setting research priorities, mobilizing resources, and enhancing linkages among research stakeholders (Beintema ***et al.***, 2017) NARS research therefore directly informs agricultural development policies and strategies at national and state levels, ensuring research relevance and alignment with national priorities.

In order to address the impending losses in agricultural research capacity as senior researchers in the field near retirement age and also due to the current brain drain the nation is experiencing, much more training and recruitment is required. Moreover, Nigeria's agricultural research infrastructure remains underdeveloped as a result of the low levels of capital investment, which clearly has a detrimental effect on the quantity and quality of research outputs. Prioritizing investment in research center rehabilitation is necessary and important for producing high-quality outputs, successful research, and keeping and engaging researchers.

However, NARS in Nigeria faces various challenges, mirroring those experienced globally. These include non-functional consultation frameworks, precarious funding for research activities, limited human resources and capacity, limited private sector engagement, inadequate mechanization of agriculture, and budgetary constraints as well as inadequate monitoring and evaluation systems

Agricultural Extension Institutions: According to research by Khan et al. (2012), agricultural extension services can improve farmers' agricultural knowledge and skills, spread new technology, and alter their attitudes. They can also help farmers access markets, manage their natural resources sustainably, and promote community development (Bonye et al., 2012; Swanson, 2008). In Nigeria, agricultural extension institutes play a crucial role in the country's agricultural industry by giving farmers, rural communities, and other stakeholders access to agricultural knowledge, technologies, and services. Nigeria has an impressive infrastructure for agricultural extension, which includes specialized extension offices or Agricultural Development Programs (ADPs) in each state, a significant number of agricultural research institutions and extension training programs, a system to connect them to farmers called the Research-Extension-Farmer-Input Linkage System (REFILS). The Research-Extension-Farmer-Input-Linkage-System (REFILS) is a platform for the effective engagement, coordination and collaboration with: Research (for technology generation); Extension (for technology adaptation, dissemination and services provision); Farmers (for indigenous knowledge generation and technology adoption); "Inputs" representing the Private Sector (for Inputs and services provision and marketing). The majority of these facilities were built in the 1980s with help from the World Bank but have since had a significant lack of finance and coordination in times of both economic growth and recession. Nonetheless, there is increased involvement of the private sector in agricultural extension and advisory services (EAS) (Huber et al., 2017).

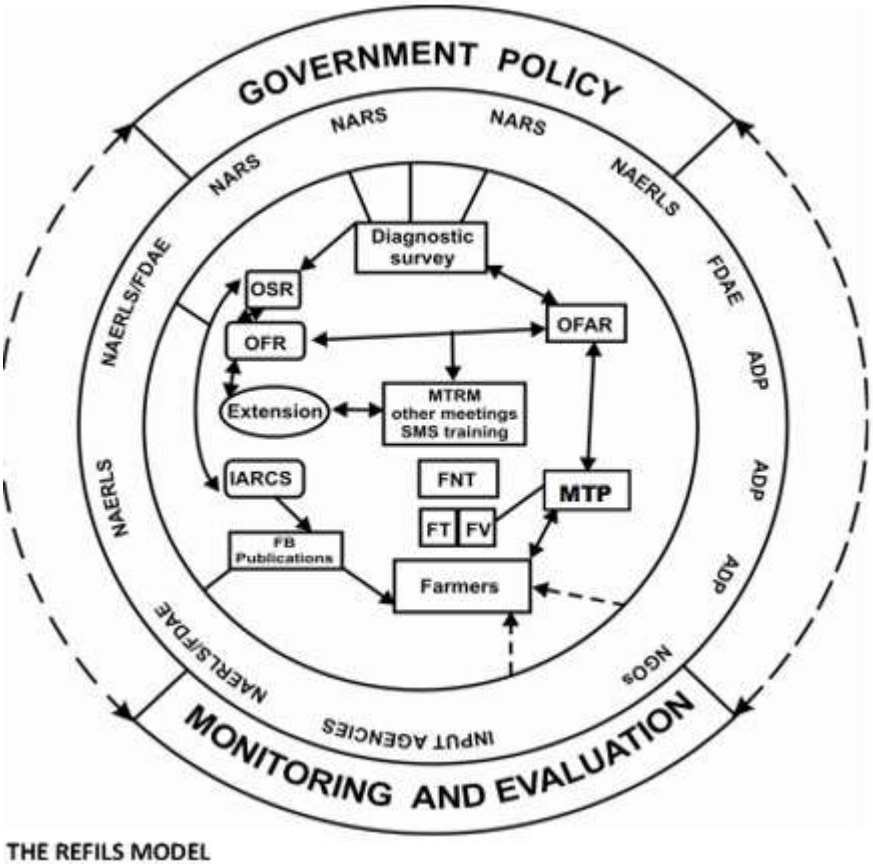

Figure 4: The Refils Model

Very conservative estimates for the present ratio of extension agents to farm families in Nigeria range from 1:5000 to 1:10000, according to Davis ***et al***. (2019). There is very poor data of farmers and extension agents in Nigeria. Also, 60% of extension agents are over 40 years old and 28% of them are female, highlighting the aging of the extension industry and the dearth of fresh hires. At the individual level, extension agents receive adequate foundational education. Public extension agents undergo specialised training in agricultural extension, including an Ordinary National Diploma, Higher National Diploma, and Bachelor of Science degree. Basic crop or livestock science is the main focus of most training, with little emphasis placed on post-harvest management, business and market aspects, or functional skills.

The Nigerian Agricultural Extension Research and Liaison Services (NAERLS), which has six zonal offices and is based in Zaria, is in charge of developing and training extension providers throughout the nation but struggles with insufficient funding for the majority of its programs. The 36 state-level Agricultural Development Programs receive training from NAERLS. ADPs, however, frequently lack the resources to attend NAERLS trainings. Typically, only five agents from each state attend trainings, with additional attendees coming from the state where the training is being held (Davis ***et al***., 2019).

Pluralism, particularly private sector involvement in EAS, is on the rise (Huber ***et al***., 2017). Numerous initiatives from public, corporate, and non-governmental organizations (NGOs) point to growing pluralism within EAS, but coordination across parties remains an issue. Partnerships between the public and private sectors are obvious areas of opportunity. The Anchor Borrowers Programme, sponsored by the Central Bank of Nigeria, is one of the largest public-private partnerships on extension in Nigeria.

Nigeria's agricultural extension landscape comprises diverse institutions operating at national, state, and local levels. The Agricultural Extension Institutions have several strengths and opportunities that contribute to their potential for effective and sustainable agricultural transformation. The Agricultural Extension Institutions have a wide coverage and outreach, reaching millions of farmers across the country with various extension methods, such as training and visit, farmer field school, demonstration plot, radio and television programs, and mobile phone applications. The Agricultural Extension Institutions have a diverse and multidisciplinary team of extension agents, with different backgrounds and specializations, such as crop production, livestock production, fisheries, forestry, agro-processing, marketing, and gender. The Agricultural Extension Institutions also face several challenges and constraints that hinder their performance and impact. These include: inadequate funding and resource allocation for agricultural extension services; aging and inadequate human resources and capacity; low adoption and utilization of agricultural innovations; poor coordination and collaboration among extension actors and limited private sector engagement.

Agricultural Education Institutions: The ATVET institutions in Nigeria comprise public and private universities, polytechnics, colleges of agriculture, colleges of education, and other specialized training centers. ATVET institutions operate based on characteristics that are their strength and offer them opportunities. ATVET institutions emphasize hands-on learning and professional training (Adesoji ***et al***., 2017; FMARD, 2021). This enables students to acquire practical and directly applicable skills in their chosen field, which increases their employability and enables them to meet the needs of the labor market. These training centers are designed to meet the specific needs of the labor market. They work with industry, business and employers to adapt their training programs to the requirements of the sector concerned. This ensures that graduates are prepared for available jobs and promotes their professional integration (Akinbile and Odebode, 2018). Agricultural education provides learners with the necessary skills to become self-reliant and create job opportunities (Hayes & Stewart, 2016; Okoye & Udoudo, 2015). Agriculture education and training is essential for national development, as it prepares researchers, educators, extension staff, and farmers to make useful contributions. Similar to this, there is a direct connection between agricultural education,training and food supplies (Hermans ***et al***.,2015). This is because graduates of agricultural education and training are responsible for finding solutions to sustainable food production problems as well as delivering services and opportunities to people.

Colleges of agriculture are designed to produce knowledgeable technicians in sufficient numbers to effectively transfer technology to farmers. They also strive to equip their trainees to work efficiently in government agencies, research facilities, and other similar organizations. Additionally, they aim to provide trainees with the knowledge necessary to understand various technologies and put them into practice, as well as to prepare them for farming as a career. The courses offered include crop and animal husbandry, general agriculture, soil and water conservation, irrigation engineering, agronomy, agricultural mechanization, forestry, fisheries and wildlife, animal health, home economic/food technology, and laboratory technology.

The Leventis Foundation's ATVET training program is an effort made to enhance agricultural technical and vocational education and training in Nigeria.. The Foundation was founded in 1979 with the goal of teaching small-scale farmers modern agricultural techniques to increase productivity, efficiency, and enhance environmental sustainability. Nine schools have been established in Nigeria and Ghana as a result. The training is geared towards skill development and capacity building in agriculture and agro-related businesses, with a short training course and farmers' field days for the local area. Trainees spend one year at the schools, after which they return to their farms and communities and are provided with continued support and guidance through school-led extension programs. Additionally, the foundation offers technical assistance through: the provision of improved seeds, short courses to address farm issues and familiarize participants with cutting-edge information and technologies, linkage to input sources and output markets, and farmers field days (Kirui and Kozicka, 2018).

ATVET institutions build strong partnerships with businesses and professional organizations. The establishment of strong partnerships between ATVETs and businesses, as well as professional organizations, creates avenues for internships, on-the-job learning experiences, and collaborative engagement in real-world projects. These partnerships not only enrich students' education but also provide opportunities to establish professional connections within their chosen fields of study through Market-Driven Training. Students can thus acquire relevant professional experience and establish contacts in their field of study. Several challenges and constraints faced by agricultural education institutions include limited outreach and unequal access to quality ATVET programs, particularly in rural areas; mismatch between training and demand; lack of funding to support research in training centers.

With a vast research and extension network, Nigeria possesses immense potential for agricultural transformation. Its 17 research institutes, dedicated extension institute, over 70 faculties of agriculture, and diverse service providers from academia, government, and civil society offer a valuable platform for knowledge production and dissemination. However, optimizing this network's effectiveness requires addressing resource constraints, strengthening research-extension linkages, and promoting inclusive outreach.

Chapter 3 Methods and Sampling

3.1. Mapping of AREE institutions

The research sampling methodology consisted of several steps. First, recognizing the ecological diversity and complexity of Nigeria's agricultural research, extension, and training network, which spans a vast and varied terrain, a purposive sampling method was employed. This approach facilitated the strategic selection of relevant and representative cases from states within both the southern (Oyo and Osun States) and northern (Kaduna and Kano States) regions of the country, ensuring a comprehensive understanding of the diverse agricultural systems and challenges. The states were purposively selected because of the high number of AREE institutions located in the states. Secondly, the National Agricultural Research Systems (NARS) institutions were identified based on their regional and national focus, with a primary emphasis on crops or crops and livestock, in collaboration with the Program of Accompanying Research for Agricultural Innovation (PARI) team. Following this, four institutions were purposively chosen for in-depth examination, namely the Institute for Agricultural Research in Zaria, the Institute of Agricultural Research and Training in Ibadan, the Faculties of Agriculture at the Ahmadu Bello University and the University of Ibadan. Finally, agricultural advisory services and Agricultural Technical and Vocational Education and Training (ATVET) institutions were selected from the states and surrounding areas where the chosen NARS institutions are located, ensuring diverse representation of service models and proximity to research expertise.

Description of agricultural research institutions studied

- The Institute for Agricultural Research (IAR), Samaru was established in 1922 and is affiliated to Ahmadu Bello University (ABU). The IAR has a national mandate for the genetic improvement of maize, cowpea, sorghum, cotton, sunflower and groundnut together with research into their respective agronomy and plant health. Irrigation engineering and irrigated crop production; mechanization of crop production and post-harvest research. In addition the Institute also is mandated to provide solutions to problems of the general farming systems in North-west Nigeria
- The Institute of Agricultural Research and Training, affiliated with Obafemi Awolowo University, Ife, has both national and zonal mandates. Nationally, the institute is tasked with researching the efficient use and management of soil resources to increase and sustain agricultural productivity, as well as the genetic improvement of kenaf and jute. On a zonal level, the institute focuses on farming systems research and extension in various agroecologies in the southwest region. Additionally, they conduct research into maize, grain legumes, and trypanotolerant livestock specific to the southwest Nigerian ecologies, and develop improved processing and utilization technologies for crops and livestock.
- The Faculty of Agriculture at Ahmadu Bello University was established in October 1962, as one of the six pioneer faculties of the university. Its main objective is to develop human resource capacity for directing and implementing Nigeria's agricultural development programs. The faculty offers undergraduate programs in agricultural economics, agricultural extension and rural development, agronomy, animal science, crop protection, fisheries and aquaculture, forestry and wildlife management, plant science, and soil science. Prior to the 2016/2017 academic session, the faculty offered two programs (B. Agric and B.Sc. Agricultural Extension) at the undergraduate level, but with the addition of two new programs, the faculty now has seven departments.

- The University of Ibadan's Faculty of Agriculture was founded in 1949 with the primary goal of generating competent graduates capable of solving new challenges in crop protection, crop improvement, and environmental management. The faculty is dedicated to fostering a supportive environment for cutting-edge research in crop protection, improvement, and environmental management, as well as delivering exceptional diagnostic and management services to address pest and environmental challenges. The faculty provides a range of undergraduate programs in Agricultural Economics, Agricultural Extension Services & Rural Development, Agronomy, Animal Science, and Crop Protection & Environmental Biology.
-

3.2 Interviews with key stakeholders of AREE institutions

Drawing on the AREE institutional mapping in section 3.1, a purposive sample of institutions was selected, comprising four institutions from each category (NARS, ATVET, extension). In-depth interviews were conducted in person with key decision-makers at each institution, including research directors, program managers, and extension experts. The interview guide consisted of sections on general background questions tailored to each category (e.g., NARS research focus, ATVET program offerings, extension service delivery models); questions exploring the institutions' vision, mission, and objectives related to sustainable agriculture; and category-specific questions delving into their roles and challenges within the agricultural innovation system. This customized and targeted approach ensured the collection of relevant data, providing an improved understanding of the diverse perspectives of the diverse stakeholders engaged in AREE.

Table 3.1: Distribution of key stakeholders of AREE institutions

	NARS	ATVET	Extension
Number of organizations	6	4	4
Names of organizations	- Institute for Agricultural Research, Zaria - Institute of Agricultural Research and Training, Ibadan - Univ. of Ibadan - Ahmadu Bello University - CGIAR centers – Ibadan (IITA) & SG 2000	- Kaduna State Agricultural Development Agency (KADA) Oyo State Agricultural Development Programme (OYSADEP Ogun State Agricultural Development Programme (OGADEP) Kano State Agricultural and Rural Development Authority (KNARDA)	- Federal Polytechnic, Kaduna - Samaru College of Agriculture (SCA), Zaria Kaduna State - Federal College of Agriculture, Moor Plantation, Ibadan - Oyo State College of Agriculture and Technology, Igbo Ora,
Number of respondents	7	6	

3.3. Survey of staff from AREE institutions

After selecting the institutions, a list of researchers linked with each of these institutions was collated. Next, in-person interviews were conducted with randomly selected researchers from each of the four institutions. These interviews aimed to collect information about the specific research questions being addressed, the innovative approaches being used to achieve sustainability goals, and the challenges and opportunities faced by these institutions. Different research institutions were compared on their roles in sustainable agricultural transformation through innovation systems in Nigeria.

A set of standardized questionnaires was developed jointly by the PARI partners in Nigeria, Benin, Mali and Kenya. The questionnaire design was based on the research questions to be addressed in the study. Table 3.2 shows the sample for the study. Twenty five (25) respondents were used per institution for this category.

Table 3.2: Distribution of key stakeholders of AREE institutions

	NARS	ATVET	Extension
Number of organizations	4	4	4
Names of organizations	Ahmadu Bello University, Zaria. Institute for Agricultural Research, Zaria. University of Ibadan Institute of Agricultural Research & Training, Ibadan	Kaduna Polytechnic, Kaduna. Samaru College of Agriculture (Dac), Zaria. Oyo State College of Agriculture and Technology, Igbo Ora Federal College of Agriculture, Ibadan	Kaduna State Agricultural Development Agency (KADA), Kano State Agricultural and Rural Development Authority (KNARDA), Oyo State Agricultural Development Programme (OYSADEP), Osun State Agricultural Development Program (OSADP)
Number of respondents	100	100	100

3.4. Survey with students from ATVET institutions

In the selected ATVET institutions (Table 3.3), a survey among students was conducted to better understand their perspective on the skills obtained and needed for sustainable transformation. Four (4) ATVET institutions were randomly selected. From each selected ATVET institution, 25 students were randomly selected, making the total sample to be 100.

Table 3.3: Distribution of students from ATVET institutions

	ATVET
Number of organizations	4
Names of organizations	Federal College of Agriculture, Ibadan Federal (Kaduna) Polytechnic, Kaduna. Oyo State College of Agriculture and Technology, Igbo Ora Samaru College of Agriculture (SCA), Zaria
Number of respondents	**100**

Chapter 4 Results

Figure 4 shows the map of Nigeria with the study states (Kano, Kaduna, Oyo and Osun) mapped out.

4.1. Mapping

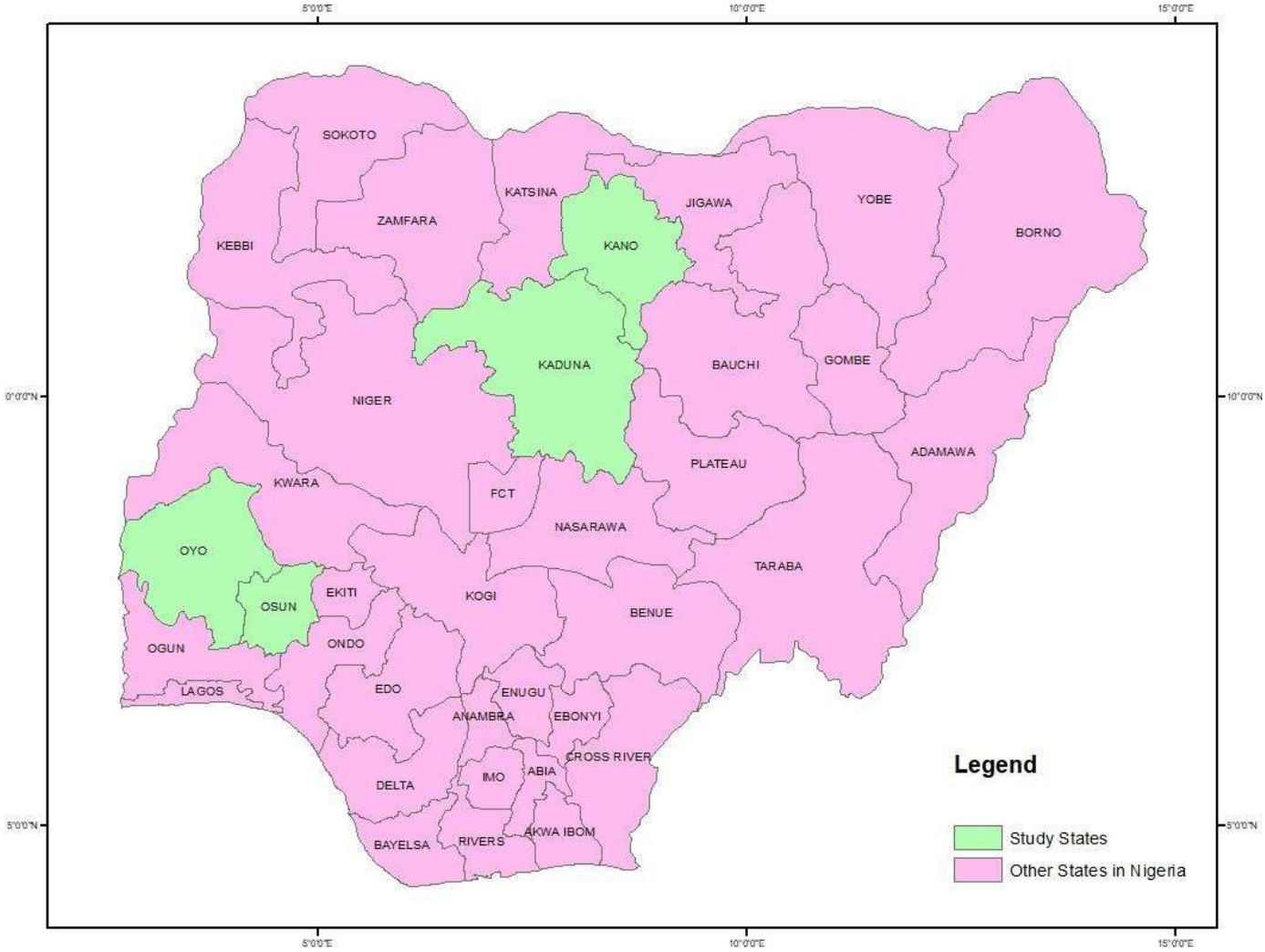

Figure 5: Map of Nigeria showing the study state

4.2. Staff survey

4.2.1. Staff characteristics and motivation

General background of the respondents

Gender of respondents: : Table 4.1 presents the distribution of respondents across gender categories. In Nigeria, the majority (76%) of researchers were male, with notable variations observed among different institutions. Females constituted 25% of NARS respondents, while the ATVET sector recorded a lower percentage at 23.47%. According to the European Commission's She Figures Handbook, in 2012 only 33% of European researchers were women. This percentage tends to be even lower in typically male-dominated fields. Throughout the years, She Figures has also provided evidence that women have been historically underrepresented at the head of higher education institutions (European Institute for Gender Equality, 2016).

The Nordic Institute for Studies in Innovation, Research and Education (NIFU) (2020) conducted a review

where the following data was revealed:

- The proportion of women among researchers rose by six percentage points in the period 2010–2020.
- Women make up 45 per cent of researchers and academic staff.
- Technical-industrial institutes have the lowest percentage of women: 30%.
- The proportion of women at social science institutes was 52 percent.
- At primary industry institutes (agriculture, fisheries and veterinary medicine), 48 percent of employees are women.

Statista (2020) revealed a higher number of non-academic staff among women in the academia. In the academic year 2018/2019, male personnel represented the vast majority of people working at Nigerian universities. This was composed of around 87,000 and 52,000 male non-academic and academic staff, respectively. On the contrary, women were about 65,000 in total. This indicates that the number of male was more than double of the females. In a study on gender and work-productivity of academic staff in selected private universities in Kampala city, Uganda, less than 28% of the workforce were female (Amunaka and Ssemugenyi, 2013).

Work experience: The respondents had an average of 16 years of work experience, with extensionists having the highest (20 years) and ATVET staff having the lowest (13 years).
This result implies that the respondents had good knowledge of how their institutions have promoted sustainable agricultural transformation through innovation systems, and the possibility of having been involved in the process over the years. Issa ***et al***. (2022) found that years of experience and salary grade level were the major determinants of job performance of extension agents in Nigeria. This result also suggests a cadre of senior researchers with substantial experience, potentially enhancing their effectiveness. The primary role of researchers and extensionists in Nigeria is to generate and validate new knowledge, information and technologies; disseminate and commercialize them to sustain agro-industrialization in the country. Hence, longer work experience is expected to make them more effective and efficient on the job.

Age: The average age of all the respondents was 44 years, with extensionists being the oldest (48 years) and NARS staff being the youngest (39 years). This result indicates that the respondents were in their active and productive age. This finding is consistent with previous studies that reported that the mean age of extension agents in Nigeria ranged from 40 to 44 years (Issa ***et al***., 2022).

This findings could have engendered skill building and research-extension linkages since research and extension activities requires some level of agility on the part of practitioners.

Origin: More than half (52%) of the total respondents were originally from a rural area, with NARS staff having the highest share (58%) and ATVET staff having the lowest share (51%). This indicates that the respondents had adequate rural background, which could enhance their performance and ensure sustainable agricultural transformation. Possession of rural background is crucial in extension work, since most clients operate in the rural area. Rural background may also influence the motivation and interest of researchers and educators in addressing the challenges and opportunities of the rural population.

Overseas study: An average of 11 respondents studied abroad. None of the respondents in the extension agencies studied abroad. Twenty-six percent of NARS staff studied abroad, while none (0%) of respondents in extension studied abroad. Studying abroad is about exposure to relevant research and extension experience. Researchers and extensionists who had opportunity to study abroad are likely to have wide-spread collaborators beyond the shores of their home country, thus capable of ensuring the expected linkages that can foster sustainable agricultural transformation. The challenges of extension education and training in Nigeria are inherent in the nature and characteristics of the extensionist themselves, the trainers, training needs and the ability of the training institutions and agencies to develop and deliver appropriate training programmes relevant to the system (Issa ***et al***.,

2010).

Table 4.1: Respondents' general background

General background	NARS	ATVET	Extension	Average
Gender (share of females)	25 (25%)	23 (23.47%)	24 (24.7%)	24
Work experience (years)	Av=16	Av=13	Av=20	16
Age (years)	Av=39	Av=44	Av=48	44
Origin (share rural)	58 (58%)	50 (51%)	49 (50.5%)	52
Studied abroad (share yes)	26 (26%)	7(7.14%)	0 (0%)	11

Professional backgrounds of respondents

The professional background of respondents revealed the following averages: Agronomy/Plant Breeding/Entomology (21%), Social Sciences/Economics, Public Health/Educational Studies (16%) and Livestock/Veterinary (15%) (Table 4.2). The fact that majority of the respondents were from research institutes could have accounted for this result. Crop production is, no doubt, ahead of other subsectors in agriculture. This could also have accounted for this finding, where 27.40% of respondents in extenion agencies were of agronomy background. In line with this finding, Issa *et al*. (2022) found that 29.4% of extension staff had agricultural extension/management as their area of specialization. It should however be noted that the study included only core professionals in the extension service.

According to European Institute for Gender Equality (2016), women and men tend to concentrate in certain scientific fields (horizontal segregation). For instance, while women are more likely to be found in fields like social sciences and humanities, men are more inclined to study, teach and/or research topics related to engineering or technology.

Table 4.2: Distribution of respondents by professional background

Professional background	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**
Agronomy / Plant Breeding / Entomology	24	12	27.4	21
Livestock / Veterinary	17	11	15.9	15
Social Sciences / Home Economics, Public Health / Educational Studies	17	17	13.8	16
Environmental sciences / Biology	7	3	2.1	4
Management / Business / Public Administration	10	4	2.1	5
Engineering / Processing / Conservation of Agri-food Products	8	30	3.2	14
Agricultural Economics	11	8	9.5	10
Aquaculture, Fisheries and Forestry Management	-	3	-	3
English	-	1	-	1
Library Sciences	-	1	-	1

Agricultural Extension and Rural Development	6	8	19.1	11
Total	100	98	100	100

Educational qualification of respondents

Most (31.5%) of the respondents were MSc holders (Table 4.3). Computation revealed that 62.53% of the respondents had degrees beyond first degree. This reflects that the majority of the respondents were well schooled. The majority (68%) of the NARS staff had PhD degree. The lowest percentage of PhD holders was recorded among extension staff. Ability to build research-extension linkage could be better enhanced with higher level of education. NARS and ATVET place emphasis on higher education compared to extension agencies. This could have been due to the demand of the job in the different institutions. Only 15.9% of the extension officers in Kaduna State ADP had PGD/MSc, while none had PhD (Issa et al., 2022).

Table 4.3: Percentage Distribution of respondents by Educational qualification

Education	NARS	ATVET	Extension	Average
~~Vocational school~~	~~0~~	~~0~~	~~0~~	~~0~~
Certificate in Agriculture (%)	0	2	3.10	1.70
Bachelor's degree (%)	0	20	35.10	18.36
Higher National Diploma (%)	5	5	41.20	17.07
Master's degree (%)	27	50	17.50	31.50
Ph.D. Degree (%)	68	22	3.10	31.03

Additional training acquired by respondents

Among the extension staff, 43.91% agreed that training in agronomic aspects had been covered to a great extent (Table 4.4). Most (32.18%) of the respondents across the institutions agreed that training in agronomic aspects had been covered to a great extent. However, it is counter-intuitive that 26.15% of staff across board believed that additional training in agronomic aspect had not been covered at all, since only one of the scenario must be correct. About half (48.96%) of the respondents agreed that additional training in economic aspects had been covered to a great extent. Yet, 20.85% believed that economic aspects had not been covered at all in the additional training.

Most (39.16 and 35.04%) of the respondents agreed that additional training in the aspects of social and environmental aspects, respectively, had been covered to a great extent.
The majority (69.63%) of the staff agreed that additional training in the aspects of social and digital aspect had been covered to a great extent.

Generally, most of the respondents believed that all the aspects had been covered to a great extent. Almost 62% of ATVET staff did not have additional training in any aspect.
Training is the process of acquiring specific skills to perform a job better. It helps people to be qualified and proficient in doing some jobs. Professional training is expected to be regular and result oriented if it must achieve the desired goal.

Table 4.4: Percentage Distribution of respondents by additional training acquired

Additional training		Category	NARS	ATVET	Extension	Average
Additional training besides formal training (share yes)			78 (78%)	38 (38.78%)	63 (64.9%)	60 (61.00%)
In the additional training, which aspects have been covered? *(On a scale from 1=Not at All to 4=To a Great Extent)*	Agronomic aspects (%)	Not at All	25.45	42.11	10.90	26.15
		Very Little	23.68	23.68	18.20	21.85
		Somewhat	7.89	7.89	11.74	9.17
		To a Great Extent	26.32	26.32	43.91	32.18
	Economic aspects (%)	Not at All	23.68	23.68	15.18	20.85
		Very Little	13.16	13.16	12.87	13.06
		Somewhat	15.79	15.79	19.79	17.12
		To a Great Extent	47.37	47.37	52.15	48.96
	Social aspects (%)	Not at All	21.05	21.05	14.29	18.80
		Very Little	15.79	15.79	15.55	15.71
		Somewhat	26.32	26.32	26.36	26.33
		To a Great Extent	36.84	36.84	43.80	39.16
	Environmental aspects (%)	Not at All	31.58	31.58	14.76	25.97
		Very Little	13.16	13.16	16.52	14.28
		Somewhat	26.32	26.32	21.51	24.72
		To a Great Extent	28.95	28.95	47.22	35.04
	Digital tools (%)	Not at All	2.63	2.63	11.80	5.69
		Very Little	13.16	13.16	15.28	13.87
		Somewhat	10.53	10.53	11.39	10.82
		To a Great Extent	73.68	73.68	61.53	69.63

Motivations received by respondents

Result in Table 4.5 indicates that the majority (67.05%) of NARS staff were motivated by sharing/transfer of knowledge, while only 12.5% of them were motivated by change in the country. This implies that there was not substantial positive change in the country especially for farmers. That less than 31% of NARS staff were motivated by regular income implies that income for NARS staff was not satisfactorily regular. In the same vein, less than 10% of ATVET staff (9.18%) and extension staff (9.3%) were motivated by prestige. This implies that ATVET and extension jobs are not considered adequately prestigious in Nigeria.

Only about 40% of the staff across board had personal fulfilment. Against *apriori* expectation, less than 40% of the staff believed that there is job security.

Opportunity for promotion and growth is the most important motivational factor found by Ajayi and Banmeke (2006). This was closely followed by opportunity for in-service training and development. Extension workers in Odisha (a state in India) are highly motivated when farmers recognize and appreciate their work and services (Jaya, 2021).

Table 4.5: Percentage distribution of respondents by motivation

Motivation	NARS	ATVET	Extension	Average
Regular income (%)	30.68	27.55	35.10	31.11
Job security (%)	39.77	35.71	44.30	39.93
Prestige (%)	12.50	9.18	9.30	10.33
Change in the country / for farmers (%)	12.50	52.04	55.70	40.08
Personal fulfilment (%)	59.09	37.76	23.70	40.18
Share / transfer knowledge (%)	67.05	58.16	39.20	54.80
Gain work experience (%)	43.18	30.61	35.10	36.30
Only available job (%)	-	6.12	-	6.12

** Multiple responses allowed

Respondents' perceived main goals of the type of organization

Increased productivity, increased food security, and poverty reduction remained the main organizational goal as indicated by 76.06%, 74.52%, and 62.11% of the respondents, respectively (Table 4.6). Only 18.22% of the respondents across board saw fostering the use and development of digital tools as main organizational goal.

Table 4.6: Distribution of respondents by perceived main goals of the type of organization

**Perceived main goals of the type of organization	NARS	ATVET	Extension	Average
Increase productivity (%)	78.41	68.37	81.40	76.06
Reduce poverty (%)	69.32	51.02	66.00	62.11
Improve mitigation and adaptation to climate change (%)	54.55	27.55	48.50	43.53
Foster women's empowerment (%)	28.41	23.47	30.90	27.59
Improve food security (%)	82.95	65.31	75.30	74.52
Contribute to biodiversity conservation (%)	42.05	28.57	37.10	35.91
Integrate marginalized groups and the poorest (%)	27.27	16.33	26.80	23.47
Improve access to financial services (%)	27.27	11.22	20.60	19.70
Foster the use and development of digital tools (%)	23.86	15.31	15.50	18.22
Others (%)	-	4.08	-	4.08

** Multiple responses

Amount spent on three different aspects of sustainability by respondents

A large percentage (46.45%) of the national agricultural budget was believed to be spent on economic sustainability (Table 4.7). This implies that the major problem of staff across board is basically economic. This result cannot be divorced from hunger, poverty and poor living standard in the country which had been accentuated by poor agricultural growth.

Table 4.7: Distribution of respondents by amount spent on three different aspects of sustainability

Out of 100% of the national agricultural budget, what percentage should be spent on the three different aspects of sustainability?	NARS	ATVET	Extension	Average
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.) (%)	45.00	44.34	50.00	46.45
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.) (%)	32.23	26.89	26.10	28.41
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.) (%)	22.77	28.77	23.90	25.14
Total (%)	100	100	100	100

4.2.2. Professional networks

Background of the colleagues respondents mostly work with from within the organization

Respondents mostly worked with agronomist/plant breeders and entomologists as indicated by the majority (81.61%) (Table 4.8). Similarly, 64.02% of the respondents worked with livestock/veterinary officers, while 47.11% worked with colleagues in the processing and conservation of agri-food products.

Table 4.8: Percentage distribution of respondents by background of colleagues they mostly work with from within the organization

Background of the colleagues you mostly work with from within the organization	NARS	ATVET	Extension	Average
Agronomy / Plant Breeding / Entomology (%)	48.90	95.92	100	81.61
Livestock / Veterinary (%)	42.05	50.00	100	64.02
Social Sciences / Economics, Public Health / Educational Studies (%)	15.90	57.14	60.80	44.61
Environmental Sciences / Biology (%)	48.86	49.90	15.50	38.09
Management / Business / Public Administration (%)	14.77	19.39	17.50	17.22
Engineering / Processing / Conservation of agri-food products (%)	39.78	52.04	49.50	47.11
Agric Extension (%)	47.37	2.04	23.60	24.34
Agricultural Economics (%)	17.05	2.04	13.10	10.73
Aquaculture and Fisheries Management (%)	-	1.02	6.80	3.91
Chemistry (%)	-	1.02	-	2.55
Soil Science (%)	-	4.08	-	4.08

** Respondents gave multiple response

Number of times respondents met with staff members from other organizations

About 55% of the respondents met with staff members of the national research organizations only up to 5 times during the last 12 months, while only very few (14.21%) did more than 10 times within same period (Table 4.9).

Majority (62.32%) of the respodents indicated meeting with members from CGIAR centers just up to 5 times. Similarly, 63.61% indicated meeting with personnel from other international research organizations for just up to 5 times.Also, 58.22% of the respondents reported to have interacted with persons from educational institutions, while 61.2% reported to have met with officers from extension agencies for up to 5 times in the past 12 months.

Many of the respondents (59.6%) reported to have met with NGOs , and 59.46% with farmers' organizations for up to 5 times within the 12 month period, while they reported to have met with actors in the value chain for the same number of times and within the same period.

Generally, meeting with staff members in other organizations was poor. Though the research did not pick interest in the nature and outcome of the meetings, it is not impossible that some or most of such meetings were merely ceremonial and lack technical relationships on research issues.

Regular meetings with other research and extension organizations remain crucial for technology sharing and dissemination to farmers. It is also important for capacity building and knowledge broadening. It exposes staff to current thinking in the world of agricultural research.

Results indicate that the number of meeting times remained inadequate to harness derivable benefits. It must be noted that the meetings among institutions are usually sporadic and left to the discretion of the CEOs of the institutions based on informal existing relationships among them. Reviewing the Ibadan experience about relationship that exists among agricultural institutions declared that agricultural institutions even when they share a fence, do not know what the other ones close to them are doing. This is because there was no agreed arrangement for them to meet and discuss common issues that can promote agricultural development, a situation that has led to unnecessary duplications of efforts and waste of limited resources.

Poor relationship with educational institutions have led to the continuous use of moribund curriculum, where students are not exposed to current issues in agricultural research and extension.

Table 4.9: Percentage distribution of respondents by number of times they met with staff members from other organizations

During the last 12 months, how many times did you meet with staff members from ...?	Category	NARS	ATVET	Extension	Average
... national research organizations (including university staff)	Up to 5 times (%)	55.0	47.37	61.7	54.69
	Between 6 and 10 times (%)	32.0	32.89	28.4	31.10
	More than 10 times (%)	13.0	19.74	9.9	14.21
... members from CGIAR centers	Up to 5 times (%)	61.0	62.96	63.0	62.32
	Between 6 and 10 times (%)	28.0	33.33	32.6	31.31
	More than 10 times (%)	11.0	3.70	4.3	6.33
... other international research organizations	Up to 5 times (%)	64.81	53.13	72.9	63.61
	Between 6 and 10 times (%)	25.93	43.75	25.0	31.56
	More than 10 times (%)	9.26	3.13	2.1	4.83
... education institutions (e.g., vocational schools)	Up to 5 times (%)	57.69	55.56	61.4	58.22
	Between 6 and 10 times (%)	30.77	30.86	34.1	31.91
	More than 10 times (%)	11.54	13.58	4.5	9.87

… extension service offices, including from private and third sector	Up to 5 times (%)	55.81	60.00	67.8	61.20
	Between 6 and 10 times (%)	32.56	35.00	27.1	31.55
	More than 10 times (%)	11.63	5.00	5.1	7.24
… NGOs?	Up to 5 times (%)	41.94	76.47%	60.4%	59.60%
	Between 6 and 10 times (%)	33.87	20.59	30.2	28.22
	More than 10 times (%)	24.19	2.94	9.4	12.18
… farmer organizations/ cooperatives	Up to 5 times (%)	55.0	43.59	37.8	45.46
	Between 6 and 10 times (%)	35.0	39.74	28.9	34.55
	More than 10 times (%)	10.0	16.67	33.3	19.99
… actors of the value chain (e.g., input dealers, processors, retailers, consumers)	Up to 5 times (%)	55.36	59.32	55.4	56.69
	Between 6 and 10 times (%)	37.5	32.20	37.5	35.73
	More than 10 times (%)	7.14	8.47	37.50	17.70

4.2.3. Perceptions of challenges in the agricultural sector, mission of organisation, and sustainability aspects

The agricultural sector is an important part of any economy and also one of the most challenging sectors due to the numerous complexities and risks associated with it. Different stakeholders in the sector have different perceptions of the challenges in the sector. Table 4.10 shows the perceptions of the the respondents by type of institutions of the main challenges in the agricultural sector. . Low productivity such as crop harvest, milk, meat, etc. (60% and 55%), incidence of pests and diseases (50% and 52%), availability and cost of inputs (51% and 38%), changing climatic patterns (37% and 39%), low soil fertility (38% and 36%), and lack of access to finance (39% and 42%) are viewed as the main challenges of the agricultural sector today/currently and 10-20 years ago, respectively.

Low productivity seems to be particularly perceived among NARS and ATVET institutions staff as the main challenge of the agricultural sector while incidence of pests and diseases is viewed by staff of extension institutions as the main challenge of the sector today and 10-20 years ago. The Table also shows that lack of access to digital tools and unreliable and/or lack of network coverage are relatively not considered by the respondents as a major challenge to the agricultural sector.

The lack of access to digital tools and network coverage is not perceived as a major challenge to the agricultural sector because traditional farming practices are still widely used in many rural areas. These practices do not require the use of digital tools and the lack of access to them is often seen as an advantage because it allows farmers to rely on their own knowledge and experience. Additionally, many farmers do not have the financial resources needed to purchase digital tools such as smartphones, computers, and tablets, or to access networks that would allow them to use them. Furthermore, there is often inadequate infrastructure in rural areas, meaning that even if the digital tools were available, they might not be able to be used due to a lack of reliable internet connection (Trendov ***et al***., 2019).

Finally, the agricultural sector is often a low priority for government and private sector initiatives, meaning that there is often limited investment in these areas.

Table 4.10: Perception of the main challenges in the agricultural sector

Perceived main challenges of farming	NARS		ATVET		Extension		Average	
	10-20 years ago	Currently	10-20 years ago	Currently	10-20 years ago	Currently	10-20 years ago	Currently
Low productivity (%)	64.77	69.32	57.14	61.22	42.30	50.50	54.74	60.35
Pests and diseases (%)	45.45	43.18	51.02	48.98	60.80	56.70	52.42	49.62
Livestock health and welfare (%)	21.95	39.39	21.43	21.43	16.90	12.40	20.09	24.41
Low soil fertility (%)	36.36	72.74	34.69	29.59	37.10	10.30	36.05	37.54
Water issues (%)	19.51	16.28	20.41	16.33	31.60	24.70	23.84	19.10
Low and unpredictable rainfall (%)	41.46	46.59	24.49	26.53	43.30	17.5%	36.42	30.21
Flooding (%)	21.21	37.88	22.45	25.51	21.95	39.39	21.87	34.26
Changing climatic patterns (%)	32.95	18.60	39.80	47.96	43.30	44.30	38.68	36.95
Inputs issues (%)	42.05	50.00	27.55	46.94	44.30	54.60	37.97	50.51
Poverty and inequality (%)	19.09	27.27	27.55	18.37	42.30	25.76	29.65	23.80
Roads and rural infrastructure (%)	30.03	37.21	28.57	18.37	11.30	16.67	23.30	24.08
Marketing issues (%)	10.61	53.49	17.35	14.29	9.30	44.19	12.42	37.32
Finance issues (%)	61.06	44.19	38.78	35.71	24.70	36.10	41.51	38.67
Extension service issues (%)	40.91	18.60	20.41	6.12	16.50	49.50	25.94	24.74
Education issues (%)	18.52	30.23	21.43	10.20	19.60	7.20	19.85	15.88
Digital tool issues	16.67	11.63	11.22	4.08	17.50	4.10	15.13	6.60
Electricity issues	6.06%	9.30	8.16	5.10	10.30	27.80	8.17	14.07
Network coverage	10.09	16.28	5.10	3.06	5.20	15.50	6.80	11.61
Other (Post-harvest losses, insecurity, policy inconsistency)	13.03	37.21	11.22	12.24	13.40	11.30	12.55	20.25

Table 4.11 shows that only 34% of all respondents consider the mission of AREE institutions to have significantly changed in the last 10 years. The proportion of respondents that perceived a change in mission of their organisation is highest in extension institutions (almost five times compared to NARS). Agricultural research, extension and education institutions' missions need to evolve dramatically over time to keep up with the world's food system's growing complexity. There is an increasing demand for innovative and efficient farming methods as the world's population continues to rise and more land is needed for agricultural production. So, in order to develop new technologies and processes that can help in meeting the needs of the growing population while preserving natural resources and safeguarding the environment, relevant institutions must continue to be at the forefront of research and development.

Furthermore, as climate change becomes more prevalent, agricultural research, extension and education institutions must be prepared to develop new methods and solutions to handle the consequences of changing climates on agriculture. As a result, in order to remain relevant and effective, these organizations' missions must evolve with the times. However, since the goal of an agricultural institution is to assist in enhancing food production and the sustainability of farming operations, the institution's objective may not significantly change with time. This mission is important for the long-term health of the agricultural sector and the global population. By maintaining the same mission, the institution can work towards consistent goals that benefit the industry and its stakeholders. With regular updates and improvements, the institution can ensure it is providing the best possible services to its customers.

Table 4.11 further shows how important the different stakeholders see some critical research roles in their daily activities and whether their institutions place importance on such roles. The table confirms that the different stakeholders considered in this study have mostly positive views on the different sustainability aspects. For example, the result shows that majority of the staff across all AREE institutions considered aspects regarding increasing crop yields and field productivity (63%), efficiency of input use (55%), efficient and safe handling of agro-chemicals (48%), and marketing/commercialization of products (46%) as very important. Similarly, majority of the staff across all AREE institutions considered activities and practices related to improving nutrition (53%) as an important aspect while reducing land degradation (41%), integrating aspects that relate to climate change (51%), provision of information on improving agricultural water management (47%), biodiversity-friendly measures in the agricultural landscape (51%), increasing livestock productivity (50%), activities and practices which implement and promote animal health (49%), and integrating gender aspects when promoting and/or designing agricultural activities and/or practices (54%) are viewed as slightly important sustainability aspects.

Table 4.11 also shows that majority of the staff across all the institutions think that the institutions should place more importance on increasing crop yields and field productivity (78%), efficiency of input use (79%), efficient and safe handling of agro-chemicals (76%), marketing/commercialization of products (68%), provision of information on microfinance opportunities as saving and credit options (58%), reducing land degradation (73%) and integrating aspects that relate to climate change (86%). Other sustainability aspects the respondents wished AREE institutions would place more importance on include provision of information on improving agricultural water management (67%), biodiversity-friendly measures in the agricultural landscape (86%), increasing livestock productivity (79%), activities and practices which implement and promote animal health (77%), activities and practices related to improving nutrition (76%), integrating gender aspects when promoting and/or designing agricultural activities and/or practices (66%), integrating marginalized groups and/or the poorest when promoting and/or designing agricultural activities and/or practices (60%). However, there are variations in the perceptions of respondents across the different institutions.

Scientists actively seek to discover procedures that will increase crop/livestock yields, improve farmland productivity, reduce losses due to diseases and insects, develop more efficient equipment, and increase overall food quality. Researchers look for ways to increase farmers' profits and to protect the environment. The issue of how efficiently farmers use various farm inputs in crop cultivation has been an important topic of research over the years. In crops like gram and sugarcane, the low productivity states have outperformed the high productivity states not only in the overall resource use efficiency but even at the individual level input use efficiency. The yield augmenting cost-intensive inputs such as fertilisers, irrigation and seed seem to have not been used efficiently over time (Narayanamoorthy ***et al***., 2017). The unsafe handling and use of agrochemicals can lead to excessive exposures and accumulation of hazardous chemicals in the body; causing adverse effects on health (Ekwempu, 2019). It is the role and responsibility of the researcher to use the understanding of the needs of the market to find applications for new products that will satisfy these needs. Most commercial marketing research and research conducted internally by research departments is applied research since companies are seeking solutions to problems or information that can help them exploit potential opportunities. Marketing research should provide information that will allow managers to make better marketing decisions. Research has shown that integrating biodiversity-friendly measures in agricultural landscape is a very important innovation system for promoting sustainability of agricultural transformation (Bisht ***et al***., 2020).

Table 4.11: Perceptions of mission of organization and sustainability aspects

			NARS	ATVET	Extension	Average
Has the mission of your institution significantly changed in the last 10 years? (Share yes)			12 (12%)	36 (36.73%)	56 (57.7%)	35 (33.5%)
How important are the following topics for your institutio n? *(On a scale from 1=Not Importan t to 4=Very important)*	Crop yields and productivity (%)	Not important	-	0.00	-	0.00
		Slightly important	1.0	4.08	3.1	2.73
		Important	29.0	39.80	33.0	33.93
		Very important	70.0	56.12	63.9	63.34
	Efficient input use (%)	Not important	3.0	0.00	-	1.50
		Slightly important	4.0	4.08	6.2	4.76
		Important	30.0	48.98	38.1	39.03
		Very important	63.0	46.94	55.7	55.21
	Safe handling of agrochemicals (%)	Not important	5.0	0.00	1.0	2.00
		Slightly important	11.0	3.06	3.1	5.72
		Important	38.0	50.00	44.3	44.10
		Very important	46.0	46.94	51.5	48.15
	Marketing/ commercializat ion (%)	Not important	2.27	3.33	-	2.80
		Slightly important	6.82	5.00	4.1	5.31
		Important	39.77	55.00	44.3	46.36
		Very important	51.14	36.67	51.5	46.44
	Microfinance (%)	Not important	25.0	3.06	3.1	10.39
		Slightly important	47.0	7.14	5.2	19.78
		Important	16.0	56.12	54.6	27.59
		Very important	12.0	33.67	37.1	2.03
	Land degradation (%)	Not important	2.0	0.00	4.1	19.39
		Slightly important	51.0	4.08	3.1	40.76
		Important	29.0	48.98	44.3	37.81
		Very important	18.0	46.94	48.5	2.09
	Climate change (%)	Not important	2.0	2.17	-	3.82
		Slightly important	5.0	4.35	2.1	50.94
		Important	53.0	56.52	43.3	43.85
		Very important	40.0	36.96	54.6	3.31
	Water management (%)	Not important	6.82	1.02	2.1	6.93
		Slightly important	13.64	3.06	4.1	46.96
		Important	45.45	45.92	49.5	42.80
		Very important	34.09	50.00	44.3	1.03
	Biodiversity-friendly agriculture (%)	Not important	1.0	0.00	2.1	24.81
		Slightly important	62.0	8.33	4.1	51.12
		Important	29.0	66.67	57.7	23.03
		Very important	8.0	25.00	36.1	1.70
	Livestock productivity (%)	Not important	2.0	0.00	3.1	2.01
		Slightly	4.0	1.02	1.0	50.13

		important				
		Important	55.0	48.98	46.4	47.20
		Very important	39.0	50.00	52.6	0.78
	Animal Health (%)	Not important	1.35	0.00	1.0	3.63
		Slightly important	6.76	1.02	3.1	49.25
		Important	51.35	50.00	46.4	46.34
		Very important	40.54	48.98	49.5	1.47
	Nutrition (%)	Not important	3.41	0.00	1.0	3.23
		Slightly important	4.55	2.04	3.1	42.44
		Important	32.95	47.96	46.4	52.86
		Very important	59.09	50.00	49.5	3.17
	Gender (%)	Not important	2.27	2.04	5.2	18.03
		Slightly important	6.82	9.18	38.1	54.16
		Important	46.59	59.18	56.7	26.37
		Very important	44.32	29.59	5.2	2.86
	Marginalized groups and/ or the poorest (%)	Not important	3.41	3.06	2.1	4.27
		Slightly important	5.68	6.12	1.0	52.00
		Important	42.05	52.04	61.9	40.91
		Very important	48.86	38.78	35.1	-
Do you think your institutio n should place more importan ce on this aspect? (Share yes)	Crop yields and productivity		82 (82%)	54 (53.06%)	49 (98%)	77.69%
	Efficient input use		85 (85%)	59 (60.20%)	51 (91.1%)	78.77%
	Safe handling of agrochemicals		67 (67%)	60 (61.22%)	60 (98.8%)	75.67%
	Marketing/ commercializat ion		74 (74%)	42 (42.86%)	53 (88.3%)	68.39%
	Microfinance		37 (37%)	46 (53.06%)	60 (84.5)	58.19%
	Land degradation		33 (76.7%)	46 (46.94%)	60 (95.2%)	72.95%
	Climate change		35 (85.4%)	50 (78.26%)	54 (93.1%)	85.59%
	Water management		37 (59.6%)	48 (48.98%)	60 (92.3%)	66.96%
	Biodiversityfriendly agriculture		33 (76.7%)	53 (87.50%)	69 (93.5%)	85.90%
	Livestock productivity		32 (91.4%)	54 (55.10%)	56 (91.8%)	79.43%
	Animal Health		32 (86.5%)	50 (51.02%)	58 (93.5%)	77.01%
	Nutrition		41 (91.2%)	44 (44.90%)	53 (91.4%)	75.83%
	Gender		45 (80.4%)	47 (47.96%)	50 (70.4%)	66.25%
	Marginalized groups and/or the poorest		32 (66.7%)	38 (38.78%)	56 (75.5%)	60.33%

4.2.4. Digitalization

Digitalization refers to the integration of digital technology into livestock and crop management and other processes related to cultivating and managing food resources. It is often used to describe different uses for the variety of data collection and analysis in agricultural sector. According to Padhy *et al.* (2022), digital skills and people who are capable of using digital devices, comprehending outputs and developing programmes and applications are in high demand as a result of digitalization. Basic literacy, numeracy, data handling and communication skills are required. Education must improve quickly in areas where skills are low.

Majority (98.6%) (as represented in Table 4.12) of the respondents used digital tools for various agricultural activities. The type of devices mostly used on average was smartphone (97.3%) while the least used device was GPS (37.9%). All staff of NARS (100%) used digital tools for teaching. However, for extension staff, none (0%) of them used it for teaching but preferred using it for social media (90.7%), weather forecast (79.4%) and news (83.5%). The ATVET used digital tools for weather forecast (29.9%) which need to be improved on, especially this period that the climate information is needed to be passed across to farmers. Basso and Antle (2020) discovered that digital agriculture can improve farmers' capacity to respond to weather conditions affected by climate change through accurate climate forecasts. Digital tools was averagely used for market price by 34.4% of the AREE staff. This is another area of digital agriculture that requires improvement.

Table 4.12: Digitalization in Agriculture expressed in percentage

Digital tools		NARS	ATVET	Extension	Average
In your daily activities, do you use digital tools? (Share yes) (%)		100	99	96.9	98.63
What kind of devices do you use?	Phone/Smartphone (%)	98.00	98	95.90	97.30
	Computers (%)	96.00	87	58.80	80.60
	Tablets (%)	47.70	45	40.20	44.30
	GPS devices (%)	44.30	22	47.40	37.90
	Other (resistivity metre) (%)	-	1	-	1.00
What do you use these devices for?	Teaching (%)	100	76.29	0	58.76
	Communication (e.g., WhatsApp) (%)	93.00	93.81	62.90	83.24
	Social media (e.g., Facebook, Twitter, Instagram) (%)	94.00	83.51	90.70	89.40
	News (e.g., BBC, local TV or radio) (%)	80.00	67.01	83.50	76.84
	Banking (%)	73.01	83.51	66.00	74.17
	Weather forecast (%)	79.00	29.90	79.40	62.77
	Agricultural information/ advice/ training (crop, livestock, etc.) (%)	22.00	23.71	43.30	29.67
	Information/ advice/ training on other aspects (e.g., marketing, finance) (%)	25.00	42.27	46.40	37.89
	Price information (%)	32.00	12.37	58.80	34.39
	Transport options (%)	10.00	12.37	23.70	15.36
	Leisure (e.g., videogames, video clips, music) (%)	63.00	37.11	18.60	39.57
	Others (%)	25.00	2.06	39.20	22.09

4.2.5. Work environment

As presented in Table 4.13, more than sixty percent (67.2%) of the AREE staff agreed that they received feedback about the quality of work they did while only 4.3% disagreed. On average, 56.5% of the respondents set high standard of performance for themselves whereas 73.3% agreed that they were given the freedom at the station to make decisions and solve problems about their work. More than fifty percent (54.5%) of the respondents felt recognized by their peers as a hard worker while less than 2% of the respondents disagreed that their boss placed a great deal of confidence in their judgment. More than 60% of the respondents agreed that they had job satisfaction.

Table 4.13: Work environments

What is your view on the following statements related to **job satisfaction**? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*		**NARS**	**ATVET**	**Extension**	**Average**
You receive feedback about the quality of your work	Strongly Disagree (%)	2.27	0.00	1.00	1.09
	Disagree (%)	5.68	4.08	3.10	4.29
	Agree (%)	68.18	68.37	64.90%	67.15
	Strongly Agree (%)	23.86	25.51	30.90	26.76
	Not Applicable (%)	-	2.04	-	2.04
You have set for yourself a high standard of performance	Strongly Disagree (%)		2.04	2.10	2.07
	Disagree (%)	3.41	1.02	3.10	2.51
	Agree (%)	43.18	60.20	66.00	56.46
	Strongly Agree (%)	53.41	36.73	28.90	39.68
	Not Applicable (%)	-	0.00	-	0.00
You are given the freedom at the station to make decisions and solve problems about your work	Strongly Disagree (%)	-	1.02	1.00	1.01
	Disagree (%)	4.55	9.18	8.20	7.31
	Agree (%)	77.27	64.29	78.40	73.32
	Strongly Agree (%)	18.18	25.51	12.40	18.70
	Not Applicable (%)	-	0.00	-	0.00
You feel recognized by your peers as a hard worker	Strongly Disagree (%)	-	0.00	-	0.00
	Disagree (%)	63.64	1.02	2.10	22.25
	Agree (%)	36.36	59.18	68.00	54.51
	Strongly Agree (%)	-	39.80	29.90	34.85
	Not Applicable (%)	-	0.00	-	0.00
Your boss places a great deal of confidence in your judgment	Strongly Disagree (%)	-	0.00	-	0.00
	Disagree (%)	2.27	2.04	1.00	1.77
	Agree (%)	69.32	62.24	67.00	66.19
	Strongly Agree (%)	28.41	35.71	32.00	32.04
	Not Applicable (%)	-	0.00	-	0.00

Your job has made you gain experience in life, which will help you in the future.	Strongly Disagree (%)	-	1.02	2.10	1.56
	Disagree (%)	2.27	1.02	4.10	2.46
	Agree (%)	46.59	48.98	59.80	51.79
	Strongly Agree (%)	51.14	48.98	34.00	44.71
	Not Applicable (%)	-	0.00	-	0.00
You are satisfied with your job	Strongly Disagree (%)	1.14	0.00	2.10	1.08
	Disagree (%)	11.36	12.24	9.30	10.97
	Agree (%)	69.32	60.20	67.00	65.51
	Strongly Agree (%)	18.18	26.53	21.60	22.10
	Not Applicable (%)	-	1.02	-	1.02

Table 4.14 shows that 43.98% of the respondents disagreed that their salary encouraged them to work better while only 28.5% were happy with the salary they received. In terms of salary received by AREE staff as compared with salary received by other departments/institutions, not up to fifty percent of the respondents (47.82%) agreed they received salary that is equal to staff in other departments/institutions who do comparable tasks. However, 52.1% of the respondents agreed that they always receive their salaries on time. About forty-five percent (45.3%) of the respondents agreed to have received salary increase as expected since they started the job. Sixty-two percent (62%) of the respondents agreed that the pay scales reflect differences in workload and responsibilities they carried out.

Table 4.14: Perception of AREE Staff on Salary/Renumeration

What is your view on the following statements related to **payments**? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*	**Category**	**NARS**	**ATVET**	**Extension**	**Average**
Your salary encourages you to work better	Strongly Disagree (%)	37.50	9.18	4.10	16.93
	Disagree (%)	38.64	50.00	43.30	43.98
	Agree (%)	22.73	30.61	39.20	30.85
	Strongly Agree (%)	1.14	7.14	13.40	7.23
	Not Applicable (%)	-	3.06	-	3.06
You are happy with the salary you receive	Strongly Disagree (%)	31.82	8.16	8.20	16.06
	Disagree (%)	51.14	52.04	41.20	48.13
	Agree (%)	13.64	32.65	39.20	28.50
	Strongly Agree (%)	3.41	4.08	11.30	6.26
	Not Applicable (%)	-	3.06	-	3.06
Staff is paid equally to staff in other departments/institutions who do comparable tasks	Strongly Disagree (%)	11.36	7.14	13.40	10.63
	Disagree (%)	20.45	34.69	44.30	33.15
	Agree (%)	62.50	47.96	33.00	47.82
	Strongly Agree (%)	5.68	7.14	9.30	7.37
	Not Applicable (%)	-	3.06	-	3.06

Staff always receive their salaries on time	Strongly Disagree (%)	20.45	8.16	6.20	11.60
	Disagree (%)	40.91	33.67	18.60	31.06
	Agree (%)	37.50	52.04	67.00	52.18
	Strongly Agree (%)	1.14	6.12	8.20	5.15
	Not Applicable (%)	-	0.00	-	0.00
You receive salary increases as you expected when you started this job	Strongly Disagree (%)	21.59	3.06	8.20	10.95
	Disagree (%)	40.91	39.80	33.00	37.90
	Agree (%)	36.36	51.02	48.50	45.29
	Strongly (%)	1.14	5.10	10.30	5.51
	Agree (%)				
	Not Applicable (%)	-	1.02	-	1.02
The pay scales reflect differences in workload and responsibility	Strongly Disagree (%)	6.82	6.12	6.20	6.38
	Disagree (%)	23.86	20.41	22.70	22.32
	Agree (%)	61.36	68.37	58.80	62.84
	Strongly Agree (%)	7.95	5.10	12.40	8.48
	Not Applicable (%)	-	0.00	-	0.00

Table 4.15 shows that 58.74% of the respondents agreed members of **s**taff are hired purely based on merit in their institutions while 69.75% agreed that staff members are promoted purely based on merit. However, when it comes to promotion, 43.60% disagreed that promotion depends on how long staff have served. Whereas 70.94% agreed that there were good opportunities for promotion in their institutions and 70.86% agreed performance appraisals were carried out fairly. The majority (57.25%) of the respondents agreed that people in their office are well qualified to do their job and 59.57% agreed that male and female have equal opportunities. Additionally, about 30% among the respondents agreed that staff have to be worried about losing their jobs in the near future while 44.81% disagreed to this.

Table 4.15: Perception of AREE staff on merit consideration

What is your view on the following statements related to **hiring and promotion**? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*	**Category**	**NARS**	**ATVET**	**Extension**	**Average**
Members of staff are hired purely based on merit (%)	Strongly Disagree	5.68	4.08	1.00	3.59
	Disagree	21.59	27.55	27.80	25.65
	Agree	60.23	54.08	61.90	58.74
	Strongly Agree	12.50	13.27	9.30	11.69
	Not Applicable	-	1.02	-	1.02
Staff is promoted purely based on merit (%)	Strongly Disagree	1.14	2.04	4.10	2.43
	Disagree	4.55	4.08	10.30	6.31
	Agree	72.73	61.22	75.30	69.75
	Strongly Agree	21.59	32.65	10.30	21.51
	Not Applicable	-	0.00	-	0.00
Promotion depends on how long you have served (%)	Strongly Disagree	10.23	6.12	3.10	6.48
	Disagree	48.86	52.04	29.90	43.60
	Agree	32.95	30.61	59.80	41.12
	Strongly Agree	7.95	9.18	7.20	8.11
	Not Applicable	-	2.04	-	2.04
There are good opportunities for promotion (%)	Strongly Disagree	1.14	0.00	2.10	1.08
	Disagree	5.68	3.06	15.50	8.08
	Agree	69.32	75.51	68.00	70.94
	Strongly Agree	23.86	21.43	14.40	19.90
	Not Applicable	-	0.00	-	0.00
Performance appraisals are carried out fairly (%)	Strongly Disagree	2.27	2.04	2.10	2.14
	Disagree	6.82	17.35	18.60	14.26
	Agree	76.14	67.35	69.10	70.86
	Strongly Agree	14.77	13.27	10.30	12.78
	Not Applicable	-	0.00	-	0.00
The majority of people in this office are well-qualified to do their job (%)	Strongly Disagree	1.14	2.04	16.50	44.18
	Disagree	10.23	14.29	42.30	22.27
	Agree	69.32	66.33	36.10	57.25
	Strongly Agree	19.32	17.35	5.20	13.96
	Not Applicable	-	0.00	-	0.00

Male and female staff have equal opportunities in getting promoted (%)	Strongly Disagree	1.14	0.00	3.10	1.41
	Disagree	1.14	4.08	9.30	4.84
	Agree	54.55	58.16	66.00	59.57
	Strongly Agree	43.18	37.76	21.60	34.18
	Not Applicable	-	0.00	-	0.00
Staff has to be worried about losing their jobs in the near future. (%)	Strongly Disagree	21.59	21.43	20.60	21.21
	Disagree	53.41	45.92	35.10	44.81
	Agree	22.73	27.55	37.10	29.13
	Strongly Agree	2.27	4.08	7.20	4.52
	Not Applicable	-	1.02	-	1.02

About 80% (Table 4.16) of the respondents agreed that the programs they have to implement in office have specified targets and only 8.9% among the staff have enough resources available to carry out their work as required. Almost 13% of the staff agreed that inputs and resources for work come regularly and on time. On mobility, just 6% agreed that mobility to the operational area is easy.

Table 4.16: Perception of AREE Staff on Overall Support

What is your view on the following statements related to **overall support**? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*		**NARS**	**ATVET**	**Extension**	**Average**
The programs you have to implement in office have specified targets (%)	Strongly Disagree	2.27	3.06	8.20	4.51
	Disagree	82.95	80.61	74.20	79.25
	Agree	14.77	14.29%	17.50	15.52
	Strongly Agree	-	2.04	-	2.04
	Not Applicable	-	19.39%	20.60	20.00
Staff has enough resources available to carry out their work as required by professional norms(%)	Strongly Disagree	2.27	53.06	35.10	30.14
	Disagree	82.95	23.47	37.10	47.84
	Agree	14.77	4.08	7.20	8.68
	Strongly Agree	-	0.00	-	0.00
	Not Applicable	1.14	7.14	1.00	3.09
Inputs and resources for your work come regularly and on time (%)	Strongly Disagree	10.23	37.76	10.30	19.43
	Disagree	69.32	47.96	74.20	63.83
	Agree	19.32	4.08	14.40	12.60
	Strongly Agree	-	3.06	-	3.06
	Not Applicable	3.41	6.12	10.30	6.61
Mobility to your operational area is easy (%)	Strongly Disagree	35.23	44.90	41.20	40.44
	Disagree	57.95	39.80	41.20	46.32
	Agree	3.41	7.14	7.20	5.92
	Strongly Agree	-	2.04	-	2.04
	Not Applicable	2.27	3.06	8.20	4.51

Job Satisfaction

The AREE staff indicated that they have job satisfaction (56.29%), and that their performances were pleasing to their supervisors (60%), supervisor knows the job (71.7%), supervisor is always around when needed (67.4%), supervisor does not show favoritism (66.3%) and that they have a clear structured work program (60.5%) (Table 4.17).

Table 4.17: Perception of AREE staff on job satisfaction

What is your view on the following statements related to **supervision**? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*		NARS	ATVET	Extension	Average
Your supervisor has increased your job satisfaction	Strongly Disagree (%)	12.50	0.00	1.00	-
	Disagree (%)	69.32	9.18	10.30	29.60
	Agree (%)	18.18	79.59	71.10	56.29
	Strongly Agree (%)	-	9.18	17.50	13.34
	Not Applicable (%)	-	2.04	-	2.04
It is hard to please your supervisor	Strongly Disagree (%)	-	7.14	1.00	4.07
	Disagree (%)	3.41	66.33	8.20	25.98
	Agree (%)	78.41	20.41	81.40	60.07
	Strongly Agree (%)	18.18	3.06	9.30	10.18
	Not Applicable (%)	-	3.06	-	3.06
Your supervisor praises good work	Strongly Disagree (%)	-	1.02	15.50	8.26
	Disagree (%)	4.55	2.04	45.40	17.33
	Agree (%)	71.59	79.59	35.10	62.09
	Strongly Agree (%)	23.86	15.31	4.10%	14.42
	Not Applicable(%)	-	2.04	-	2.04
Your supervisor knows the job well	Strongly Disagree (%)	-	1.02	-	1.02
	Disagree (%)	12.50	4.08	5.20	7.26
	Agree (%)	72.73	71.43	71.10	71.75
	Strongly Agree (%)	14.77	22.45	23.70	20.31
	Not Applicable (%)	-	1.02	-	1.02
Your supervisor is always around when needed	Strongly Disagree (%)	2.27	0.00	-	1.14
	Disagree (%)	15.91	7.14	5.20	9.42
	Agree (%)	65.91	68.37	68.00	67.43
	Strongly Agree (%)	15.91	22.45	26.80	21.72
	Not Applicable (%)	-	2.04	-	2.04
Your supervisor does not show favoritism	Strongly Disagree (%)	2.27	1.02	2.10	1.80

	Disagree (%)	11.36	22.45	7.20	13.67
	Agree (%)	72.73	55.10	71.10	66.31
	Strongly Agree (%)	13.64	20.41	19.60	17.88
	Not Applicable (%)	-	1.02	-	1.02
Your workload is adequate	Strongly Disagree (%)	-	3.06	2.10	2.58
	Disagree (%)	7.95	15.31	18.60	13.95
	Agree (%)	79.55	67.35	62.90	69.93
	Strongly Agree (%)	12.50	14.29	16.50	14.43
	Not Applicable (%)	-	0.00	-	0.00
You have a clear, structured work program	Strongly Disagree (%)	25.00	0.00	1.00	8.67
	Disagree (%)	38.64	5.10	17.50	20.41
	Agree (%)	30.68	79.59	71.10	60.46
	Strongly Agree (%)	5.68	15.31	10.30	10.43
	Not Applicable (%)	-	0.00	-	0.00

4.3. Students Survey

4.3.1. Student Characteristics and Motivation

Gender: The majority (53%) of the respondents were male (Table 4.18).

Figure 5: Gender distribution of students

Age: Average age of students was estimated as 24 years, however, majority (93.6%) falls within the age bracket of 20-30 years.

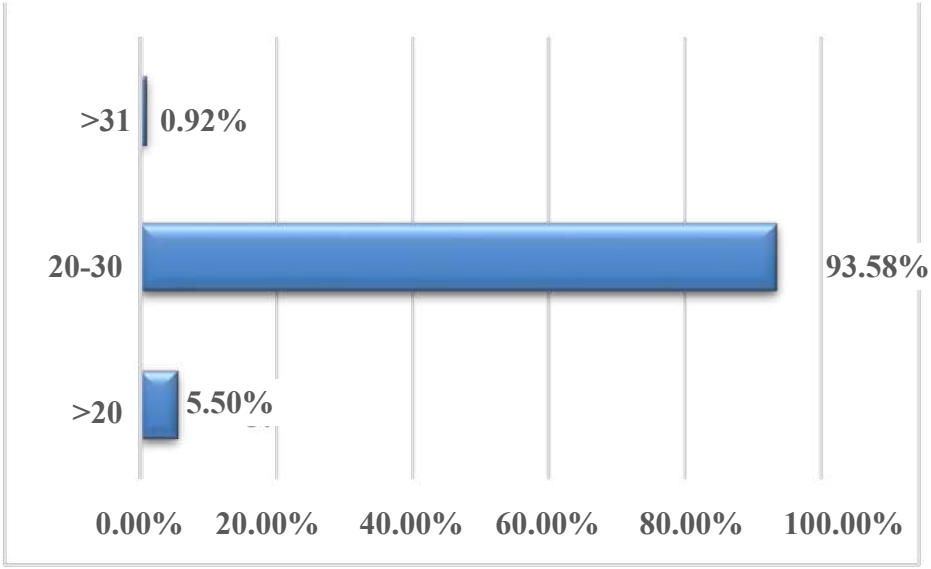

Figure 6: Age distribution of students

Origin: Only 47% of the students were from rural origin

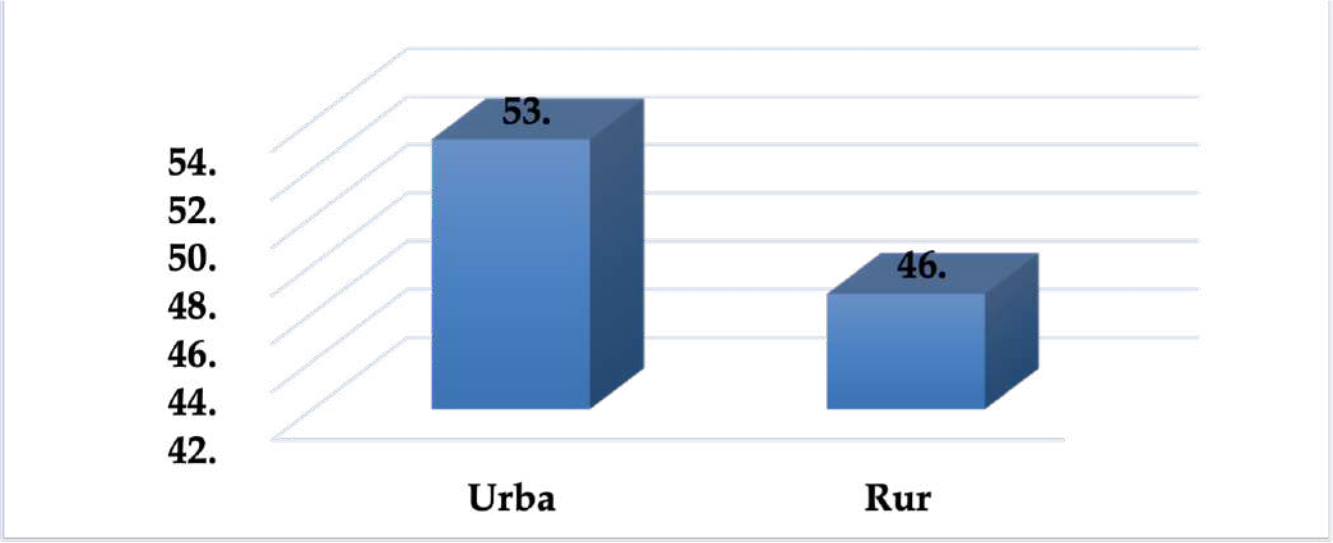

Figure 7: Origin (home base) of students (Rural vs. Urban)

Own cultivation: Only 48% of the students cultivate own land for agriculture.

Years of training: fifty-seven percent (57%) of the students were at the final year of their studies.
Motivation to start the course: Knowledge to bring about change in farming was the motivating factor for the majority (74.31%) to start the course.
What students see themselves doing after graduation: Most (39.45%) of the students see themselves engaged in agri-entrepreneurial business after graduating from school.

Table 4.18: Socio-economics Characteristics of the Students

		Average
Gender (share of females)		51 (47%)
Age		24 years
Origin (share rural)		51 (47%)
Origin (share farming)		78 (72%)
Own cultivation (share yes)		52 (48%)
Year of training *(2nd Year)*		62 (57%)
Motivation to start the course	Secure job	16.51%
	A job with a regular income	18.35%
	Representative (prestigious) job	14.68%
	Knowledge to bring about change in farming	74.31%
	To own my private firm/self-employ	5.50%
	It deals with all aspects of agriculture	0.92%
	Choosen for me/Only available course	2.75%

What do you see yourself doing after graduation?	Private, public, or third-sector extension service	20.18%
	Jobs in the Ministry of agriculture	11.01%
	Agricultural Research Institute	16.51%
	Academia	2.75%
	Independent Consultant	10.09%
	Agro-entrepreneur	39.45%
	Other	-

Table 4.19: Students' Opinion on Agriculture Budgetary Allocations to Economic, Social and Environmental Sustainability Issues

Out of 100% of the national agricultural budget, what percentage should be spent on the three different aspects of sustainability?	Average
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.) (%)	50.50
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.) (%)	24.91
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.) (%)	24.59
Total (%)	100

Where students wish to make the greatest contribution in future

The majority (63% and 58%) of the students wish to make their greatest contribution to be increased productivity and poverty reduction, respectively in future, even without fostering the use and development of digital tools (9%). The challenges posed by inadequate capacity for digital tools development (amongst myriads of challenges) might not be unconnected with this result.

Table 4.20: Distribution of students according to where they wish to make the greatest contribution in future

Where do you wish to make the greatest contribution in the future?	Average
Increase productivity	69 (63%)
Reduce poverty	63 (58%)
Improve the adaptation to climate change	23 (21%)
Foster women's empowerment	15 (14%)
Improve food security	58 (53%)
Contribute to biodiversity conservation	12 (11%)
Integrate marginalized groups and the poorest	20 (18%)
Improve access to financial services	21 (19%)
Foster the use and development of digital tools	9 (9%)

4.3.2 Perceptions of challenges in the agricultural sector

According to Table 4.21, students from ATVET institutions think that the biggest problems of farming are a lack of access to financing (59%), the prevalence of pests and diseases (50%), changing climatic patterns (36%), low productivity (33%), the availability and cost of inputs (30%), and limited options for marketing. Poverty and inequality (26%), lack of access to extension service (24%), low soil fertility (19%), lack of access to roads and other rural infrastructure (19 %) and lack of education (19%) were other perceived challenges. This suggests that students in the study attributed the poor performance of the Nigerian agricultural sector to these issues. These challenges can have significant impacts on agricultural production and must be addressed in order to ensure a successful transformation of the agricultural sector.

Table 4.21: Perception of challenges in the agricultural sector among ATVET students

Perceived main challenges of farming	Average
Low productivity	36 (33%)
Pests and diseases	54 (50%)
Livestock health and welfare	20 (18%)
Low soil fertility	21 (19%)
Water issues	11 (10%)
Low and unpredictable rainfall	0 (0%)
Flooding	0 (0%)
Changing climatic patterns	39 (36%)
Inputs issues	33 (30%)
Poverty and inequality	28 (26%)
Roads and rural infrastructure	21 (19%)
Marketing issues	33 (30%)
Finance issues	64 (59%)
Extension service issues	26 (24%)
Education issues	21 (19%)
Digital tool issues	17 (16%)
Electricity issues	4 (4%)
Network coverage	0 (0%)
Others	7 (6%)

4.3.3 Perceptions of Training

Table 4.22 shows that 46.79% students agreed and 44.95% strongly agreed that the course they have chosen adequately accommodate their background needs while 54% strongly agreed that the objectives of the course were clearly defined. This was an indication that the courses were not just imposed on the students. Almost half (48.6%) of the students strongly agreed that topics covered were relevant and 57.8% agreed that the contents were organized and easy to follow. Fifty-two percent (52%) of the students agreed that the time allotted for the course work was sufficient. All the students (100%) believed that they could recommend their course of studies to others. This means they are well pleased with their courses and ready to introduce the courses to their friends.

What is your view on the following statements related to the course? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*		**Average**
The course you have chosen accommodates well to your background needs	Not Applicable (%)	0.00
	I cannot tell (%)	3.67
	Strongly Disagree (%)	0.92
	Disagree (%)	3.67
	Agree (%)	46.79
	Strongly Agree (%)	44.95
The objectives of the course were clearly defined	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	0.00
	Disagree (%)	1.83
	Agree (%)	44.04
	Strongly Agree (%)	54.13
Participation and interaction were encouraged	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	0.00
	Disagree (%)	0.00
	Agree (%)	48.62
	Strongly Agree (%)	51.38
The topics covered were relevant to me	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	0.92
	Disagree (%)	2.75
	Agree (%)	46.79
	Strongly Agree(%)	48.62
The content was organized and easy to follow	Not Applicable (%)	0.00
	I cannot tell (%)	1.83
	Strongly Disagree (%)	0.92
	Disagree (%)	4.59
	Agree (%)	57.80
	Strongly Agree (%)	34.86
The content meets my expectations	Not Applicable (%)	0.00
	I cannot tell (%)	1.83
	Strongly Disagree (%)	0.92
	Disagree (%)	7.34
	Agree (%)	61.47
	Strongly Agree (%)	28.44

The materials distributed were helpful and relevant	Not Applicable (%)	0.00
	I cannot tell (%)	1.83
	Strongly Disagree (%)	0.00
	Disagree (%)	2.75
	Agree (%)	60.55
	Strongly Agree	34.86
This course experience will be useful in my work	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	0.00
	Disagree (%)	0.92
	Agree (%)	41.28
	Strongly Agree (%)	56.88
The trainers were knowledgeable about the course topics	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	0.00
	Disagree (%)	1.83
	Agree (%)	41.28
	Strongly Agree (%)	56.88
The quality of the answers to the questions was good	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	0.00
	Disagree (%)	0.92
	Agree (%)	61.47
	Strongly Agree (%)	37.61
The trainers were well prepared	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	0.00
	Disagree (%)	1.83
	Agree (%)	55.96
	Strongly Agree (%)	41.28
The course objectives were met	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	0.00
	Disagree (%)	7.34
	Agree (%)	59.63
	Strongly Agree (%)	33.03

The time allotted for the course work was sufficient	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	0.00
	Disagree (%)	16.51
	Agree (%)	52.29
	Strongly Agree (%)	30.28
The time allotted for the practical work was sufficient	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	1.83
	Disagree (%)	20.18
	Agree (%)	54.13
	Strongly Agree (%)	22.94
The course rooms and facilities were adequate and comfortable.	Not Applicable (%)	0.00
	I cannot tell (%)	3.67
	Strongly Disagree (%)	12.84
	Disagree (%)	32.11
	Agree (%)	41.28
	Strongly Agree (%)	10.09
The course offers capacity in digital tools	Not Applicable (%)	0.00
	I cannot tell (%)	2.75
	Strongly Disagr(%)ee	9.17
	Disagree (%)	27.52
	Agree (%)	54.13
	Strongly Ag(%)ree	6.42
The course allows visiting farms and or/interacting with farmers	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	1.83
	Disagree (%)	12.84
	Agree (%)	55.96
	Strongly Agree (%)	29.36
Would you recommend this course to a friend or family? (Share yes)	Yes (%)	100.00

On the students' perception on the share of time and teaching devoted to sustainability goal, almost half (48.7%) went for economic sustainability, 25% for social sustainability and 26.3% for environmental sustainability (Table 4.23). This means that economic sustainability was considered as the most important factor in term of sustainability.

Table 4.23: Respondents' perception on share of time and teaching devoted to sustainability

Perception, how much of the time and teaching of the courses were devoted to economic, social, and environmental sustainability aspects	Average
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.) (%)	48.72
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.) (%)	25.00
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.) (%)	26.28
Total (%)	100

As reported in Table 4.24, 50.4% of the respondents agreed that aspects of crop yields and field productivity have been sufficiently addressed by the course program. Efficient input use (52.3%), safe handling of agro-chemicals (56%), marketing/commercialization (50.5%), land degradation (55.1%), climate change (58.7%) and water management (51.38%), were agreed to have been sufficiently addressed by the course program.

Table 4.24: Perception on some selected topics

Have the following aspects been sufficiently covered? *(On a scale from 1 = Strongly disagree to 4 = Strongly agree)*		Average
Crop yields and productivity	Not Applicable (%)	0.00
	I cannot tell (%)	2.75
	Strongly Disagree (%)	0.92
	Disagree (%)	6.42
	Agree (%)	50.46
	Strongly Agree (%)	39.45
Efficient input use	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	1.83
	Disagree (%)	11.01
	Agree (%)	52.29
	Strongly Agree (%)	33.94
Safe handling of agro-chemicals	Not Applicable (%)	0.00
	I cannot tell (%)	0.00
	Strongly Disagree (%)	1.83
	Disagree (%)	9.17
	Agree (%)	55.96
	Strongly Agree (%)	33.03

Marketing/ commercialization	Not Applicable (%)	0.00
	I cannot tell (%)	2.75
	Strongly Disagree (%)	1.83
	Disagree (%)	8.26
	Agree (%)	50.46
	Strongly Agree (%)	36.70
Prices, quality standards, value creation, and cost-saving techniques	Not Applicable (%)	0.92
	I cannot tell (%)	1.83
	Strongly Disagree (%)	2.75
	Disagree (%)	7.34
	Agree (%)	54.13
	Strongly Agree (%)	33.03
Microfinance	Not Applicable (%)	0.92
	I cannot tell (%)	3.67
	Strongly Disagree (%)	6.42
	Disagree (%)	35.78
	Agree (%)	41.28
	Strongly Agree (%)	11.93
Land degradation	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	1.83
	Disagree (%)	14.68
	Agree (%)	55.05
	Strongly Agree (%)	27.52
Climate change	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	1.83
	Disagree (%)	11.01
	Agree (%)	58.72
	Strongly Agree (%)	27.52
Water management	Not Applicable (%)	0.00
	I cannot tell (%)	0.92
	Strongly Disagree (%)	0.92
	Disagree (%)	10.09
	Agree (%)	51.38
	Strongly Agree (%)	36.70
Biodiversity-friendly agriculture	Not Applicable (%)	0.00
	I cannot tell (%)	3.67
	Strongly Disagree (%)	1.83
	Disagree (%)	8.26
	Agree (%)	60.55
	Strongly Agree (%)	25.69
Livestock productivity	Not Applicable (%)	0.00

	I cannot tell (%)	0.92
	Strongly Disagree (%)	0.92
	Disagree (%)	8.26
	Agree (%)	50.46
	Strongly Agree (%)	39.45
Animal health	Not Applicable (%)	0.00
	I cannot tell (%)	5.50
	Strongly Disagree (%)	4.59
	Disagree (%)	12.84
	Agree (%)	52.29
	Strongly Agree (%)	24.77
Livestock welfare	Not Applicable (%)	0.00
	I cannot tell (%)	5.50
	Strongly Disagree (%)	7.34
	Disagree (%)	11.93
	Agree(%)	53.21
	Strongly Agree (%)	22.02
Nutrition	Not Applicable (%)	0.00
	I cannot tell (%)	2.75
	Strongly Disagree (%)	1.83
	Disagree (%)	8.26
	Agree (%)	62.39
	Strongly Agree (%)	24.77
Gender	Not Applicable (%)	0.92
	I cannot tell (%)	7.34
	Strongly Disagree (%)	2.75
	Disagree (%)	27.52
	Agree (%)	42.20
	Strongly Agree (%)	19.27
Marginalized groups and/or the poorest	Not Applicable (%)	0.00
	I cannot tell (%)	5.50
	Strongly Disagree (%)	2.75
	Disagree (%)	21.10
	Agree(%)	55.05
	Strongly Agree (%)	15.60
Youth	Not Applicable (%)	0.00
	I cannot tell (%)	5.50
	Strongly Disagree (%)	0.92
	Disagree (%)	18.35
	Agree(%)	57.80
	Strongly Agree (%)	17.43

Inclusion of Digital Tool Training (share of yes)	Yes (%)	81.65

According to Table 4.25, there were other aspects the courses should focus more on to even better address the country's challenges. The areas were low productivity (41.3%), which was ranked first, crops pest and diseases (39.5%) ranked second while farm waste recycling (1.3%) was ranked last in the sixteenth position.

Table 4.25: Challenges to be focused on in addressing courses taught

Challenges	Frequency	Percent (%)	Rank
Low productivity	45	41.28	1st
Crops pests and diseases	43	39.45	2nd
Challenges in livestock health/welfare	27	24.77	8th
Low soil fertility	32	29.36	5th
Limited access to water	17	15.60	12th
Low and unpredictable rainfall	13	11.93	13th
Flooding	31	28.44	6th
Changing climatic pattern	36	33.03	3rd
Availability and cost of inputs	32	29.36	5th
Poverty and inequality	33	30.28	4th
Lack of access to rural infrastructure	33	30.28	4th
Limited options for marketing	20	18.35	11th
Lack of access to finance	33	30.28	4th
Access to extension services	23	21.10	10th
Lack of education	24	22.02	9th
Lack of access to digital tools	29	26.61	7th
Lack of electricity	13	11.93	13th
Unreliable/lack of network coverage	10	9.17	14th
Insecurity	6	5.50	15th
Farm waste recycling	2	1.83	16th

Perception of the challenges being faced in the chosen courses

More than 60% of AREE staff agreed that there were challenges being faced in their chosen courses. The challenges were highlighted as insufficient access to computers (47.06%), insufficient access to internet (36.76%), insufficient access to relevant literature (30.88%) and incessant strikes (1.47%).

Table 4.26: Perception on the challenges being faced in the chosen courses

		Average
Are there any challenges you are facing in the course you have chosen? (Share yes) (%)		62.39
What are these challenges?	Insufficient access to computers (%)	47.06
	Insufficient access to internet (%)	36.76
	Insufficient access to relevant literature (%)	30.88
	Not easy access to consult with teachers/lecturers (%)	8.82
	Insufficient access to modern materials for practical lessons (%)	19.12
	Poor teaching method/incompetency (%)	2.94
	Difficulty in accessing research data (%)	1.47
	Slow understanding certain courses (%)	2.94
	Financial Challenge (%)	2.94
	Incessant strikes (%)	1.47
	Tight/stressed programme (%)	4.41
	Limited lecture thearter/Poor social amenities (%)	2.94
	Outdated curriculum (%)	4.41

4.4. Qualitative insights from interviews with managers

4.4.1. Overall mission and changes in mission

Agricultural Research Institutions: The primary focus of agricultural research institution surveyed is to conduct research on crops of mandate, sustainable technologies, and enhance farm productivity and product utilization in a sustainable manner.

This focus has evolved over the past 5 to 10 years in response to the changing needs and demands of the target beneficiaries, the policy shifts by the government, and the challenges of climate change and environmental sustainability. The major challenges faced by the agricultural research institutions are lack of consistent and adequate funding, low manpower, recruitment bottlenecks, limited transportation and resources, siloed structures and inter-departmental collaboration, and lack of involvement of the younger generation in agriculture.

The agricultural research institutions have adopted various strategies to cope with the changes in mission, such as strengthening linkages with farmer organizations, extension services, and private partners, establishing business incubation and mechanization platforms, scaling up innovations and capacities, and reviewing outdated recommendations.

The Agricultural Research Institutions in Nigeria were found to show a commitment to their core mission while actively adapting to changing needs, policies, and external challenges. The responses reflect a blend of continuity, innovation, and a proactive approach to overcome existing challenges and embrace future changes.

The agricultural engineer's example in developing a palm tree climber, exemplifies the NARS commitment to innovative solutions as well as emphasis on sustainable, affordable, efficient, and easily adoptable

technologies while demonstrating a forward-looking approach.

The changes in mission of agricultural research institutions were reported to be little and mainly driven by the changing needs and demands of the target beneficiaries, the policy shifts by the government, and the challenges of climate change and environmental sustainability.

The agricultural research institutions have adopted various strategies to cope with the changes in mission, such as strengthening linkages with private partners, establishing business incubation and mechanization platforms, scaling up innovations and capacities, and reviewing outdated recommendations. Some institutions are putting more effort into engaging younger generations in modern agriculture.
The responses to challenges and preparedness for change reflect an awareness of the need for additional funding, manpower, and collaboration to overcome these challenges. The major challenges faced by the agricultural research institutions are low funding, low manpower recruitment, limited transportation and resources, and lack of involvement of the younger generation in agriculture.

The Agricultural Research Institutions in Nigeria demonstrate a commitment to their core mission while actively adapting to changing needs, policies, and external challenges. The responses reflect a blend of continuity, innovation, and a proactive approach to overcome existing challenges and changing agricultural landscape.

Agricultural Extension Institutions: Nigeria's agricultural extension institutions play a crucial role in the nation's agricultural transformation journey. The overall mission of the agricultural extension institutions surveyed is to ensure that the results of research reach the local farmers for the purpose of adoption, dissemination, and utilization. Their mandate extends beyond technology transfer, encompassing critical areas like food security, empowerment of women and youth, rural productivity, agribusiness development, food security and value chain development. The extension institutions strive to improve the food security of Nigeria and to become world-class training and extension centres for sustainable production and management.

The mission of the extension institutions has evolved in the past 5 to 10 years in response to the changing needs and demands of the farmers and the society, the policy shifts by the government, and the challenges of climate change and environmental sustainability. The extension institutions have adopted various strategies to cope with the changes in mission, such as introducing climate smart technologies, conducting demand-driven and farmer-centred researches which address the problems and opportunities identified by the farmers through the Research-Extension-Farmers Input-Linkage System (REFILS) workshops; adding value to the research outputs by developing and promoting value-added products and strengthening the linkages and collaborations with farmer organizations, NGOs, private sector partners, and other research institutes to leverage the resources, expertise, and networks for effective and efficient extension service delivery.

The major challenges faced by the extension institutions are low funding, low recruitment of staff, retirement of experienced staff without replacement, inadequate transportation and office facilities, poor communication, lack of practical knowledge, and low participation of women. These challenges hamper the capacity and performance of the extension institutions and limit their impact on the farmers and the society. The extension institutions foresee a lot of changes in the near future based on the new policy of the current administration, the need to cater for the rural people, and the emerging issues of climate change and smart agriculture. The extension institutions anticipate a shift in their general or broad mission to focus more on community value chain and smart agriculture approaches, which entail the integration of social, economic, and environmental dimensions of agricultural development. To prepare for the evolving landscape, extension institutions must prioritize options for enhancing capacity building and training programs, securing adequate and sustainable funding from various sources, such as the government, donors, the private sector, and the clienteles, smart agriculture adoption, engaging and effective communication with partners and stakeholders.

The agricultural extension institutions in Nigeria stand at a crossroads. They are burdened by challenges yet hold the key to food security and sustainable agricultural transformation

Agricultural Education Institutions: Nigeria's agricultural education institutions are undergoing a significant mission transformation to the changing needs and demands of the economy, the industry, the employers, and the society. Staff shortages, outdated curriculum, limited resources, lack of functional equipment and laboratory, bureaucracy, low participation of women and youth, and weak extension linkage pose challenges. These challenges affect the capacity and performance of the agricultural education institutions and limit their impact on the agricultural sector and the society. Institutions are leveraging partnerships and embracing innovative approaches like curriculum review, capacity building, strengthening the linkages and collaborations with other sister research institutions, extension agencies, farmer organizations, NGOs, and private partners to cope with the changes in mission,

The agricultural education institutions in Nigeria play a vital role in building skills and research-extension linkages for sustainable agricultural transformation. They are faced with challenges yet hold the key to innovation and empowerment.

4.4.2. Innovation system

Agricultural Research Institutions: Innovation in agricultural research institutions is crucial for sustainable agricultural transformation in Nigeria. Discussions with stakeholders from agricultural research institutions in Nigeria revealed critical insights into the challenges, opportunities, and transformations within the innovation system. Research, recognized as a driving force for agriculture, faces significant challenges in Nigeria. These include low funding, underutilization of research, lack of essential equipment and technical expertise, weak linkages, low capacity, and low adoption of research outputs. These challenges affect the quality and relevance of the research, limiting its impact on the agricultural sector and society.

The responses indicate that while research in agriculture is pivotal for agricultural development, most of the results remain on the shelves, not reaching the farmers due to weak linkage and inadequate funding. However, research can be improved in several ways, such as incorporating changes, providing necessary equipment, and building capacity for technical staff.

The innovation system of agricultural research institutions in Nigeria also presents opportunities, such as collaboration, synergy, and technology. The responses reveal that these institutions collaborate with various types of organizations, including CGIAR centers, international donor organizations, local NGOs, farmer organizations, and private businesses. These collaborations leverage resources, expertise, and networks for effective and efficient innovation. Through these partnerships, research institutions strive to bridge the gap between research and practice, translating valuable findings into tangible solutions for farmers.

However, to fully tap into the potential of agricultural research for sustainable transformation, concerted efforts are required from the government, research institutions, and all stakeholders. Increased funding, stronger extension linkages, infrastructure upgrades, and continued strategic partnerships can pave the way for a vibrant innovation system, propelling Nigeria's agricultural sector towards a more sustainable and prosperous future.

Agricultural Extension Institutions: The innovation system of agricultural extension institutions in Nigeria consists of the interactions and linkages among various actors, such as researchers, educators, extension agents, farmers, donors, NGOs, and private businesses, who generate, exchange, and use knowledge and technologies for agricultural development. The respondents emphasized the critical role of extension services in the agricultural system, serving as a vital link between research outcomes and practical implementation in the field. Some respondents' multiple faceted expertise as both agricultural lead and extension specialists underscores the importance of knowledge in agriculture for effective leadership.

The innovation system of agricultural extension institutions in Nigeria faces several challenges, such as:

- low funding, which affects the availability and quality of the extension services and the resources and facilities for the extension agents;
- poor linkage, which reduces the coordination and communication among the extension agents, the researchers, the farmers, and other stakeholders, and hinders the transfer and adoption of the research

outputs;

- low capacity, which affects the skills and knowledge of extension agents and farmers, and limits their ability to use and apply new varieties, technologies, and practices;

- low participation, which means that farmers and other beneficiaries are not adequately involved in the identification and prioritization of their needs and demands, and in the evaluation and feedback of extension services;

- low inclusion, which means that the gender and social aspects are not sufficiently considered and addressed in the design and delivery of the extension services.

These challenges affect the relevance and impact of the extension services and limit their contribution to the agricultural sector and the society.

Agricultural Education Institutions: The agricultural educational institutions include universities, colleges, polytechnics, and research institutes that offer various programs and courses in agriculture and related fields. The agricultural educational institutions also collaborate with extension services, farmer organizations, and other stakeholders to ensure the transfer and utilization of agricultural knowledge and technologies.

The innovation system of agricultural educational institutions in Nigeria faces several challenges, such as:

- low funding: which affects the availability and quality of the educational and research activities and the resources and facilities for the educators and researchers;

- weak policy support: which means that there is no clear and coherent strategy or framework to guide and coordinate the educational and research activities and to align them with the national development goals;

- poor coordination: which reduces the coordination and communication among the educators, researchers, students, farmers, and other stakeholders, and hinders the relevance and impact of the educational and research outputs;

- limited end-user engagement/low practical application: research activities often fail to fully consider the specific needs and priorities of farmers, resulting in irrelevant or inapplicable solutions.
Most of the research outputs are tailored towards academic purposes and not addressing the real problems and needs of farmers and other end users;

- inadequate infrastructure: limited access to essential equipment and technology in laboratories creates research bottlenecks and restricts innovation potential.

- low capacity, which affects the skills and knowledge of the educators, researchers, and students, and limits their ability to produce and apply innovative and sustainable solutions for the agricultural sector and the society.

These challenges affect the performance and contribution of the agricultural educational institutions and require urgent attention and actions.

Sustainability Aspects

Agricultural Research Institutions: The sustainability aspects of agricultural research institutions in Nigeria include the environmental, social, and economic dimensions of agricultural development. Discussions with stakeholders from Nigerian agricultural research institutions reveal a growing awareness of the need to balance productivity with other sustainability aspects, such as gender, environment, and biodiversity. Agricultural research institutions in Nigeria are actively engaged in projects focused on sustainable agricultural transformation. These projects primarily revolve around farming system research (environment sustainable production), varietal development, and extension systems. The institutions recognize the trade-offs between productivity and other sustainability aspects such as gender, social issues, and the environment. They address these tradeoffs by adopting technologies that have minimal impact on the environment and

health, controlling factors detrimental to soils while maintaining good productivity levels.

The projects address environmental issues through farming systems that involve regenerative agriculture practices like zero tillage, rotation, mixed cropping, and the use of adaptable varieties. They also integrate gender aspects by setting specific targets for inclusion, usually 40% women and youth, and 10% vulnerable groups. The projects ensure inclusivity by working towards the targets set under the Sustainable Development Goals (SDGs) and encouraging participation through incentives.

The environmental aspects that receive the most attention today are climate change, resilience, regeneration of lost nutrients, and afforestation. The institutions collaborate with various organizations such as TECHNOSERVE, GIZ, etc. Some important organizations they collaborate with include IITA, AGRA and SG2000. The collaborative projects are mainly focused on capacity building, breeding, and farming systems. They address productivity issues and also focus on sustaining the environment and maintaining the soil. The agricultural research institutions also collaborate with extension services, farmer organizations, NGOs, and private businesses to ensure the adoption and utilization of agricultural technologies and innovations.

Agricultural Extension Institutions: The analysis of the sustainability aspects of agricultural extension institutions in Nigeria reveals a comprehensive approach encompassing productivity, environmental awareness, and social inclusion. Key findings include:

Sustainability orientation: Agricultural extension institutions prioritize high productivity and low cost of production, indicating a strong focus on economic sustainability. The inclusion of gender mainstreaming and allocated responsibilities for women and children suggests an awareness of social sustainability aspects as well.

Sustainability Transitions: Agricultural extension institutions appear to be making efforts towards environmental sustainability, as indicated by the emphasis on environmental friendliness.

However, use of high amounts of agrochemicals remains a major concern, highlighting the need for transition towards more sustainable farming methods. For example, excessive use of pesticides and fertilizers could harm the environment and human health and increase the cost of production.

Balancing trade-offs: Extension institutions acknowledge the complex trade-offs between productivity and other sustainability aspects like gender, social, and environmental factors. Striking a balance between productivity and environmental protection presents a significant challenge. To address this, agents utilize readily available and affordable inputs while promoting soil conservation practices. Climate change resilience is also integrated through training on adaptation strategies and resource-efficient techniques. Furthermore, social aspects like labor requirements and equitable access to resources are considered in extension activities.

Paradigm shift: Agricultural extension institutions acknowledge the need for a major paradigm shift to achieve greater sustainability. This shift towards a more holistic and participatory approach to sustainable agriculture is recognized as necessary but requires broader stakeholder engagement and policy support.

Driving the Shift towards Sustainable Agriculture:

Achieving a paradigm shift towards sustainable agriculture in Nigeria requires concerted action on multiple fronts. Here are key actions and potential constraints to consider:

Actions for Enabling Change:

Increased funding and resource allocation: Equipping institutions with necessary resources is crucial for expanding their reach, providing effective services, and fostering innovation.
Robust policy support: Clear and coherent policies aligned with sustainability goals are essential for guiding efforts and providing direction.
Strengthened collaboration and linkages: Building partnerships across research institutions, NGOs, stakeholders, and extension services facilitates knowledge sharing, resource mobilization, and coordinated action.
Enhanced participation and inclusion: Empowering women, youth, and marginalized communities through tailored outreach and training programs ensures equitable access to knowledge and opportunities.

Capacity building: Equipping farmers, extension agents, and other stakeholders with the necessary skills and knowledge is essential for adopting and implementing sustainable practices effectively. Fostering innovation: Encouraging research and development of sustainable technologies and tools will provide solutions for overcoming challenges and advancing sustainable agriculture.

Constraints to Address:

Inadequate infrastructure: Limited access to technology, communication networks, and transportation hinder knowledge dissemination and outreach efforts.

Poor marketing services and limited outreach: Inadequate access to markets and information about sustainable practices discourage farmers from adopting them.

Low capacity to balance productivity and environmental challenges: Difficulty in striking a balance between economic viability and environmental protection can pose a significant barrier.

Poor coordination and linkages among stakeholders: Fragmented communication and collaboration can hinder information flow, resource sharing, and collective action.

By prioritizing these actions and proactively addressing the identified constraints, Nigerian agricultural extension institutions can unlock their full potential to drive widespread adoption of sustainable practices. This will pave the way for a future of environmentally sound, socially equitable, and economically viable agriculture in Nigeria.

Agricultural Education Institutions:

Sustainability Orientation:

Nigerian agricultural education institutions demonstrate a growing commitment to integrating sustainability principles into both education and research. This is evident in the responses, which reveal an awareness of the educational system's strengths and weaknesses in preparing students and researchers for sustainable agricultural practices. Notably, a strong emphasis is placed on practical aspects, local content, and gender inclusion. Additionally, diverse collaborations with research institutions, NGOs, private sector entities, and international organizations are seen as crucial for advancing sustainable agriculture. These partnerships facilitate resource pooling, knowledge sharing, and wider dissemination of sustainable practices.

Trade-off: A key theme emerging from the responses is the balance between productivity and environmental stewardship. Recognizing both the strengths and weaknesses of the educational system is important in this regard. Focus on practical aspects ensures graduates are equipped for real-world agricultural challenges. They try to manage these trade-offs by utilizing readily available and affordable inputs while advocating for increased capacity and teaching on agricultural conservation practices. Furthermore, promoting gender inclusion creates a more equitable and effective agricultural sector.

Sustainability Transitions:

Paradigm Shift Needed: The participants' opinions and perspectives acknowledge the need for a significant paradigm shift within educational institutions to achieve greater sustainability in the agricultural sector. This necessitates strengthening the educational system and enhancing the preparedness of institutions for the continuous integration of relevant components, ensuring alignment with the evolving needs of the agricultural sector. This may involve changing deeply rooted practices, addressing social barriers, and strengthening education on environmentally friendly technologies. These aspects are related to the challenges and opportunities of sustainable agriculture in Nigeria, such as soil health, climate change, food security, and value addition. They also indicate the role and contribution of the agricultural education institutions in providing modern technologies, conducting relevant research, teaching good practices, and disseminating innovations.

Major Stakeholders and Collaboration:

Engagement with Diverse Stakeholders: The agricultural institutions recognize the importance of involving a broad range of stakeholders in the sustainability transition. These include policymakers, researchers, farmers, donor agencies, and extension services. The collaborative approach involves adequate funding, policy shifts, and effective communication channels. The focus is on overcoming constraints such as inadequate funding, lack of political will, and low collaboration with partners. The commitment to achieving a paradigm shift

towards sustainability is evident in the readiness of dedicated staff and the proactive stance, provided the necessary conditions are in place.

Role of the Institutions:

Influence and Contributions: The institutions play a crucial role in driving sustainability in agriculture through their influence on educational programs, research activities, and community engagement. The responses highlight various initiatives, including research assistance, extension messages, student training, and collaboration with private sector organizations. These initiatives contribute to improving practical aspects of teaching work and enhancing the overall sustainability of agricultural practices

Challenges and Recommendations:

Increased Funding and Resource Allocation: Equipping institutions with necessary resources is critical for the effective implementation of sustainable practices. Respondents highlighted budget constraints as a key challenge. The institutions need adequate resources to equip themselves with modern technologies, infrastructure, and equipment. Recommendations include actively seeking additional funding from various sources, such as government, donors, and private sector, advocating for grants and exploring alternative resource mobilization strategies.

Enhanced Capacity Building: Training all stakeholders on sustainability principles and best practices is crucial for knowledge transfer. This necessitates comprehensive training programs tailored to each stakeholder group. The institutions need to develop the skills and knowledge of their staff, students, and partners to understand and contribute to the agricultural systems. The recommendations include conducting relevant research, teaching good practices, and disseminating innovations.

Improved Infrastructure and Outreach: The institutions face some challenges, such as poor internet connectivity and resistance to change, that hinder the teaching, impact and adoption of sustainable practices. Developing communication channels and support networks for effective agricultural education of stakeholders is essential. This includes developing sustainable strategies to overcome challenges and ensuring a continuous information flow to all.

Major Projects and Sustainability Goals:

Supportive policy and regulatory framework: Implementing policies and regulations that incentivize sustainable practices and address environmental educational concerns is crucial for a lasting impact. This includes aligning education with sustainability goals and ensuring that practices are adaptive to changing socio-economic and environmental conditions. The recommendations include improving policy coordination, participation, and enforcement.

The responses point towards a promising but challenging landscape for sustainable agriculture education in Nigeria. While institutions are increasingly embracing sustainability principles, significant barriers remain. By addressing the identified challenges through resource mobilization, capacity building, improved infrastructure, and supportive policy frameworks, Nigerian agricultural education institutions can play a pivotal role in transforming the sector towards a more sustainable and equitable future.

4.4.3. Staff and Sustainability Aspects

Agricultural Research Institutions:

Staff Profile Changes and Challenges: The responses indicate that there have been substantial changes in staff profiles within the institutions over the past 5 to 10 years. These changes are primarily due to promotions, career progression, retirements, and a decrease in recruitment, particularly at the junior cadre level. Various factors have driven these changes, including shifts in institutional focus, funding shortages, political interference, and centralized control processes. The impacts of these changes on the staff's quality and quantity are significant. For instance, the loss of junior cadre staff has potentially created gaps in the organizational structure. Additionally, the senior cadre is aging, and there is a lack of replacements, leading to a reduced carrying capacity within the institutions.

Expertise and Recruitment: The responses indicate that the institutions face numerous challenges in recruiting the right profiles for their organization, particularly for higher-level or research scientist positions due to the required experience. Many institutions have not hired new staff in years, leading to an aging workforce, loss of institutional knowledge and innovation gaps. The responses also highlight some of the causes of these gaps, such as the aging and retirement of existing expertise, recruitment policies at the institutional level, and the imposition of staff who sometimes lack expertise.
The responses specify several areas where expertise is lacking, including climate change, food technology, soil science, business incubation, agribusiness, agronomy, advisory services, and big data handling. A lack in these areas of expertise limited capacity for fulfilling the organization's mission in sustainable transformation. The scarcity of such expertise in the labor market and competition with other organizations contribute to this deficiency.
To address this, the institutions rely on alternatives such as short-term employment using grants, part-time/visiting/sabbatical positions, and capacity building within existing staff. The hiring process is challenging due to centralized control processes, competition with other organizations, and political and IPPIS (Integrated Personnel Payroll Information System) issues. The centralized control makes the hiring processes slow and bureaucratic, making it difficult to attract qualified candidates.

Sustainability Alignment: The institutions acknowledge the importance of sustainability, considering economic (productivity, prices), social, and environmental aspects. However, the responses indicate a gap between the available expertise and the sustainability goals and a need to enhance the alignment of the existing expertise with sustainability goals. The responses suggest that some institutions possess certain expertise that align with the sustainability goals, such as farming systems research, carbon sequestration, crop rotation, and tree planting. The responses also suggest potential gaps in expertise necessary for addressing other crucial sustainability aspects such as social equity and inclusivity, economic viability and market linkages, policy and governance.

Agricultural Extension Institutions: The responses depict a concerning scenario where Nigerian agricultural extension institutions face a crisis of shrinking capacity and expertise, grappling with significant sustainability challenges, which impede their effective contribution and role in driving sustainable agricultural transformation. These institutions encounter numerous obstacles in identifying and retaining suitable profiles for their organization, particularly for technical and research positions that necessitate experience and expertise.

Staff Profile Changes and Challenges: The discussions reveal a significant transformation in the staff profiles at agricultural extension institutions over the past 5 to 10 years. Non replacement of retired staff results in an aging workforce, increasing the risk of knowledge loss and hindering innovation. This shift is primarily attributed to low recruitment, limited funding, and retirements. The institutions confront substantial challenges in identifying and retaining the right profiles for their organization, especially for technical and research positions that demand specific experience and expertise. These changes have led to an aging workforce, created knowledge gaps, and resulted in a reduced carrying capacity within the institutions.

Expertise and Recruitment: The institutions face numerous challenges in identifying and retaining the right profiles for their organization, particularly for technical and research positions that require specific experience and expertise.
Shrinking Workforce: Factors such as low recruitment, retirements, and limited funding have led to a shrinking workforce, resulting in technical cadre deficiencies.
Technical Cadre Deficiencies: Technical positions, especially in areas like communication, irrigation, climate change, storage expertise, and innovation incubation in knowledge and agribusiness, are often vacant or understaffed.
Alternative Measures: To address these deficiencies, the institutions rely on alternatives such as hiring part-time staff, utilizing social media (WhatsApp), and engaging lead farmers for communication.
Increased Workload: The remaining staff members face an increased workload and potential knowledge transfer gaps due to the lack of replacements for retiring experts.
Hiring Process Challenges: The hiring process is hampered by bureaucracy, political interference, and low remuneration, which affect both the quality and quantity of the staff.

Difficult Profiles to Recruit: The most challenging profiles to recruit are those related to adaptive research, data science, communication, and innovation. These areas require specialized knowledge and expertise, making it difficult to find suitable candidates.

Sustainability Alignment: The institutions acknowledge the importance of sustainability, considering economic factors (such as productivity and prices), social elements, and environmental aspects. However, the responses indicate a gap between the available expertise and the sustainability goals.
The necessity for labor-saving devices emerges as a practical consideration for sustainability. This is particularly relevant in enticing graduates into farming, given the prevalent aversion to labor intensive large-scale agriculture.
Limited staff capacity and expertise pose a hindrance to effective extension support for sustainable agricultural practices. This leads to potential challenges in achieving economic, social, and environmental sustainability goals. Therefore, the introduction of labor-saving devices, given the reluctance towards labor-intensive large-scale agriculture, re-emerges as a practical solution for sustainability.

Agricultural Education Institutions:
The responses to the questions reveal the current state and challenges of the staff and sustainability aspects of the agricultural education institutions in Nigeria. The main themes that emerged from the responses are:

Staff Profile Changes and Challenges: Over the past 5 to 10 years, there have been significant changes in staff profiles due to promotions, career progression, and the self-development drive of individuals. The staff profiles have changed significantly in the past 5 to 10 years, mainly due to promotion, retraining, and career development. The institutions have many staff at the professorial and senior cadre, as well as senior technologists. The challenge of the system for self-development has motivated the staff to advance their careers. However, recruitment has been low, leading to a shortage of staff in certain areas, particularly in extension, crop protection, and breeding.

Expertise and Recruitment: The institutions struggle to recruit the right staff for their organization, especially for roles that need specific expertise such as breeders, biotechnology and crop protection specialists. Some institutions have more lower-level staff than they need, but they face employment restrictions and low funding. These challenges are caused by centralized and cumbersome hiring processes, budget constraints, and low salaries. Policy and political obstacles, such as restrictive policies like IPPIS (Integrated Personnel Payroll Information System) and political interference have worsen the recruitment challenges and deter potential candidates. To cope with this, the institutions use alternatives such as casual labor and visiting lecturers on sabbatical, and explore part-time engagements.

Sustainability Expertise and Alignment: Institutions acknowledge the multifaceted goals of holistic sustainability, encompassing economic viability, social equity, and environmental responsibility. While Some institutions possess strengths in crucial areas contributing to specific sustainability pillars, the responses highlight potential gaps in expertise needed for addressing other vital sustainability aspects such as policy advocacy and governance, social inclusion and equity, market linkages and value chains.
However, the responses suggest a need to enhance the alignment of existing expertise with these sustainability goals. A greater emphasis on interdisciplinary collaboration is necessary to bridge existing expertise gaps and address the multifaceted challenges of sustainable agriculture.
Partnerships with stakeholders possessing expertise in social sciences, economics, and policy can be instrumental in achieving holistic sustainability goals.

Chapter 5 Discussion and policy recommendations

Innovation System in Agricultural Research Institutions: Innovation is crucial for sustainable agricultural transformation in Nigeria. However, discussions with stakeholders reveal significant challenges within the innovation system. These include low funding, underutilization of research, lack of essential equipment and technical expertise, weak linkages, low capacity, and low adoption of research outputs. These challenges limit the quality, relevance, and impact of research on the agricultural sector and society.

While research is pivotal for agricultural development, most results remain unused due to weak linkages and inadequate funding. However, improvements can be made by incorporating changes, providing necessary equipment, and building capacity for technical staff.

The innovation system also presents opportunities such as collaboration, synergy, and technology. Institutions collaborate with various organizations, leveraging resources, expertise, and networks for effective innovation. Through these partnerships, research institutions strive to bridge the gap between research and practice, translating valuable findings into tangible solutions for farmers.

Policy Recommendations:

To fully tap into the potential of agricultural research for sustainable transformation, concerted efforts are required from the government, research institutions, and all stakeholders:

- Increase the funding for agricultural research, especially for the areas that are relevant for the sustainability goals, such as biotechnology, climate change, and crop protection.
- Strengthen the linkage between research and extension, ensuring that the research outputs are disseminated and adopted by the farmers and other end-users.
- Provide the necessary equipment and technical expertise for the research activities, upgrading the infrastructure and building the capacity of the technical staff.
- Sustain momentum and growth through encouragement, support, and expansion of the strategic partnerships with various organizations, such as CGIAR centers, international donor organizations, local NGOs, farmer organizations, and private businesses, leveraging their resources, expertise, and networks for innovation to propel Nigeria's agricultural sector towards a more sustainable and prosperous future.

Innovation System in Agricultural Extension Institutions: The innovation system in agricultural extension institutions in Nigeria consists of interactions and linkages among various actors who generate, exchange, and use knowledge and technologies for agricultural development. Respondents emphasized the critical role of extension services in the agricultural system, serving as a vital link between research outcomes and practical implementation in the field.
However, the innovation system faces several challenges, such as low funding, poor linkage, low capacity, and limited farmer participation. These challenges affect the availability and quality of extension services, the resources and facilities for extension agents, the skills and knowledge of extension agents and farmers, and the ability to use and apply new varieties, technologies, and practices. Low participation means that farmers and other beneficiaries are not adequately involved in identifying and prioritizing their needs and demands.

Policy Recommendations:

- Increase the funding for agricultural extension services to improve the availability and quality of the extension services and the resources and facilities for the extension agents.
- Strengthen linkages with research institutions, farmer organizations and other stakeholders, through support for joint planning, training programs, and feedback mechanisms. This will ensure that the extension agents are informed and trained on the new varieties, technologies, and practices that are generated by the research institutions.
- Build the capacity of the extension agents and the farmers, enhancing their skills and knowledge to

use and apply the new varieties, technologies, and practices.

- Increase the participation and inclusion of the farmers and other beneficiaries in the extension services, involving them in the identification and prioritization of their needs and demands, and in the evaluation and feedback of the extension services.
- Develop and implement gender-sensitive and socially inclusive extension programs in the design and delivery of the extension services, ensuring that the extension services are responsive and inclusive to the diverse needs and preferences of the farmers and other beneficiaries.

Innovation System in Agricultural Education Institutions: The agricultural educational institutions in Nigeria offer various programs and courses in agriculture and related fields and also collaborate with extension services, farmer organizations, and other stakeholders to ensure the transfer and utilization of agricultural knowledge and technologies. However, the innovation system of agricultural educational institutions in Nigeria faces several challenges such as low funding, weak policy support, poor coordination, limited end-user engagement/low practical application, and inadequate infrastructure.

Policy Recommendations:

- Increase funding for agricultural education institutions to improve the availability and quality of educational and research activities, and to provide resources and facilities for educators and researchers.
- Develop a clear and coherent strategy or framework to guide and coordinate the educational and research activities of agricultural education institutions, and align them with the national development goals.
- Improve coordination and communication among the educators, researchers, students, farmers, and other stakeholders to enhance the relevance and impact of educational and research outputs.
- Increase the end-user engagement and practical application of the research activities, ensuring that research activities fully consider the specific needs and priorities of the farmers and other end-users, and that research outputs address the real problems and needs of the farmers and other end-users.
- Provide adequate infrastructure and technology for research activities, ensuring access to essential equipment and technology in laboratories to create research opportunities and enhance innovation potential.
- Build the capacity of the educators, researchers, and students, enhancing their skills and knowledge to produce and apply innovative and sustainable solutions for the agricultural sector and the society.

Sustainability Approach in Nigerian Agricultural Research Institutions:

With the aim to achieve sustainability, balancing food production with environmental, social, and economic considerations. They undertake projects that target sustainable transformation through farming system research, varietal development, and extension systems. They recognize the potential trade-offs between yield and sustainability aspects, such as gender, environment, and biodiversity. To address these trade-offs, they adopt technologies that have minimal environmental and health impact, and practices that prevent soil degradation while maintaining good productivity.

Policy Recommendations:

· Strengthen the focus on environmental sustainability:

- Increase funding for research projects that address climate change resilience, regenerative agriculture practices, afforestation, and soil health improvement.
- Develop and promote environmentally friendly technologies and farming systems that reduce the reliance on agrochemicals.
- Strengthen collaboration with environmental NGOs and international organizations to share best practices and access expertise on sustainable farming systems.
- Implement robust monitoring and evaluation mechanisms to track the environmental impact of research projects.

· Enhance integration of social aspects:

- Conduct research on the social dimensions of agricultural sustainability, such as gender equity, land access, and community development.
- Develop gender-inclusive research methodologies and ensure equitable participation of women and

marginalized groups in projects.
- Collaborate with social development organizations to address social barriers to sustainable agriculture adoption.
- Disseminate research findings in accessible formats and languages to reach diverse stakeholders.

· Improve collaboration and knowledge sharing:

- Strengthen partnerships with extension services, farmer organizations, and private sector actors to facilitate technology transfer and adoption.
- Develop effective communication channels to share research findings with stakeholders in a timely and accessible manner.
- Participate in knowledge-sharing platforms and conferences to learn from other countries and institutions.
- Encourage joint research projects with diverse stakeholders to address complex sustainability challenges.

· Advocate for supportive policies:

- Collaborate with policymakers to develop and implement policies that incentivize sustainable agricultural practices.
- Provide evidence-based recommendations to inform policy decisions on issues such as best bet options for agrochemical use, land management, and environmental protection.
- Engage in advocacy campaigns to raise awareness about the importance of sustainable agriculture for long-term development.

· Innovation for Environmental Sustainability:

- Encourage research and development of sustainable agricultural technologies.
- Prioritize innovations that minimize environmental impact while maintaining or improving productivity.

***Sustainability Approach in Nigerian Agricultural Extension Institutions**:*

Agricultural Extension Institutions: The sustainability aspects of Agricultural Extension Institutions in Nigeria involve a comprehensive approach that balances productivity, environment, and social inclusion. The institutions focus on economic sustainability by prioritizing high productivity and low cost of production, gender mainstreaming and addressing labor/resource access for social inclusion and climate resilience for environmental protection. However, they face challenges such as excessive agrochemical use, trade-offs between yield and other sustainability aspects, and the need for a paradigm shift towards a more holistic and participatory approach to sustainable agriculture.

Policy Recommendations:

· Promote Holistic Sustainability:

- Move beyond just productivity, integrate environmental and social aspects into extension activities.
- Train extension agents on sustainable practices like regenerative agriculture and soil health management.
- Develop clear policies aligning extension activities with sustainability goals.
- Encourage environmentally friendly farming methods through policies and extension messages.
- Support farmer experimentation and adoption of tailored sustainable practices.

• Address Trade-offs:

- Equip farmers to make informed decisions balancing productivity with environmental and social concerns.
- Promote readily available, affordable, low-impact inputs.
- Train extension agents to facilitate participatory decision-making with farmers for addressing trade-offs.
- Advocate for policies incentivizing sustainable practices despite potential yield reductions in the short term.

- Strengthen Capacity and Outreach:
  - Train extension agents on new technologies, sustainable practices, and gender-inclusive approaches.
  - Invest in communication infrastructure and tools to reach remote farmers.
  - Utilize diverse communication channels like radio, mobile apps, and community meetings.
  - Collaborate with farmer organizations and community leaders to build trust and promote adoption.
- Foster an Enabling Environment:
  - Advocate for increased funding for extension services to support capacity building and outreach.
  - Promote collaboration among research institutions, NGOs, and private sector actors.
  - Encourage knowledge sharing and peer learning among extension agents for service improvement.
  - Advocate for policies simplifying access to land, credit, and markets for sustainable farming.

Specific Actions:

- Increased Funding and Resource Allocation: Allocate resources for sustainable agriculture extension services, prioritizing training programs on reducing agrochemical dependence.
- Capacity Building for Sustainable Practices: Develop and implement comprehensive capacity-building programs on sustainable agricultural practices, equipping extension agents with the necessary skills for promoting and implementing sustainability initiatives.

Sustainability Approach in Nigerian Agricultural Education Institutions

Nigerian agricultural education institutions are committed to integrating sustainability principles into both education and research. They do this by emphasizing practical skills, local content, and gender inclusion, making their outputs relevant and applicable to the Nigerian context. They recognize the trade-off between high productivity and environmental stewardship, striving to manage it through affordable, low-impact inputs and conservation training.

Policy Recommendations:

- Integrate Sustainability Principles into the Curriculum:
  - Review and revise curricula to comprehensively address environmental, social, and economic dimensions of sustainable agriculture.
  - Develop interactive and hands-on learning experiences to equip students with practical skills for sustainable agricultural practices.
  - Include case studies and field visits to expose students to real-world challenges and opportunities in sustainable agriculture.
  - Offer courses on topics such as climate change resilience, regenerative agriculture, and gender equity in agriculture.
- Strengthen Links with Research and Practice:
  - Encourage collaboration between researchers and educators, ensuring research findings inform curriculum development.
  - Provide opportunities for students to participate in research projects and internship programs related to sustainable agriculture.
  - Foster innovation and entrepreneurship.
  - Encourage students to develop innovative solutions for addressing sustainability challenges in agriculture.
- Support student-led initiatives and businesses promoting sustainable practices.
  - Connect students with investors and funding opportunities to facilitate the development and scaling of sustainable agriculture technologies.
  - Offer courses on entrepreneurship and business development in the context of sustainable agriculture.
- Build Capacity and Address Infrastructure Challenges:
  - Provide professional development opportunities for educators, students, staff, and partners on sustainability principles.

- Invest in continuous development of skills and knowledge relevant to sustainable agricultural practices.

- Supportive Policy and Regulatory Framework:
  - Advocate for policies and regulations incentivizing sustainable practices and addressing environmental education concerns.
  - Align education with sustainability goals and ensure adaptive practices.

Staff and Sustainability Aspects in Agricultural Research Institutions: Agricultural Research Institutions in Nigeria have undergone significant changes in staff profiles primarily due to promotions, career progression, retirements, and a decrease in recruitment, particularly at the junior cadre level. The impacts of these changes on the staff's quality and quantity are significant. The institutions face numerous challenges in recruiting the right profiles for their organization, particularly for higher-level or research scientist positions due to the required experience. Many institutions have not hired new staff in years, leading to an aging workforce, loss of institutional knowledge and innovation gaps. The institutions have several areas where expertise is lacking.

Policy Recommendations:

- Streamline Recruitment Processes:
  - Decentralize hiring authority to allow institutions more autonomy in filling vacancies. - Implement the utilization of innovative recruitment platforms for faster application processing and candidate selection.
  - Invest in Knowledge Transfer and Capacity Building:

- Develop robust mentorship programs for senior staff to transfer knowledge and skills to junior staff:
  - Establish partnerships with universities and research institutions for staff exchange and training programs.
  - Support skill development workshops and training courses on critical sustainability topics.
  - Support staff participation in conferences and professional development opportunities.

- Promote interdisciplinary collaboration through partnerships for knowledge sharing and capacity building in sustainability expertise:
  - Create platform for knowledge sharing and brainstorming among different research teams within the institution.
  - Formalize partnerships with private sector stakeholders, NGOs, and civil society organizations.
  - Develop joint research projects and initiatives that address the multifaceted challenges of sustainable agriculture.
  - Establish interdisciplinary research centers or units focused on specific sustainability priorities.

Staff and Sustainability aspects in Agricultural Extension Institutions:

Staff and Sustainability aspects in Agricultural Extension Institutions: The institutions face staff profile changes and challenges, such as aging, knowledge gaps, low recruitment, retirements, and limited funding. These affect their technical capacity and sustainability alignment. They also struggle to recruit experts in adaptive research and data science, creating a gap between their expertise and sustainability goals. They need to align their expertise with economic, social, and environmental aspects, and address the increased workload and knowledge transfer gaps.

Policy Recommendations:

- Increase funding for recruitment and staff development, prioritizing critical technical positions to attract and retain qualified personnel.
- Streamline hiring processes to reduce bureaucracy and attract qualified candidates.
- Empower staff to tackle sustainability goals through targeted training programs and knowledge-

sharing initiatives focused on essential skills and expertise.

- Strengthen and complement traditional extension approaches by leveraging social media, farmer knowledge networks, and digital tools to reach wider audiences and compensate for staff shortages.
- Promote the adoption of labor-saving technologies, such as precision agriculture tools and automation solutions, to attract youth and alleviate labor-intensive challenges.
- Build strategic partnerships with research institutions and universities to access expertise, co-develop relevant extension materials, and conduct joint research on sustainable agricultural practices.

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Staff and Sustainability Aspects in Agricultural Education Institutions:

Agricultural education institutions have experienced significant staff profile changes due to promotions, career progression, and self-development. Senior staff has increased due to promotions, retraining, and career development. Recruitment challenges persist, especially for roles requiring specific expertise like breeders and biotechnologists. There is a need to enhance alignment with sustainability goals. While strengths exist in certain sustainability areas, gaps are identified in expertise related to policy advocacy and governance. This has increased the senior staff, but also the recruitment challenges, especially for roles that need specific expertise, such as breeders and biotechnologists. The institutions need to align their expertise better with sustainability goals. They have strengths in some sustainability areas, but gaps in others, such as policy advocacy and governance.

Policy Recommendations:

- Restructure recruitment policies to target critical expertise gaps.
- Decentralize recruitment processes for faster and more efficient hiring.
- Allocate funding for targeted recruitment initiatives and staff development programs.
- Explore partnerships with private sector and civil society organizations to access expertise in areas like social sciences, economics, and policy.
- Promote interdisciplinary collaboration within institutions to bridge expertise gaps and address the multifaceted challenges of sustainable agriculture.
- Develop curricula and courses that focus on practical skills and knowledge for sustainable agriculture practices.

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