



Research Report

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

FRR VOLUME
8 No 7

Authors

Alpha O. KERGNA
Abdoulaye NIENTAO



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

Authors:

Alpha O. KERGA

Abdoulaye NIENAO

Citation

Alpha O. Kergna and Abdoulaye Nientao: Building Skills, Institut d'Economie Rurale and Building skills and Research-Extension Linkages for Sustainable Agricultural Transformation: Insights from Mali. Forum for Agricultural Research In Africa, Volume 8 Number 7; PP 1 -36

FARA encourages fair use of this material. Proper citation is requested.

Forum for Agricultural Research in Africa (FARA)

No. 7 Flower Avenue, New Achimota Mile 7, Accra, Ghana Tel: +233 302 772823 / 302 779421

Fax: +233 302 773676 Email: info@faraafrica.org Website: www.faraafrica.org

Editorials

Mr. Benjamin Abugri (babugri@faraafrica.org)

Dr. Fatunbi A. O (ofantunbi@faraafrica.org)

ISSN: 2550-3359

About FARA

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.

About FARA Research Result (FRR)

FARA Research Report (FRR) is an online organ of the Forum for Agricultural Research in Africa (FARA). It aims to promote access to information generated from research activities, commissioned studies or other intellectual inquiry that are not structured to yield journal articles. The outputs could be preliminary in most cases and in other instances final. The papers are only published after FARA secretariat internal review and adjudgment as suitable for the intellectual community consumption.

Disclaimer

"The opinions expressed in this publication are those of the authors. They do not purport to reflect the opinions or views of FARA or its members. The designations employed in this publication and the presentation of material therein do not imply the expression of any opinion whatsoever on the part of FARA concerning the legal status of any country, area or territory or of its authorities, or concerning the

delimitation of its frontiers

Table of Content

1.Introduction.....	4
1.1.Insights from existing literature and data.....	4
2.Methods and Sampling.....	6
2.1.Mapping of AREE institutions.....	6
2.2. Interviews with key stakeholders of AREE institutions	7
2.3.Survey of staff from AREE institutions	8
2.4. Survey with students from ATVET institutions	9
3. Results	9
3.1. Mapping.....	9
3.2.Staff Survey.....	10
3.2.1.Staff characteristics and motivation.....	10
3.2.2.Professional Networks	15
3.2.3. Perceptions of the Challenges in the Agricultural Sector. Mission of Organisation. and Sustainability Aspects.....	17
3.2.4. Digitalization	21
3.3.Students Survey	26
3.3.1.Student Characteristics and Motivation	26
3.4.Budgetary allocation to agricultural aspects	27
3.5.Expected greatest contribution after graduation.....	27
3.5.1.Perceptions of Challenges in the Agricultural Sector.....	28
3.5.2.Perceptions of Training.....	29
3.6. Qualitative Insights from Interviews with Managers	32
3.6.1. Overall Mission and Changes in Mission	32
3.6.2. Innovation System	32
3.6.3.Sustainability Aspects	33
3.6.4.Staff and Sustainability Aspects	33
4.Discussion and policy recommendations.....	34
References.....	35

List of Tables

Table 1: Number of quantitative interviews conducted by category of institution.....	8
Table 2: Summary of qualitative interviews conducted by category of institution	8
Table 3: Number of students interviewed in sampled training institutions	9
Table 3: General information of staff from AREE institutions	10
Table 4: Percentage of AREE institutions staff and areas of study	11
Table 5: AREE staff and their educational qualifications.....	12
Table 6: Types of additional trainings AREE staff had undergone.....	13
Table 7: Motivation of staff in the AREE institutions.....	13
Table 8: Goals of AREE institutions.....	14
Table 10: Collaborators' background of staff of AREE institutions	15
Table 11: Meeting with staff from other organizations.....	16
Table 13: Main challenges of farming according to staff from AREE institutions	17
Table 12: Main challenges of farming according to staff from AREE institutions	17
Table 13: Changes in AREE institutions' missions and focuses.....	19
Table 14: AREE institutions' focus	20
Table 15: Types of digital tools used by staff members of AREE institutions.....	21
Table 17: Staff's opinion on payment-related issues.....	22
Table 18: Staff's opinion on hiring and promotion-related issues.....	23
Table 19: Staff's opinion on overall support.....	24
Table 20: Staff's opinion on supervision by reporting officers.....	25
Table 21: Characteristics of students undergoing training.....	26
Table 22: Students' suggestion on partitioning of the national agriculture budget allocation	27
Table 23: Students' perception on how they could impact agricultural production	28
Table 24: Students' perceived challenges of farming ten years ago and currently.....	28
Table 25: Students' perception of their courses of study	29
Table 26: Students' perception of teaching time devoted to economic, social and environmental sustainability aspects their courses.....	30
Table 27: Students' perception on adequacy of components of course contents.....	30
Table 28: Students' perception of aspects that should be captured by their courses to address the country's challenges.....	31
Table 29: Challenges faced by students.....	32

List of Figures

Figure 1: Overview of selected institutions and schools	7
Figure 2: Agricultural Technical and Vocational Education and Training Institutions.....	7
Figure 3: Stages of the Sampling Process	10

1. Introduction

Agricultural transformation plays a key role for meeting the Sustainable Development Goals (SDGs). Governments can support agricultural transformation by promoting innovations and skills development. An important strategy in this regard is investing in agricultural research, extension, and education. In the past two decades, the “agricultural innovation system” has become a widely accepted framework for guiding public investments in these areas (e.g., Spielman & Birner, 2008; World Bank, 2012). Agricultural innovation systems have traditionally been focused on increasing agricultural land and labor productivity. While this focus continues to be highly relevant, meeting the SDGs requires innovations and skills development to not only increase agricultural productivity but also contribute to other environmental and social goals such as climate resilience, agrobiodiversity conservation, and inclusiveness.

In recent years, African countries have engaged in various efforts aimed to consider multiple sustainability goals within their agricultural innovation systems. 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. There are, however, major knowledge gaps on what can be learned from such efforts. One reason for this knowledge gap is the fact that past studies have mostly focused on the role of these institutions in improving agricultural productivity but hardly covered other sustainability goals (e.g., Fuglie et al., 2020; Fuglie, 2021; Seck et al., 2013). Hence, there is limited empirical evidence on how to move beyond a productivity focus and address multiple sustainability goals within research, extension, and education institutions. Moreover, there is a limited understanding of the extent to which these institutions reflect that farmers increasingly need a wide variation of skills, for example, to pursue multifunctional livelihoods based on the combination of crop, livestock, and horticulture, among others, and to benefit optimally from rural agricultural development processes.

This report aims to support the sustainability transition of the agricultural innovation system in Mali by analyzing strategies within agricultural research, extension, and educational institutions that aim to meet multiple sustainability goals and exploit the potential that digital solutions offer in this regard. The focus of the research was on (a) National Agricultural Research Systems (NARS), (b) agricultural advisory services, and (c) Agricultural Technical and Vocational Education and Training (ATVET) institutions. In the following, these institutions will be jointly referred to as AREE (agricultural research, extension, and education) institutions.

A particular focus of this report is to explore what types of synergies and trade-offs between productivity and other sustainability goals managers and staff members of the above-mentioned institutions address in their efforts to generate and promote agricultural innovations and skill development. The report also explores the general status of the AREE, including exploring digitalization efforts, working environments, and staff satisfaction, and examining to what extent AREE institutions are linked with each other (e.g. between NARS and agricultural advisory services) and with international research partners (e.g. CGIAR). The goal is to better understand how to make sure that AREE institutions promoting agricultural development efforts in Mali and elsewhere embrace all dimensions of sustainability.

1.1. Insights from existing literature and data

In Mali, the evolution of the AREE institutions has followed the same pathway as it did in the other francophone countries in West African Sahel (KIT, 2020). From independence in 1960 to 1970, agricultural research and extension services were exclusively provided by the public sector. During this period, the services were provided by a large number of government agencies and autonomous projects (World Bank, 1999). During that period, parastatals such as Compagnie Malienne pour le Développement des Textiles (CMDT) and Office du Niger developed their own agricultural extension approaches. In the mid-eighties, the system of agricultural research and extension became costly and had failed to achieve its objectives according to the World Bank.

Also, with the structural adjustment program in the 1980s, public agricultural services scaled down and were dismantled in some cases. This influenced the operations of agricultural extension organization with less fund and staff. Therefore, several approaches were implemented through various World Bank funded programs such as the Training & Visit (T&V) and the rapid rural appraisal approaches (DLEC, 2018).

Then, market liberalisation of the Malian agricultural sector; privatisation of input supply and outputs trading from 1990 to 2000; led producers to seek for extension and advisory services. Therefore, the Government requested the assistance of the International Development Agency (IDA) to launch larger scale operations such as Agricultural Extension Test Program (PTVA), followed by National Agricultural Extension Program (PNVA), Program of Support to Agricultural Services and Farmers' Organizations (PASAOP) and Fostering Agricultural Productivity Project (PAPAM). All programs, were inspired by the Benor Method (Training and Visits). The aims of these programs were the development of decentralized rural services, search for better performance of agricultural services, increased empowerment of rural development actors, financial participation of beneficiaries, making direct actors more responsible by sharing some of the agricultural extension services costs through an experimentation on agricultural extension service management transfer to beneficiaries and private services providers. According to Berthé (2015), in Africa the extension practices were based on three major paradigms: (1) public led Technology Transfer with Training and Visit system (T&V system); (2) public and private Advisory Services and; (3) Non-formal Education (NFE) involving Farmers Field Schools (FFS) and Facilitation Extension where front-line extension agents primarily work as "knowledge brokers" in facilitating the teaching-learning process among all types of farmers (including women) and rural young people.

As for extension, World Bank institutional support programs also took interest in agricultural research by drawing up in 1994 a strategic plan for Malian agricultural research system. This plan for NARS has been revised in 1998 and ended in 2005 with deep structural changes through PNRA and PASAOP programs (CNRA, 2010). The operationalization of these successive plans led to the improvement of CNRA's institutional capacity, the reinforcement of agricultural research funding mechanism and networking with regional and international research institutions. Regarding operational mechanism of research activities, we also noted changes in agricultural research project's governance, intervention methods and direct participation of producers with an effective involvement of farmers' organizations in designing technology generation and transfer programs.

Despite, the implementation of these programs, agricultural research and extension systems in Mali are still facing challenges, which are mainly poor organisation and coordination and a lack of human and financial resources. As indicated by KIT (2020) and DLEC (2018), public funding for agricultural research and extension systems in Mali is limited and depend mainly on external financing. According to Sokona (2020) and DLEC (2018) the number of staff involved in the field of agriculture was 922 for research and 839 for extension services of which only 646 are in direct contact with farmers. They pointed out that, the number of female researchers and extension agents tends to be low; only 15% for research and between 10 to 25% for extension. This lower number of extension staff makes the workload high as a supervisor covers an average of 15 to 16 villages instead of the 6 to 8 villages' standard established by the Government (IFPRI/FAO/IICA, 2011).

In Mali, there are a variety of agricultural extension and advisory public and private training institutes (DLEC, 2018). The public institutes include mainly the Rural Polytechnic Institute of Training and Applied Research (IPR/IFRA), the University of Segou, the Centers of Agricultural Apprenticeship (CAAs) in agronomy, livestock and forestry, vocational schools, etc. The formal education system in Mali includes three types of education, which are the fundamental education (divided into primary study certificate and diploma of fundamental study), the secondary education and the higher education (Atchoarena and Delluc., 2002). The ATVET institutions included secondary Schools and are composed of three types of programs such as the vocational training certificate (certificate d'aptitude professionnelle/CAP) in two years, the technical Bac in three years and a technical certificate (Brevet de Technicien/BT). The ATVET programs are delivered at different levels in different types of institutions (public and private), including technical and vocational

schools, polytechnics, enterprises and apprenticeship training centers.

The enrolment in this type of education has quite increased and the male to female ratio has changed when comparing the data from 2002 (67% for male and 33% for female) to 2020. The share of female students in vocational education is about 40.8 per cent of the 127,700 students in general (UNESCO, 2022). Kirui and Kozicka (2018) said that TVET in most Sub-Saharan African countries has played a marginal role despite numerous policy actions addressed for promoting youth employment (2018)

2.Methods and Sampling

2.1.Mapping of AREE institutions

To shed light on the research questions, a comparative survey-based study approach was planned by employing a mixed-method research design. A list of National Agricultural Research Systems, agricultural advisory services, and Agricultural Technical and Vocational Education and Training institutions was compiled based on documents at the ministries of education and rural development. This overview displays the institutions and schools by category and specialization in the different regions of Mali. Through the display, one can see that most institutions and schools are distributed in the administrative regions of Koulikoro, Segou, Sikasso and the District of Bamako.

In order to further define the sample, a selection of the most important localities in terms of the number of institutions and schools distributed was undertaken. This choice was done in a way that the retained localities accounted for approximately 100% of the institutions and/or schools present. In each region, a map of institutions and schools was obtained based on agricultural activities.

The final sample size that was required for the questionnaires were 400 interviewees from NARS, Extension services, EVET, CGIAR, Farmer Organizations and NGOs. This size represented approximately the entire innovation system environment in Mali. To be consistent with our approach we randomly selected respondents in each institution or school. The following charts present an overview of the institutions and schools selected.

(a) National Agricultural Research Systems

(b) agricultural advisory services

(c) Agricultural Technical and Vocational Education and Training

National Research Inst.

- IER (Institut d'Economie Rurale)

6 departments both for crops and livestock

International Research Inst.

- ICRISAT
- ICRAF
- IITA
- ILRI
- AVRDC (world veg)

Agric. extension

- DNA (national extension service)

departments both for crops and livestock

AGRA

Crop specific

- CMDT (cotton)
- Office du Niger (rice agency)
- DNPIA (livestock)
- DNREF (forestry)
- DNPECHE (fisheries)
- IFDC (Fertilizer)

Figure 1: Overview of selected institutions and schools

Agricultural Technical and Vocational Education and Training inst.

1-	L'IPR/IFRA : (L'institut Polytechnique de Formation et de recherche Appliquée) de Katibougou (Koulikoro)	19-	Kone Grilles-Ecole Secondaire Agropastorale ESAP
2-	IFP Institut de Formation Professionnelle	20-	Champs-Ecoles de la FAO
3-	Agronomie-Université de Ségou	21-	Kairaso, Ecole de l'agriculture durable au sahel
4-		22-	Les Formations agricoles qualifiantes
5-	CFAP : le Centre de Formation Agro-pastoral de Bamako	Les Centres d'animation rurale (CAR) :	
6-	CAPS : le Centre Agro-pastoral de Ségou	23-	IFGR (Institut de Formation en Genie Rural)
7-	CFPPAS : le Centre de Formation Professionnelle pour la Promotion de l'Agriculture au Sahel de Gao	24-	Ecole Agro-Pastorale de Paul Diallo
8-	CFPR : le Centre de Formation Polytechnique Rurale de Kita	25-	Ecole Agro-Pastorale de Blaise Pascale
9-	CFPE : le Centre de Formation Pratique en Elevage de Sotuba	26-	Ecole Agro-Pastorale Cite Verte
10-	CFPF : le Centre Formation en Foresterie de Tabakoro	27-	Ecole Agro-Pastorale Momo
11-	L'institut de Formation Professionnelle Malick Sidibe	28-	Ecole Agro-Pastorale Fadiala Coulibaly
12-	Le Centre d'Apprentissage Agricole de Same (Kayes)	29-	IGR (Institut de Genie Rural)
13-	Le Centre d'Apprentissage Agricole de Samanko (Koulikoro)	30-	Complexe Agro-Pastoral Fatoumata Coulibaly
14-	Le Centre d'Apprentissage Agricole de M'pessoba (Sikasso)	31-	Complexe Agro-Pastoral Mamadou Moussa Kone
15-	Le Centre d'Apprentissage Agricole de Dioro (Ségou)	32-	EFAP-W (Ecole Agro-Pastorale de Wayerma)
16-	Le Centre d'Apprentissage Agricole de Kita (Kayes)	33-	Complexe Agro-Pastoral Salama
17-	Université Bazo de Bamako	34-	Complexe Agro-Pastoral Binta Diaby
18-	Ecole des Infirmiers Vétérinaires de Sotuba		

Red- good to be included in the sample (gov. Inst.)
 Blue- government inst.
 Green- private inst.

Figure 2: Agricultural Technical and Vocational Education and Training Institutions

2.2. Interviews with key stakeholders of AREE institutions

The research team in Mali facilitated the meetings with the staff at management positions within each of the institutions visited. Participants were briefed upfront of the upcoming mission and were given an overview of the project objectives, prior to the visit. Arrangements were made upfront with the management staff in the visited institutions. Thus, the opportunity was given to introduce the project, the activities, and the list of staff members was requested for subsequent surveys. Data collection was carried out by a team of researchers from IER with the support of the Hohenheim team.

The total number of respondents, was proportionately selected from the three groups of institutions mentioned above, which amounted to 300 professionals actively working in the agricultural sector. Additionally, 100 students from professional agriculture training courses were randomly selected. A total of 400 respondents were scheduled for interviews through a quantitative survey. In addition, 30 qualitative key-informant interviews were conducted across the institutions. A variety of actors within the AREE systems were interviewed. In most cases, interviews were undertaken within the stakeholder's office, or at IER premises. Where possible, the interview was administered to the head of the institution; otherwise, the deputy was invited for the activity. The following table presents the number of institutions in each category, their names and the number of interviews conducted.

Table 1: Number of quantitative interviews conducted by category of institution

	NARS	ATVET	Extension
Number of organizations	6	6	5
Names of organizations	IER (CRRRA Niono, CRRRA Sikasso, CRRRA Sotuba), ICRISAT, IITA, ICRAF, ILRI, AVRDC	IPR-IFRA, Universite de Segou, CAA M'Pesoba, CAA Samanko, Ecole Agro-Pastorale Blaise Pascal, Ecole Agro-Pastorale Salia Traore	DRA Koulikoro, DRA Segou, DRA Sikasso, CNOP, CARE-Mali
Number of respondents	83	83	87

In each of the 3 categories of institutions, 10 key-informant interviews were planned with the directors and key managers. Time conflict and lack of contact with stakeholders from private extension services and international research system limited the interviews. Although possibilities of subsequent online interviews (Zoom meetings or WhatsApp calls) were given, some could not fulfil the appointment. The following table shows the number of interviews conducted in the institutions.

Table 2: Summary of qualitative interviews conducted by category of institution

Summary of interviews	Number of interviews planned	Number of Interviews conducted	Numbers of interviews remaining
Extension	10	7	3
ATVET	10	10	0
NARS	10	8	2

2.3.Survey of staff from AREE institutions

A multi-stage sampling procedure was employed to select the sample for this research. After the collation of a comprehensive list of institutions (National Agricultural Research Systems, agricultural advisory services, and Agricultural Technical and Vocational Education and Training institutions), institutions working on a regional and national level focusing on crops only or crops and livestock were purposefully sampled. Once the institutions were identified, a list of all of the staff members working in the areas of agricultural research, extension, and training, as well as students from the training organizations, was randomly selected for a quantitative questionnaire-based survey.

1. In each of the institutions identified, a staff survey was conducted, if the managers of the respective institutions agreed to participate. The survey included a set of standardized questions that refer to all types of institutions as well as sets of questions that are specific to NARS, advisory services, and ATVET institutions.
2. The quantitative surveys featured a choice experiment. The options presented reflected realistic options of fictional projects. Respondents were asked to select a project featuring different levels of each sustainability dimension.
3. In each of the institutions, qualitative data was collected through key-informant interviews with the directors and key managers using interview guidelines. All interviews were held in person or—where possible and appropriate—through video conferencing/WhatsApp.

2.4. Survey with students from ATVET institutions

In addition, in selected agricultural advisory and ATVET institutions, a quantitative questionnaire-based survey among students was conducted to better understand their perspective on the skills obtained and needed for sustainability transformation. The field visit of training institutions revealed that “Paul Diallo” is no longer a reliable school; it has been dropped and replaced by Ecole Pastorale Sallia Traore. The following table presents the list of schools where interviews were conducted and the number of students interviewed.

Table 3: Number of students interviewed in sampled training institutions

	ATVET
Number of organizations	6
Names of organizations	IPR-IFRA, Universite de Segou, CAA M’Pesoba, CAA Samanko, Ecole Agro-Pastorale Blaise Pascal, Ecole Agro-Pastorale Sallia Traore
Number of respondents	108

3. Results

3.1. Mapping

The following chart presents the final sample of institutions. The NARS were composed of IER (national research institute) with 6 regional departments and the CGIAR, with 5 institutions. Within IER, 3 departments (Niono, Sikasso and Sotuba) were selected and all CGIAR (ICRISAT, IITA, ICRAF, ILRI, AVRDC) pooled as one. A total of 100 interviews were planned, 75 from IER, and 25 from all CGIAR. Some CGIAR researchers were not available for the interviews.

For public extension services, the team selected the DRA of Koulikoro, DRA of Segou and DRA of Sikasso (75 interviews). CNOP and Care Mali were selected as private and NGO (25 interviews). The team faced difficulties in conducting interviews with Care Mali agents.

Agricultural Technical and Vocational Education Training institutions selected were IPR/IFRA (25 interviews), University of Segou (25 interviews), Centre d’Apprentissage de Samanko and Centre d’Apprentissage de M’pessoba (25 interviews) and Ecole Agro-Pastorale Blaise Pascale and Ecole Agro-Pastorale Sallia Traore (25 interviews). On the field the research team found that the 2 Ecole Agro-Pastorale utilized the same set of professors (limiting the number of interviews).

A total of 100 students from ATVET were interviewed, 25 at TPR/IFRA, 25 at the University of Segou, 25 in the two (2) Centre d’Apprentissage and 25 in the two (2) Ecole Agro-Pastorale.

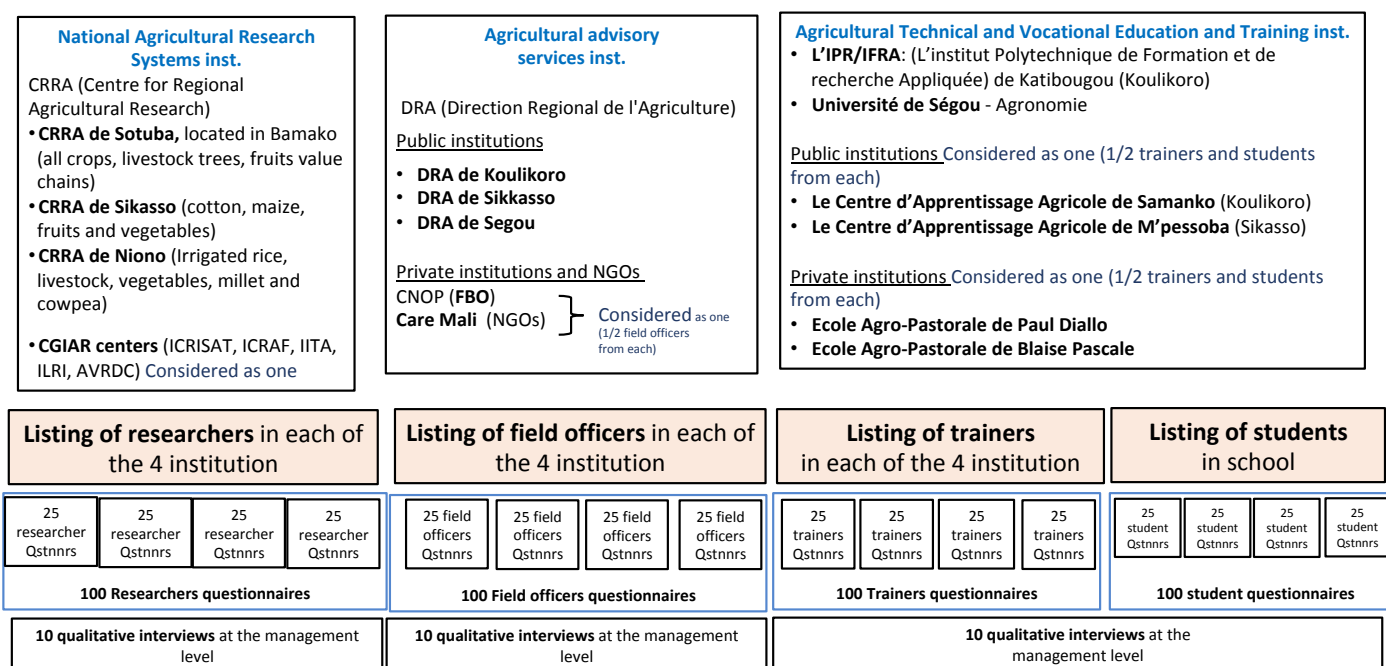


Figure 3: Stages of the Sampling Process

3.2. Staff Survey

3.2.1. Staff characteristics and motivation

The table 4 shows that among the AREE institutions' staff from the sample, women accounted for a very low proportion of 17% out of a total of 253 staff members. The lowest share of women was among ATVET staffs with 8% while NARS and extension had about 11 and 30 percent, respectively. This low representation of women was also observed by Sokona (2020) on gender assessment of science, technology and innovation ecosystem. The study noted that among the agricultural research and training institutions in Mali, only 10% and 12% of the women had Master's and Ph.D. degrees, respectively. But the situation was better with 35.54 percent regarding the support staff in those institutions. However, human resources development is one of the key drivers of economic development. Therefore, investing in education and training of a nation's citizens might let them reach their full potential. To drive and promote economic development, Sub-Saharan African countries, where women represent the majority of the population, must ensure that women are carried along. As indicated in the 2008 report of the EESC, education and training of women in developing countries yield higher return than for men.

Table 3: General information of staff from AREE institutions

General background	NARS	ATVET	Extension	Average
Gender (share of females)	10.84%	8%	29.89%	16.60%
Work experience (years)	18	14	15	15
Age (years)	45		46	43
Origin (share rural)	57%	63%	55%	58%
Studied abroad (share yes)	43%	42%	7%	30%

The average working experience in the agricultural sector was 15 years for the AREE institutions' staff with the highest number of years for NARS' staff. The ATVET and extension staffs had similar professional work experience closer to the average. More than half of the staff interviewed are from rural areas. This was the picture for NARS, ATVET and extension. In general, staff members from public AREE institutions were aging and the number of agents recruited did not fill the gaps created by the exit of retired personnels.

The average age of the AREE institutions staff was similar to 45 and 46 years observed for NARS and extension officials, respectively. Quite a number of staff studied abroad and this was due to the non-existence of certain specialization in agriculture in Mali.

The staff members' origin also influenced their choice of courses studied. As shown in Table 5 below, the courses studied by most of the staff (64%) of AREE institutions were agronomy, plant breeding and entomology. However, on further enquiry, it was observed that 85% of the extension workers studied agronomy, also most of them (about 36%) possess certificate in agriculture as presented on Table 6 below. While 66% of NARS and 39% of ATVET staff had master's or Ph.D. qualifications in other crop production related areas such as plant breeding, entomology etc. Some ATVET staff had qualification in other professional background such as social sciences, agri-food processing and conservation, livestock, environmental science and management. The agricultural vocation of the country including agriculture, forestry and pastoralism reflects the professional background of the staff members of AREE institutions. However, the proportion of trainings leading to job creation is low, therefore, to meet and labour market demands, it is important strengthen and also come up with more agriculture-oriented trainings in business management and agripreneurship.

Table 4: Percentage of AREE institutions staff and areas of study

Professional background	NARS	ATVET	Extension	Average
Agronomy / Plant breeding / Entomology	66	39	85	64
Livestock / Veterinary	5	13	9	9
Social Sciences / Economics, Public Health / Educational Studies	17	20	2	13
Environmental sciences / Biology	6	6	0	4
Management / Business / Public Administration	0	6	0	2
Engineering / Processing / Conservation of agri-food products	6	16	3	8
Others	0	0	0	0
Total	100	100	100	100

Table 6 also shows that the average education level of staff from AREE institutions. Aboutt 36% possess master's degree while about 21% possess Ph.D. degree. By considering the education level for each type of institutions, it was observed that staff of NARS and ATVET institutions are mainly master's and Ph.D. holders. While 37% and 36% of NARS staff members had master's and Ph.D. degrees, respectively, 48% of ATVET members of staff had master's degree, while 29% possessed Ph.D degree.. Extension institutions' staff were mainly technicians (35.6%) who had certificate qualification in agriculture. However, a good number of extension workers (19%) possessed master's degree.

Table 5: AREE staff and their educational qualifications

Education	NARS	ATVET	Extension	Average
Primary school (%)	0	0	3.45	1.19
Secondary school (%)	0	0	4.60	1.58
Vocational school (%)	8.43	3.61	18.39	10.28
Certificate in Agriculture (%)	7.23	12.05	35.63	18.58
Bachelor's degree (%)	10.84	14.94	14.94	11.07
Master's degree (%)	37.35	48.19	19.54	35.97
PhD (%)	36.14	28.92	0	21.34
Total (%)	100	100	100	100

In addition to the formal training, most AREE staff in all the institutions had undergone other types of trainings covering many aspects of sustainable agriculture development as shown on Table 7. It is important to indicate that the pilot and literate producers also participated in agricultural technology dissemination and are considered as field extension agents mainly among NGOs. On average, 61% of the AREE institutions' staff had been exposed to additional trainings. Most NARS staff (69%) had participated additional trainings, while only 54% of extension services staff had undergone such trainings.

The additional trainings AREE staff had been exposed to could be broadly classified into three (3): agronomic, social and digital. As shown Table 7, almost 49% of AREE staff reported to have undergone additional trainings in agronomic, social and digital aspects. It was observed that more than the half of staff from extension services had participated in comprehensive trainings in which encompassed agronomic, economic and social aspects. On the other hand, only the agronomic and digital issues were covered by additional trainings that NARS and ATVET staff participated in.

Table 6: Types of additional trainings AREE staff had undergone

Additional training			NARS (%)	ATVET (%)	Extension (%)	Average (%)
Additional training besides formal training (share yes)			68.67	61.45	54.02	61.26
In the additional training, which aspects have been covered? (share on a scale from 1=Not at All to 4=To a Great Extent)	Agronomic aspects	Not at all	10.91	25.53	4.35	13.51
		Very little	14.55	10.64	4.35	10.14
		Somewhat	20	27.66	36.96	27.70
		To a great Extent	54.55	36.17	54.35	48.68
	Economic aspects	Not at all	21.82	27.66	8.70	19.59
		Very little	7.27	10.64	13.04	10.14
		Somewhat	45.45	36.17	54.35	45.27
		To a great Extent	25.45	25.53	23.91	25
	Social aspects	Not at all	21.82	19.15	10.87	17.57
		Very little	7.27	8.51	6.52	7.43
		Somewhat	43.64	42.55	60.87	48.65
		To a great Extent	27.27	29.79	21.74	26.35
	Environmental aspects	Not at all	16.36	34.04	6.52	18.92
		Very little	5.45	12.77	6.52	8.11
		Somewhat	40	27.66	47.83	38.51
		To a great Extent	38.18	25.53	39.13	34.46
Digital tools	Not at all	9.09	14.89	19.57	14.89	
	Very little	5.45	6.38	15.22	8.78	
	Somewhat	21.82	17.02	47.83	28.38	
	To a great Extent	63.64	61.70	17.39	48.65	

Table 8 shows the motivation of staff for working in the different AREE institutions. The motivation of almost 62% of the staff of the AREE institutions was firstly the desire to share or transfer knowledge. Secondly, about 61% of them desired to contribute to the change in the country's farmers' well-being. The sharing of knowledge was the most important motivation of almost 79% of ATVET staff. While contributing to the change in the country was considered very important for 71% of NARS staff, 69% of extension staff gave the same point as basis for their motivation. As shown in the table, prestige and job security were the least important motivation of AREE institutions workers.

Table 7: Motivation of staff in the AREE institutions

Motivation	NARS	ATVET	Extension	Average
Regular income (%)	21.69	16.87	29,89	22.92
Job security (%)	13.25	12.05	24.14	16.60
Prestige (%)	4.82	0.00	3.45	2.77
Change in the country / for farmers (%)	71.08	42.17	68.97	60.87
Personal fulfilment (%)	36.14	25.30	24.14	29.64

Share / transfer knowledge (%)	51.81	79.52	56.32	62.45
Others gain of experience (%)	31.33	31.33	32.18	31.62
Total (%)	100	100	100	100

Most agricultural organizations try to achieve several goals but the emphasis on the various goals might be different from an organization to another. Table 9 shows the list of goals of AREE institutions covered by the survey. Increased productivity as the first and main objective was not unexpected. The main target for leaders and managers of a poor country's population is to meet food needs and then sell the surplus and this might be different in the case of a developed country. The five most important goals according to the respondents of the three types of institutions are ranked as follow: (1) increase productivity, (2) improve food security, (3) reduce poverty, (4) improved mitigation and adaptation to climate change and (5) contribute to biodiversity conservation. From the responses of the staff on their institutions' goals, women empowerment was not considered among the most important goals. This was also reflected in the responses of the staff members on the national agricultural budget distribution as shown on Table 10.

Table 8: Goals of AREE institutions

Perceived main goals of the type of organization	NARS (%)	ATVET (%)	Extension (%)	Average (%)
Increase productivity	84,34	72,29	90,80	82,61
Reduce poverty	55,42	36,14	40,23	43,87
Improved mitigation and adaptation to climate change	53,01	36,14	40,23	43,08
Foster women's empowerment	18,07	19,28	18,39	18,58
Improve food security	61,45	63,86	71,26	65,61
Contribute to biodiversity conservation	37,35	30,12	31,03	32,81
Integrate marginalized groups and the poorest	20,48	31,33	21,84	24,51
Improve access to financial services	14,46	27,71	19,54	20,55
Foster the use and development of digital tools	16,87	22,89	9,20	16,21

Based on the three aspects of sustainability (economic, social and environmental), AREE institutions' staff were asked to give a percentage to each one of the three aspects out of the 100% of the national agricultural budget. Therefore, 46% of the budget in average was attributed to economic sustainability such as reduction of hunger and poverty, improvement of living standards, etc. Then, follows the environmental sustainability, including climate change mitigation and adaptation, integration or conservation of biodiversity, with almost 30% of the national agricultural budget. The social sustainability aspect, by considering gender and integration of marginalized groups and the poorest, comes at the end with about 24% of the budget. As said previously, this distribution of the budget reflects the AREE institutions' staff responses on the perceived main goals of the types of organization. The social sustainability has the lowest share of the budget.

Table 9: Agricultural budget allocation as suggested by staff from AREE institutions

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.) (%)	48,19	44,10	46,31	46,20
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.) (%)	24,70	22,94	24,29	23,98
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.) (%)	27,11	32,96	29,40	29,82
Total (%)	100	100	100	100

3.2.2. Professional Networks

Networking is seen as a tool to strengthen agricultural research and extension of technology and innovation and it is used to avoid duplication of efforts and to invest resources (human and finance), at relatively low cost, in order to achieve the objectives more efficiently (Far, 1991). The same author defined agricultural networks, including research, extension workers, farmers, etc. as a group of individuals or institutions linked together because of commitment to collaborate in solving a common agricultural problem or set of problems and to use existing resources more effectively. Table 11 shows the professional background of partners with whom the AREE institutions staff mostly collaborated with. On the average, 88% of interviewed staff indicated that agronomy was the main field area for most of their collaborators, and this was the trend in each of the three (3) AREE institutions. Livestock breeding professionals (37%) were second in the ranking of collaborators of AREE personnel. Other top sets of collaborators were social scientists (34%), plant breeders (31%) and environmental scientists (31%).

Table 10: Collaborators' background of staff of AREE institutions

Professional background of collaborators	NARS	ATVET	EXTENSION	Average
Agronomy (%)	93.98	86.75	83.91	88.14
Plant breeding (%)	62.65	16.87	14.94	31.23
Entomology (%)	49.40	22.89	12.64	28.06
Social sciences (%)	49.40	34.94	18.39	33.99
Management/business (%)	13.25	12.05	9.20	11.46
Engineering (%)	10.84	19.28	9.20	13.04
Environmental science (%)	40.96	32.53	16.09	30.83
Livestock breeding (%)	42.17	43.37	26.44	37.15
Veterinary (%)	24.10	34.94	31.03	30.04
Economics (%)	33.73	30.12	10.34	24.51
Public Health (%)	10.84	8.43	5.75	8.30
Public administration (%)	19.28	12.05	17.24	16.21

Pedagogical Study (%)	9.64	12.05	3.45	8.30
Biology (%)	22.89	21.69	13.79	19.37

During the last twelve months prior to the survey, many AREE institutions' staff had met several other organizations at local, national and international levels for five (5) to more than ten (10) times. The organizations included national and international research centers, educational institutions, NGOs, private and third sector extension services, farmers' organizations, others value chain actors etc. It should be noted that some respondents could not differentiate between CGIAR centers and other international research organizations. Table 12 shows that more than 50% of AREE institutions' staff met with partner/collaborating organizations for up to five times. Most of the meetings did not exceed the 5 times scale and this could be explained by the lack of joint planning and scheduling of the activities by the partnering agencies or organizations.

The table also shows that almost 64% of staff of NARS staff met with other colleagues from international research organizations for up to five times, while 55% and 54% of extension services personnels met with national research organizations and NGOs, respectively. This shows that there was strong collaboration between Malis NARS and others international research organizations whereas these collaborations were stronger for staff of extension services, with the duo of NARS and NGOs. This confirmed the observation of DLEC (2018) report that agricultural research and extension systems in Mali was limited and depended mainly on external financing. It is important to indicate that, during the last three decades, the agricultural research and extension system in Mali had noticed a mutation with more involvement of NGOs and farmers organizations. However, 74% and 78% of ATVET staff had met many times with colleagues from extension services and CGIAR centers, respectively.

Table 11: Meeting with staff from other organizations

During the last 12 months, how many times did you meet with staff members from ...?	NARS	ATVET	EXTENSION	AVERAGE
National Research Organization				
Up to 5 times	39.39	62.50	55.56	51.19
Between 5 to 10 times	30.30	18.75	16.67	22.62
More than 10 times	30.30	18.75	27.78	26.19
Members from CGIAR centers				
Up to 5 times	50	78.26	60	59.18
Between 5 to 10 times	30	17.39	20	24.49
More than 10 times	20	4.35	20	16.33
Other international research organizations				
Up to 5 times	63.64	66.67	41.67	61.11
Between 5 to 10 times	18.18	18.52	50	23.61
More than 10 times	18.18	14.81	8.33	15.28
Education institutions (e.g. vocational schools)				
Up to 5 times	52.83	54.55	52.17	53.44
Between 5 to 10 times	28.30	7.27	21.74	18.32
More than 10 times	18.87	38.18	26.09	18.32
Extension service offices. including from private and third sector				
Up to 5 times	51.92	73.91	51.72	58.33

Between 5 to 10 times	28.85	15.22	27.59	24.36
More than 10 times	19.23	10.87	20.69	17.31
NGOs				
Up to 5 times	59.57	71.43	54.29	61.54
Between 5 to 10 times	23.40	17.14	22.86	21.37
More than 10 times	17.02	11.43	22.86	17.09
Farmer organizations/ cooperatives				
Up to 5 times	50.88	63.89	33.78	46.11
Between 5 to 10 times	26.32	16.67	13.51	18.56
More than 10 times	22.81	19.44	52.70	35.33
Actors of the value chain (e.g. input dealers. processors. retailers. consumers)				
Up to 5 times	60	57.58	41.51	51.59
Between 5 to 10 times	12.50	15.15	24.53	18.25
More than 10 times	27.50	27.27	33.96	30.16

3.2.3. Perceptions of the Challenges in the Agricultural Sector. Mission of Organisation. and Sustainability Aspects

The agricultural sector's main challenges according to the perception of AREE institutions' staff are presented on Table 13. Six major challenges were ranked for the current period and period 10-20 years earlier. An average of 62% of the staff members indicated that low productivity was one of the major issues in the Malian agricultural sector between ten to twenty years ago. During the same period, input issues, low soil fertility, changing climatic patterns, finance issues and crop diseases were also cited as other main challenges of the agricultural sector in Mali. These challenges were similar to those of today but ranked in a different way with input problems and low soil fertility, which were indicated by 59% of the interviewed staff members from AREE institutions as the first two challenges. These were followed by changing climatic patterns mentioned by 49% of the same respondents. The other three challenges were finance issues, pest and diseases, and low productivity as suggested by between 32% to 35% of the staff from the three types of agricultural organizations.

From the literature review, the major challenges of agricultural sector suggested by staff from the Malian AREE institutions were also mentioned in several research studies as being among the multiple constraints that farmers face. In southern Mali, known for cotton cultivation low or stagnation of cereal yields has been reported to have resulted from low soil fertility (Blanchard, 2010 and Droy et al., 2012). These facts combined with natural resources degradation and climate change have made the problem worse among cotton-based small-scale farmers' production systems (Soumaré, 2006; Coulibaly et al., 2009; Ickowicz et al., 2012).

Table 13: Main challenges of farming according to staff from AREE institutions

Table 12: Main challenges of farming according to staff from AREE institutions

Perceived main challenges of farming	NARS		ATVET		Extension		Average	
	10-20 years ago	Today	10-20 years ago	Today	10-20 years ago	Today	10-20 years ago	Today
Low productivity (%)	54.22	31.33	68.67	38.55	64.37	35.63	62.45	35.18
Pests and diseases (%)	40.96	49.40	25.30	22.89	24.14	31.03	30.04	34.39
Livestock health and welfare (%)	7.23	8.43	10.83	14.46	4.60	4.60	7.51	9.09

Low soil fertility (%)	50.60	65.06	39.76	53.01	40.23	58.62	43.48	58.89
Water issues (%)	20.48	26.51	19.28	24.10	18.39	19.54	19.37	23.32
Low and unpredictable rainfall (%)	20.48	25.30	18.07	25.30	11.49	9.20	16.60	19.76
Flooding (%)	6.02	7.23	7.23	4.82	10.34	10.34	7.91	7.51
Changing climatic patterns (%)	34.94	48.19	30.12	49.40	31.03	50.57	32.02	49.41
Inputs issues (%)	28.92	46.99	26.51	59.04	43.68	71.26	33.20	59.29
Poverty and inequality (%)	26.51	18.07	24.10	9.64	36.78	21.84	29.25	16.60
Roads and rural infrastructure (%)	14.46	4.82	20.48	14.46	18.39	6.90	17.79	8.70
Marketing issues (%)	19.28	9.64	24.10	16.87	18.39	17.24	20.55	14.62
Finance issues (%)	27.71	36.14	31.33	33.73	32.18	26.44	30.43	32.02
Extension service issues (%)	7.23	1.20	4.82	4.82	1.15	1.15	4.35	2.37
Education issues (%)	22.89	12.05	32.53	15.66	13.79	2.30	22.92	9.88
Digital tool issues (%)	13.25	7.23	15.66	8.43	5.75	6.90	11.46	7.51
Electricity issues (%)	6.02	2.41	6.02	3.61	2.30	0.00	4.74	1.98
Network coverage (%)	4.82	0.00	4.82	0.00	1.15	1.15	3.56	0.40
Others (%)	21.69	21.69	18.07	24.10	22.99	24.14	20.95	23.32

From the data collected, the missions of AREE institutions had not changed much according to the staff members' perception as shown on Table 14. For instance, only 39% of ARRE staff members indicated that their institutional missions had changed significantly in the last ten years. Nevertheless, the changes were connected to the fact that some agricultural topics such as climate change, crop yields and productivity, land degradation, water management, agriculture biodiversity, nutrition, efficient input use and marketing/commercialization have also attracted the organizations' attention. Other topics like marketing/commercialization, safe handling of agro-chemicals, gender, marginalized groups/poorest, microfinance, animal health and livestock productivity, have also gained some attention in the missions of AREE institutions.

However, the challenges faced by the agricultural sector in many Sub-Saharan African countries have hindered development. Several new trends, models, and initiatives for agricultural development show that the improvement of research, extension and education institutions are back on the agenda of governments, donors, and other stakeholders. Therefore, the ongoing trends of new arrangements between different stakeholders are aimed to improve the quality of agricultural service provision for the promotion of sustainable farming systems. It is obvious that, such a development of sustainable institutions for agricultural sector requires a revision of the

conventional goals and objectives of AREE institutions in terms of enhancing their institutional, organizational and financial capacities. These rather conventional missions of AREE institutions may be underpinned by different types of “sub-missions”.

Table 13: Changes in AREE institutions’ missions and focuses

Changes in AREE institutions’ missions and focuses

Has the mission of your institution significantly changed in the last 10 years? (Share yes)		NARS (%)	ATVET (%)	Extension (%)	Average (%)
		42.17	33.73	40.23	38.74
How important are the following topics for your institution? (On a scale from 1=Not Important to 4=Very important)		NARS	ATVET	Extension	Average
Crop yields and productivity	1= Not important	0	0	0	0
	2= less important	8.43	4.82	9.20	7.51
	3= Important	18.07	26.51	20.69	21.74
	4= Very important	73.49	68.67	70.11	70.75
Efficient input use	1= Not important	1.20	4.82	1.15	2.37
	2= less important	6.02	4.82	12.64	7.91
	3= Important	30.12	40.96	26.44	32.41
	4= Very important	62.65	49.40	59.77	57.31
Safe handling of agro-chemicals	1= Not important	3.61	7.23	5.75	5.53
	2= less important	15.66	14.46	16.09	15.42
	3= Important	39.76	32.53	25.29	32.41
	4= Very important	40.96	45.78	52.87	46.64
Marketing/ commercialization	1= Not important	3.61	3.61	2.30	3.16
	2= less important	20.4	14.46	10.34	15.02
	3= Important	37.35	28.92	21.84	29.25
	4= Very important	38.55	53.01	65.52	52.47
Microfinance	1= Not important	12.05	6.02	2.30	6.72
	2= less important	16.87	27.71	13.79	19.37
	3= Important	37.35	26.51	28.74	30.83
	4= Very important	33.73	55.17	39.76	43.08
Land degradation	1= Not important	1.20	0.00	0.00	0.40
	2= less important	1.20	8.43	8.05	5.93
	3= Important	26.51	34.94	18.39	26.48
	4= Very important	71.08	56.63	73.56	67.19
Climate change	1= Not important	0.00	1.20	0.00	0.40
	2= less important	4.82	8.43	4.60	5.93
	3= Important	24.10	28.92	13.79	22.13
	4= Very important	71.08	61.45	81.61	71.54

Water management	1= Not important	0.00	1.20	0.00	0.40
	2= less important	9.64	9.64	5.75	8.30
	3= Important	25.30	24.10	22.99	24.11
	4= Very important	65.06	65.06	71.26	67.19
Biodiversity-friendly agriculture	1= Not important	0.00	1.20	1.15	0.79
	2= less important	4.82	10.84	6.90	7.51
	3= Important	39.76	27.71	18.39	28.46
	4= Very important	55.42	60.24	73.56	63.24
Livestock productivity	1= Not important	1.20	2.41	13.79	5.93
	2= less important	6.02	9.64	18.39	11.46
	3= Important	43.37	36.14	42.53	40.71
	4= Very important	49.40	51.81	25.29	41.90
Animal Health	1= Not important	7.23	3.61	14.94	8.70
	2= less important	8.43	10.84	18.39	12.65
	3= Important	42.17	26.51	39.08	35.97
	4= Very important	42.17	59.04	27.59	42.69
Nutrition	1= Not important	3.61	0.00	3.45	2.37
	2= less important	4.82	7.23	4.60	5.53
	3= Important	33.73	34.94	24.14	30.83
	4= Very important	57.83	67.82	57.83	61.26
Gender	1= Not important	2.41	7.23	1.15	3.56
	2= less important	7.23	20.48	6.90	11.46
	3= Important	51.81	33.73	35.63	40.32
	4= Very important	38.55	38.55	56.32	44.66
Marginalized groups and/or the poorest	1= Not important	6.02	10.84	1.15	5.93
	2= less important	12.05	19.28	8.05	13.04
	3= Important	36.14	39.76	35.63	37.15
	4= Very important	45.78	30.12	55.17	43.87

AREE institutions should emphasize on all the concepts listed on Table 15, as 64% to 92% of staff members of AREE institutions think that more importance should be placed on of the different aspects of agricultural.

Table 14: AREE institutions' focus

Do you think your institution should place more importance on this aspect? (Share yes)	NARS	ATVET	Extension	Average
Crop yields and productivity (%)	95.45	88.46	92.31	91.89
Efficient input use (%)	83.87	83.33	54.29	74.07
Safe handling of agro-chemicals (%)	73.47	71.11	43.90	63.70
Marketing/ commercialization (%)	70.59	76.92	73.33	73.33

Microfinance (%)	65.45	72.00	69.23	68.75
Land degradation (%)	87.50	97.22	78.26	89.16
Climate change (%)	91.67	84.38	93.75	88.89
Water management (%)	75.86	89.66	96.00	86.75
Biodiversity-friendly agriculture (%)	81.08	90.91	69.57	81.72
Livestock productivity (%)	80.95	90.00	50.77	70.07
Animal Health (%)	70.83	94.12	52.38	68.28
Nutrition (%)	80.00	85.71	50.00	73.47
Gender (%)	80.39	72.55	84.21	78.57
Marginalized groups and/or the poorest (%)	71.11	79.31	87.18	78.87

3.2.4. Digitalization

Table 16 shows that almost 100% of the staff members of AREE institutions used digital tools in carrying out their daily activities. As indicated in PARI report (2022) on ICT use, the most ICT devices used are still mobile phone/smartphone and computers by the staff from the three AREE institutions. These types of digital tools are mainly used for communication, research information on agricultural techniques, teaching and social media.

Table 15: Types of digital tools used by staff members of AREE institutions

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	0.00	2.41	1.15	1.19
	Disagree	4.82	8.43	3.45	5.53
	Agree	81.93	72.29	83.91	79.45
	Strongly agree	13.25	10.84	11.49	11.86
You have set for yourself a high standard of performance	Strongly disagree	0.00	0.00	1.15	0.40
	Disagree	0.00	7.23	3.45	3.56
	Agree	80.72	59.04	72.41	70.75
	Strongly agree	19.28	30.12	22.99	24.11
You are given the freedom at the station to make decisions and solve problems about your work	Strongly disagree	1.20	2.41	2.30	1.98
	Disagree	6.02	15.66	12.64	11.46
	Agree	81.93	57.83	72.41	70.75
	Strongly agree	10.84	20.48	12.64	14.62
You feel recognized by your peers as a hard worker	Strongly disagree	0.00	2.41	1.15	1.19
	Disagree	1.20	1.20	1.15	1.19
	Agree	85.54	68.67	81.61	78.66
	Strongly agree	13.25	25.30	16.09	18.18
Your boss places a great deal of confidence in your judgment	Strongly disagree	1.20	0.00	0.00	0.40
	Disagree	0.00	1.20	1.15	0.79
	Agree	80.72	69.88	77.01	75.89
	Strongly agree	18.07	26.51	21.84	2.13

Your job has made you gain experience in life. which will help you in the future.	Strongly disagree	0.00	0.00	0.00	0.00
	Agree	0.00	2.41	2.30	1.58
	Agree	69.88	56.63	55.17	60.47
	Strongly agree	30.12	40.96	42.53	37.94
You are satisfied with your job	Strongly disagree	0.00	1.20	0.00	0.40
	Agree	1.20	2.41	2.30	1.98
	Agree	68.67	56.63	65.52	63.64
	Strongly agree	30.12	39.76	32.18	33.99

The opinion AREE institutions' staff members on payment-related issues are presented on Table 18. More than 50% of staff were not happy and disagreed on what they received as salary. Except that, they agreed with all the other statements related to payments. More than 90% of the staff confirmed that they received their salaries promptly.

Table 17: Staff's opinion on payment-related issues

What is your view on the following statements related to payments? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)		NARS (%)	TVET (%)	Extension (%)	Average (%)
Your salary encourages you to work better	Strongly disagree	7.23	6.02	8.05	7.11
	Disagree	21.69	25.30	32.18	26.48
	Agree	66.27	60.24	57.47	61.26
	Strongly agree	4.82	8.43	2.30	5.14
You are happy with the salary you receive	Strongly disagree	9.64	8.43	8.05	8.70
	Disagree	36.14	39.76	57.47	44.66
	Agree	49.40	45.78	33.33	42.69
	Strongly agree	4.82	4.82	1.15	3.56
Staff is paid equally to staff in other departments/ institutions who do comparable tasks	Strongly disagree	9.64	2.41	8.05	6.72
	Disagree	36.14	24.10	24.14	28.06
	Agree	49.40	59.04	65.52	58.10
	Strongly agree	4.82	6.02	2.30	4.35
Staff always receive their salaries on time	Strongly disagree	0.00	2.41	0.00	0.79
	Disagree	3.61	8.43	6.90	6.32
	Agree	78.31	65.06	72.41	71.94
	Strongly agree	18.07	24.10	20.69	20.95

You receive salary increases as you expected when you started this job	Strongly disagree	1.20	6.02	4.60	3.95
	Disagree	19.28	30.12	24.14	24.51
	Agree	72.29	51.81	67.82	64.03
	Strongly agree	7.23	8.43	3.45	6.32
The pay scales reflect differences in workload and responsibility	Strongly disagree	4.82	8.43	3.45	5.53
	Disagree	19.28	22.89	20.69	20.95
	Agree	68.67	61.45	73.56	67.98
	Strongly agree	7.23	3.61	2.30	4.35

Table 19 shows the staff's perceptions on hiring and promotion in AREE institutions. About half of members of staff (49%) disagreed that "promotion depends on how long you have served" while 50% also disagreed that "Staff has to be worried about losing their jobs in the near future". These were the only two statements that substantial proportion of the staff members disagreed with. This could imply that hiring and promotion of employment in AREE institutions were based on merit. But this assumption must be taken with caution because the manner and approach of recruiting and promotion by employers in Mali are far from being based on merit.

Table 18: Staff's opinion on hiring and promotion-related issues

What is your view on the following statements related to hiring and promotion? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)		NARS (%)	ATVET (%)	Extension (%)	Average (%)
Staff is hired purely based on merit	Strongly disagree	4.82	4.82	0.00	3.16
	Disagree	26.51	24.10	14.94	21.74
	Agree	63.86	61.45	77.01	67.59
	Strongly agree	4.82	6.02	8.05	6.32
Staff is promoted purely based on merit	Strongly disagree	2.41	4.82	1.15	2.77
	Disagree	21.69	25.30	26.44	24.51
	Agree	68.67	60.24	70.11	66.40
	Strongly agree	7.23	6.02	2.30	5.14
Promotion depends on how long you have served	Strongly disagree	10.84	7.23	9.20	9.09
	Disagree	49.40	43.37	52.87	48.62
	Agree	38.55	28.92	37.93	35.18
	Strongly agree	1.20	7.23	0.00	2.77
There are good opportunities for promotion	Strongly disagree	1.20	2.41	2.30	1.98
	Disagree	13.25	20.48	9.20	14.23
	Agree	79.52	65.06	83.91	76.28
	Strongly agree	6.02	8.43	4.60	6.32

Performance appraisals are carried out fairly	Strongly disagree	4.82	3.61	3.45	3.95
	Disagree	24.10	16.87	22.99	21.34
	Agree	68.67	61.45	72.41	67.59
	Strongly agree	2.41	4.82	1.15	2.77
The majority of people in this office are well-qualified to do their job	Strongly disagree	1.20	0.00	0.00	0.40
	Disagree	13.25	13.25	5.75	10.67
	Agree	77.11	73.49	87.36	79.45
	Strongly agree	8.43	10.84	6.90	8.70
Male and female staff have equal opportunities in getting promoted	Strongly disagree	2.41	2.41	1.15	1.98
	Disagree	13.25	14.46	9.20	12.25
	Agree	75.90	67.47	86.21	76.68
	Strongly agree	8.43	10.84	3.45	7.51
Staff has to be worried about losing their jobs in the near future.	Strongly disagree	8.43	19.28	14.94	14.23
	Disagree	49.40	49.40	50.57	49.80
	Agree	34.94	26.51	34.48	32.02
	Strongly agree	7.23	2.41	0.00	0.79

The perception of members of staff on overall support of the AREE institutions are presented on Table 20. A large proportion of the staff (94%) agreed that their institutions had specified targets. While about 64% of the respondents indicated that they had not been carrying out their work as they ought to because of limited and irregular supply inputs and resources.

Table 19: Staff's opinion 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 office have specified targets	Strongly disagree	0.00	0.00	0.00	0.00
	Disagree	2.41	8.43	5.75	5.53
	Agree	85.54	68.67	82.76	79.05
	Strongly agree	12.05	22.89	11.49	15.42
Staff has enough resources available to carry out their work as required by professional norms	Strongly disagree	18.07	19.28	22.99	20.16
	Disagree	61.45	51.81	65.52	59.68
	Agree	19.28	27.71	11.49	19.37
	Strongly agree	1.20	0.00	0.00	0.40
Inputs and resources for your work come regularly and on time	Strongly disagree	9.64	13.25	24.14	15.81
	Disagree	46.99	39.76	56.32	47.83
	Agree	39.76	39.76	18.39	32.41
	Strongly agree	3.61	6.02	1.15	3.56
Mobility to your operational area is easy	Strongly disagree	12.05	7.23	9.20	9.49
	Disagree	37.35	26.51	55.17	39.92
	Agree	45.78	55.42	34.48	45.06
	Strongly agree	4.82	6.02	1.15	3.95

Table 21 presents the opinion of staff of AREE institutions on their supervision. More than 80% of the staff members agreed on all the statements of job supervision except favoritism, for which 41% of the staff indicated that favoritism was exhibited by supervisors.

Table 20: Staff's opinion on supervision by reporting officers

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	1.20	2.41	1.15	1.58
	Disagree	10.84	19.28	11.49	13.83
	Agree	81.93	67.47	82.76	77.47
	Strongly agree	6.02	7.23	4.60	5.93
It is hard to please your supervisor	Strongly disagree	6.02	13.25	3.45	7.51
	Disagree	72.29	54.22	67.82	64.82
	Agree	19.28	24.10	28.74	24.11
	Strongly agree	2.41	3.61	0.00	1.58
Your supervisor praises good work	Strongly disagree	2.41	2.41	0.00	1.58
	Disagree	8.43	6.02	5.75	6.72
	Agree	81.93	75.90	86.21	81.42
	Strongly agree	7.23	14.46	8.05	9.88
Your supervisor knows the job well	Strongly disagree	3.61	2.41	0.00	1.98
	Disagree	3.61	7.23	1.15	3.95
	Agree	84.34	77.11	85.06	82.21
	Strongly agree	8.43	10.84	13.79	11.07
Your supervisor is always around when needed	Strongly disagree	2.41	2.41	0.00	1.58
	Disagree	9.64	6.02	8.05	7.91
	Agree	73.49	73.49	79.31	75.49
	Strongly agree	14.46	16.87	12.64	14.62
Your supervisor does not show favoritism	Strongly disagree	4.82	9.64	4.60	6.32
	Disagree	39.76	32.53	34.48	35.57
	Agree	45.78	49.40	58.62	51.38
	Strongly agree	9.64	8.43	2.30	6.72

Your workload is adequate	Strongly disagree	3.61	1.20	0.00	1.58
	Disagree	18.07	19.28	18.39	18.58
	Agree	75.90	75.90	78.16	76.68
	Strongly agree	2.41	2.41	3.45	2.77
You have a clear structured work program	Strongly disagree	1.20	2.41	1.15	1.58
	Disagree	4.82	9.64	12.64	9.09
	Agree	87.95	72.29	74.71	78.26
	Strongly agree	6.02	15.66	11.49	11.07

3.3. Students Survey

3.3.1. Student Characteristics and Motivation

Survey revealed that more male students were enrolled in the different training schools across the country. Only 35.19% of respondents were female and this could be explained by many reasons. Many female students did not want to study out of the city, while most of the schools (especially vocational schools) were located outside cities. Also, agriculture is not attractive for females who prefer to study business, marketing and communication etc. Many female students drop out of school midway.

Average age of enrolled students was 24 years, which was consistent with the national average age of graduating students. More than half of students originated from rural areas (55.56%) and about 69.44% had farming background. Government policy encouraged private sector entrepreneurship, so many of the respondents had been engaged in agricultural related businesses. Many of the students already owned pieces of land utilized for farming (35.19%), therefore they were conversant with agriculture-related issues. Respondents considered the number of years of training in schools reasonable for learning general agricultural practices (3.27 years) to be able to undertake basic research. However, more years of training would be necessary for specialization (especially for research and teaching).

Most students (85.19%) reported that their desire to bring about change in farming motivated them to acquire knowledge. Currently farming is cumbersome because it is manual.

Some of the students (34.26%) indicated that they aspired to become agro-entrepreneurs or third sector extension service agents (33.33%). Only 1.85% and 0.93% of graduates wished to be employed in the academia and become independent consultants, respectively. The requirement and risk in these two jobs are high in the country. The following table shows the characteristics and motivation of students involved in agricultural training.

Table 21: Characteristics of students undergoing training

	Average (%)
Gender (share of females)	35.19
Age	24.27
Origin (share rural)	55.56

Origin (share farming)		69.44
Own cultivation (share yes)		35.19
Year of training		3.27
Motivation to start the course	Secure job	45.37
	A job with a regular income	28.70
	Representative (prestigious) job	19.44
	Knowledge to bring about change in farming	85.19
What do you see yourself doing after graduation?	Private, public, or third-sector extension service	33.33
	Jobs in the Ministry of agriculture	6.48
	Agricultural Research Institute	22.22
	Academia	1.85
	Independent Consultant	0.93
	Agro-entrepreneur	34.26
	Other	0.93

3.4. Budgetary allocation to agricultural aspects

Economic sustainability was perceived as the most important aspect that should be allocated as much as 46.67% of agricultural budgetary allocations. While they suggested that environmental sustainability should be allocated 28.43% and 24.90% to social sustainability. Respondents gave this suggestion because of the need to address the living standards of the poor whose annual production level rarely meet their need. Table 23 shows the students' opinion on agricultural budget allocation to the different sustainability aspects.

Table 22: Students' suggestion on partitioning of the national agriculture budget allocation

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.)	46.67
Social Sustainability (e.g. gender aspects, integration of marginalized groups, youth, etc.)	24.90
Environmental Sustainability (e.g. integration of biodiversity goals, climate change mitigation, etc.)	28.43
Total	100

3.5. Expected greatest contribution after graduation

After graduation, 82.41% of the students wish to be able to contribute in increasing productivity, while 68.52% and 61.11% of the respondents wish to contribute to improving food security, and poverty reduction, respectively (Table 24) They opined that they would not be able to influence improve financial services (18.52%) and development, and use of digital technologies (16.67%). Students indicated that economic and social wellbeing rather than technical and financial access should attract more attention.

Table 23: Students' perception on how they could impact agricultural production

Where do you wish to make the greatest contribution in the future?	Average %
Increase productivity	82.41
Reduce poverty	61.11
Improve the adaptation to climate change	32.41
Foster women's empowerment	26.85
Improve food security	68.52
Contribute to biodiversity conservation	27.78
Integrate marginalized groups and the poorest	21.30
Improve access to financial services	18.52
Foster the use and development of digital tools	16.67

3.5.1.Perceptions of Challenges in the Agricultural Sector

As at 10 years ago, the most important challenges of farming, in the students' opinion were low productivity of agricultural production (57.41%), pest and diseases (55.56%), low soil fertility (37.96%) and flooding (35.19%). Lately and currently, the perceived challenges are low soil fertility (77.78%), low productivity (68.52%), livestock health and welfare (50.93%) and pest and diseases (39.81%). The following table presents students' perceived challenges 10 years ago and today.

Table 24: Students' perceived challenges of farming ten years ago and currently

Perceived main challenges of farming	Average %	
	10 years ago	Today
Low productivity	57.41	68.52
Pests and diseases	55.56	39.81
Livestock health and welfare	19.44	50.93
Low soil fertility	37.96	77.78
Water issues	18.52	34.26
Low and unpredictable rainfall	32.41	25.93
Flooding	35.19	30.56
Changing climatic patterns	32.41	23.15
Inputs issues	19.44	30.56
Poverty and inequality	20.37	6.48
Roads and rural infrastructure	14.81	23.15
Marketing issues	17.59	18.52
Finance issues	6.48	12.96
Extension service issues	17.59	0.00
Education issues	7.41	0.00
Digital tool issues	0.00	0.00
Electricity issues	0.00	0.00
Network coverage	0.00	0.00

The 2 most important perceived challenges remained low soil fertility and low productivity and the 2 least important were electricity issues and network coverage. This indicated that production remained low in all agricultural activities across the country. Many efforts should be taken to improve production. Although electricity and networking are important in the production process from the students' point of view there are pre-requisites before giving them priority.

3.5.2.Perceptions of Training

The majority of the students strongly disagreed that their courses were suitable for their needs but would still recommend it to friends because of lack of choice. This implied that training and employment may not match. The training sessions received by students in classes do not align, and not fully applicable on the fields. Students therefore were not made ready for employment; they needed internship in business and farming before they would be able venture into entrepreneurship.

Table 25: Students' perception of their courses of study

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	Strongly Disagree	75.00
The objectives of the course were clearly defined	Strongly Disagree	71.30
Participation and interaction were encouraged	Strongly Disagree	81.48
The topics covered were relevant to me.	Strongly Disagree	71.30
The content was organized and easy to follow.	Strongly Disagree	75.00
The content meets my expectations.	Strongly Disagree	79.63
The materials distributed were helpful and relevant.	Strongly Disagree	62.04
This course experience will be useful in my work.	Strongly Disagree	64.81
The trainers were knowledgeable about the course topics.	Strongly Disagree	69.44
The quality of the answers to the questions was good	Strongly Disagree	71.30
The trainers were well prepared.	Strongly Disagree	67.59
The course objectives were met.	Strongly Disagree	70.37
The time allotted for the course work was sufficient.	Strongly Disagree	62.96
The time allotted for the practical works was sufficient.	Strongly Disagree	54.63
The course rooms and facilities were adequate and comfortable.	Strongly Disagree	51.85
The course offers capacity in digital tools	Strongly Disagree	54.63

The course allows visiting farms and or/interacting with farmers	Strongly Disagree	55.56
Would you recommend this course to a friend or family? (Share yes)	yes	99.07

Students submitted that economic sustainability aspect (43.75%) attracted better share of course content/time allocation than environmental sustainability (31.54%) and social sustainability (24.71%). Table 27 shows students' perception of the teaching time allocated to the different sustainability aspects.

Table 26: Students' perception of teaching time devoted to economic, social and environmental sustainability aspects their courses

In your 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.)	43.75
Social Sustainability (e.g. gender aspects. integration of marginalized groups. youth. etc.)	24.71
Environmental Sustainability (e.g. integration of biodiversity goals. climate change mitigation. etc.)	31.54
Total	100

The majority of students were of the opinion that some aspects of their training were not sufficiently covered. Schools lacked library, experimental fields and adequate access to the internet which would encourage students to do research. Teaching modules were based on the existing facilities. Table 28 shows students' perception on the coverage of different agricultural aspects in their courses.

Table 27: Students' perception on adequacy of components of course contents

Have the following aspects been sufficiently covered? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)		Average %
Crop yields and productivity	Strongly Disagree	73.15
Efficient input use	Strongly Disagree	72.22
Safe handling of agro-chemicals	Strongly Disagree	70.37
Marketing/ commercialization	Strongly Disagree	64.81
Prices. quality standards. value creation. and cost-saving techniques	Strongly Disagree	62.96
Microfinance	Strongly Disagree	50.00
Land degradation	Strongly Disagree	75.00
Climate change	Strongly Disagree	70.37
Water management	Strongly Disagree	73.15
Biodiversity-friendly agriculture	Strongly Disagree	72.22
Livestock productivity	Strongly Disagree	65.74
Animal health	Strongly Disagree	57.41
Livestock welfare	Strongly Disagree	54.63
Nutrition	Strongly Disagree	64.81

Gender	Strongly Disagree	54.63
Marginalized groups and/or the poorest	Strongly Disagree	37.04
Youth	Strongly Disagree	50.93
Digital tools (share yes)		73.15

Less than half of the respondents agreed that some aspects that should be captured by their training to address the country's challenges. Only low productivity aspect was considered by more than half of students (55.56%) to be addressed by course content. Some issues were not considered by most of the students as important challenges to be addresses in the courses. They are education issues (15.74%), digital tool issues (30.56%), electricity issues (10.19%) and network coverage (15.74%). Table 29 shows aspects of the courses and the students' perception of their level of importance as challenges

Table 28: Students' perception of aspects that should be captured by their courses to address the country's challenges

In your opinion, are there other aspects the course should focus more on to even better address the country's challenges? (Share yes)	Average %
Low productivity	55.56
Pests and diseases	34.26
Livestock health and welfare	21.30
Low soil fertility	41.67
Water issues	30.56
Low and unpredictable rainfall	15.74
Flooding	16.67
Changing climatic patterns	38.89
Inputs issues	31.48
Poverty and inequality	22.22
Roads and rural infrastructure	15.74
Marketing issues	13.89
Finance issues	14.81
Extension service issues	4.63
Education issues	15.74
Digital tool issues	30.56
Electricity issues	10.19
Network coverage	15.74

Table 30 shows the challenges faced by students undergoing training. More than 70% of students reported that they faced many challenges while in the training. among the challenges they mentioned were insufficient access to internet (54.63%), insufficient access to computers (52.78%), insufficient access to relevant literature (44.44%) and difficulties to access teachers (15.74%).

Table 29: Challenges faced by students

		Average %
Are there any challenges you are facing in the course you have chosen? (Share yes)		70.37
What are these challenges?	Insufficient access to computers	52.78
	Insufficient access to internet	54.63
	Insufficient access to relevant literature	44.44
	Not easy access to consult with teachers/lecturers	15.74
	Insufficient access to modern materials for practical lessons	0.00
	Insufficient laboratory	0.00
	Few practical lessons	0.00
	Others	20.37

Among others challenges, students reported that insufficient practical lessons and financial problems were major problems faced while pursuing their courses. In addition, industrial actions (strikes), insufficient teachers/lecturers, internship problem, lack of some courses, insufficient classrooms and accommodation problems for students also constituted major challenges.

3.6. Qualitative Insights from Interviews with Managers

3.6.1. Overall Mission and Changes in Mission

In the teaching system, the missions were to train student for public services; but during the last 20 years the missions changed and training now takes cognizance of the employment requirements of private companies/employers. Extension was carried out for production systems; there were production basins and the missions were to develop farmers' capacity as a group to overcome production constraints. Currently extension focusses on crop value chains with attention on the farmers. As regards research, government funded programs; currently research depends on external funding, which implied that the goals are determined by foreign interest who often have motives other than the local interest.

Main challenges in the education system are to the need to adequately train to meet employers' needs and to conform with the regional system. For research, the main challenge is funding of activities, while for extension it is the lack of agents on the fields.

Improvement in the education system could come from online courses available on the net. Extension could use digital tools accessible to even illiterate farmers. Today, many private enterprises are thriving and that could be an opportunity for collectivities, groups and individuals to fund research for their own development.

The educational system is shifting from general to training to acquire "LMD" and this is encouraged by movement of professors from university to university in different countries and the possibilities of students to be trained in any university. For extension, digital tools are being developed and they vary from simple images to writing; farmers could now learn by seeing. Research is conducted to fit requirements in the "CAMES" system, therefore researchers need to improve their quality in order to be upgraded.

3.6.2. Innovation System

Research is lagging behind in Mali; however, some improvement seems to have been achieved in livestock production, rice and maize production. There are short duration varieties of many crops but farmers are not adopting them because they do not fit local requirements (food quality). Generally, adoption of new technologies is low due to several reasons: lack of resources, lack

of awareness and knowledge. To boost research, the government needs to have a long-term strategic program funded only by adequate resources. Subsequent initiatives could be achieved along with the strategic program. The education system lacks professors and adequate training resources. Some courses are merely handled theoretically; there is the need to expose learners to adequate practical lessons/experiences.

In Mali, like in many developing countries, farmers are mostly illiterate and lack production/marketing capacities. Extension services could help to organize and facilitate their access to some resources, therefore extension is very important in the system. IER has ongoing bilateral partnership with nations/national institutions (from France, Holland, Germany, USA, Norway etc) and also multilateral collaborations with institutions (World Bank; AGRA; African Development Bank; CGIAR etc.).

During the last 10 years, research was as much as possible aligned with identified constraints at farmers' level which involved private sector.

3.6.3.Sustainability Aspects

Currently in Mali, agriculture focuses on production and productivity aspects leading to excessive use of resources and jeopardizing future generations. Economic and environmental sustainability are generally not prioritized, while emphasis is given to technical aspects. Although, government officially promotes gender equality and inclusivity, few women and youth have access land, income and training.

Research addresses gender issues by developing technologies that suit marginalized women, pregnant women, children etc. Extension recognizes and utilizes the law that stipulates 30% slot reservation for women and youth in land allocation. Currently in Mali, schools enroll many female students in various programs. Environment protection is encouraged at school and by extension services through programs (Water, sanitation and hygiene (WASH) for example).

For greater sustainability, government programs should focus on the need of the populace, education/capacity building toward achieving these needs and appropriate use of resources for attaining the goals. The process should involve the local government, administrations, organizations, technical services, and the NGOs etc. Awareness, capacity building and funding of activities are main actions that ensure positive change. Major constraints to shift may come from lack of inclusiveness, lack of exposure to new technologies and lack of access to funding. Research can contribute in generation of technologies and knowledge, while extension could help in scaling up technologies. While the education sector trains all stakeholders.

3.6.4.Staff and Sustainability Aspects

In education, during the past 5 to 10 years, the profiles of workers have not changed much; but some specialists were engaged in the system. Digitalization encouraged students to require some courses that allow them to perform better in agriculture (creation of agri-business). For extension some tools like "Senekela", "My Agro" have enhanced the services provided by agents to farmers and input dealers/output dealers. Access to search engines/Apps such as "google" has helped many researchers to update their knowledge and to interact with others who have the same research interest with them. Many qualified persons (with certain skills) do not exist in the educational system, services of public or private agents in other institutions have to be engaged/ attracted. In research, collaborations with CGIARs and universities sometimes bridge the gaps. For extension services, the situation is crucial because NGOs and farmers organizations who should close the gaps are insufficient and most of them do not have required capacity for the jobs. Digitalization specialties are difficult to find on the market; computer program developers are also scarce to find.

Since Mali is a poor country, and emphasis is laid on living standards, extension services are more inclined to focus on economic aspects of the lives of the populace. This is also true for research. Education tries to equilibrate all aspects but still emphasize the economic aspects.

4. Discussion and policy recommendations

The educational systems (public and private) such as colleges, universities and vocational schools; extension services (public, NGOs and farmers' organizations) and research systems (NARS and CGIARs) all play roles in the agricultural innovation system and can greatly contribute to building the capacity of smallholder farmers and other actors in the agricultural value chain. This study provides an assessment of the Malian agricultural innovation system, and in general.

Results show that there are far too few agricultural universities but many vocational schools. Conditions to create agricultural universities should be simplified. The national research and extension systems cover the whole country with limited agents in the field. The educational system provides many agricultural graduates who are not employed by the public or by the private sectors. The possible reasons are related to the imbalance between training and employment. Modern farming techniques as well as business and entrepreneurial skills and value chain management are needed in the system. Thus, a new paradigm including education, research and extension should be conceptualized

Interviews with key informants revealed some similarities and differences across institutions in the country. Education, research and extension are still predominantly provided by the government (the private sector participates in the educational system). However, the private sector and the NGOs attract the larger proportion of employees. Expectedly, the proportion of male to female is quite high in all the systems, and across the institutions. We can state that women on farms, but not in institutions, carry out most of the work, which contrasts with the extensive literature indicating that women perform much of the agricultural labor. All institutions are faced with funding problems, lack of qualified personnel and equipment.

An assessment of resource allocation across economic, social and environmental sustainability in all the institutions revealed that priority is given to economic aspects. This skewness in funding allocation to economic sustainability aspects would limit the options for the other aspects. Efforts should be made to improve inclusion of social and environmental issues in the curricula of schools, and in research and extension programs. Furthermore, the skewed access to funding might imply limited possibilities for farmers and other actors to enter the job market or access employment opportunities in the later stages of agricultural value chain.

There are many graduates of agriculture who are still job hunting; one way to break the chain is through curricula development based on national labor-market priorities. Curriculum review and changes should encompass development of holistic education and training strategies, and frameworks that link theory and practice. There is a need to design comprehensive and integrated agricultural education-research-extension system program that link the institutions not only scientifically but also to address issues such as entrepreneurship and business skills, and value chain management.

All agricultural institutions require sustained financing. Expanding and diversifying of funding sources beyond the existing ones is desirable. The private sector can provide support in-kind in terms of internships, apprenticeship and infrastructure. Besides resource mobilization, there is a need to position agricultural education-research-extension in such a way that it harnesses the comparative advantages, synergies and complementarities of the various actors and institutions in the innovation process.

References

- Atchoarena, D. and Delluc, A. (2002). Revisiting Technical and Vocational Education in Sub-Saharan Africa: an Update of trends, innovations and challenges. Accessed May 9, 2023
- Benor, D., J.Q. Harrison and M. Baxter, M. 1984. Agricultural Extension: the Training and Visit System. Washington, D.C.: World Bank..
- Berthé, A. (2015). Extension and Advisory Services Rural Extension Services for Agricultural Transformation, Background Technical Paper. Accessed May 9, 2023. [Extension-and-Advisory-Services-Rural-Extension-Services-for-Agricultural-Transformation.pdf \(afdb.org\)](#)
- Blanchard, M. (2010). Gestion De La Fertilité Des Sols Et Role Du Troupeau Dans Les Systèmes Coton-Céréales-Elevage Au Mali- Sud. Savoirs Techniques Locaux et Pratiques d'Intégration Agriculture- Elevage. (PhD thesis) Université Paris-Est Créteil Val Marne, Paris. 261pp+ Annexes
- Coulibaly, D., Pocard-Chapuis, R., and Ba, A. (2009). Dynamiques territoriales et changements des modes de gestion des ressources pastorales au Mali. Rencontres Autour des Recherches sur les Ruminants. Paris, les 2 et 3 décembre, 4 pages 357 - 360, [www.instelevage.asso.f](#)
- DLEC (2018). Developing Local Extension Capacity Project. 2018. Mali: In-depth Assessment of Extension and Advisory Services. USAID.
- Droy, I., Bélières, J.F., and Bidou, J. E. (2012). Between Crisis and Surplus: Questions Regarding the Durability of Cotton Production Systems in Mali. *European Journal of Development Research*, 24 (3): 491 - 508.
- European Economic and Social Committee (2008). EU-ACP meetings: The role of organised civil society in development, Brussels 5, March 2008.
- Far, D.G. 1991. Agricultural research networks as development tools: views of a network coordinator. Ottawa, Canada: International Development Research Centre; and Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.
- Fuglie. K. O. (2021). Agricultural productivity in sub-Saharan Africa.
- Fuglie. K.. Gautam. M.. Goyal. A.. & Maloney. W. F. (2020). Harvesting Prosperity - Technology and Productivity
- Growth in Agriculture. Washington. D.C.: World Bank.
- Ickowicz, A., Ancey, V., Corniaux, C., Duteurtre, G., Pocard Chappuis, R., Touré, I., and Wane, A. (2012). Crop-Livestock Production Systems in the Sahel - Increasing Resilience for Adaptation to Climate Change and Preserving Food Security. Centre de Coopération Internationale En Recherche Agronomique Pour Le
- Développement (CIRAD), UMR SELMET, CIRAD-INRA-SUPAGRO, Montpellier, France, 261 - 294.
- IFPRI, FAO, IICA. 2011. Worldwide Extension Study. GFRAS Website. Accessed May 8, 2023. <http://www.g-fras.org/en/world-wide-extension-study.html>.
- KIT, 2020. Mali Outcome Monitoring Report 2019, AGRA-PIATA Programme. Alliance for a Green Revolution in Africa, Nairobi; KIT Royal Tropical Institute, Amsterdam.
- Kirui. O. K.. & Kozicka. M. (2018). Vocational Education and Training for Farmers and Other Actors in the Agri-Food Value Chain in Africa. Bonn: Working Paper 164. Center for Development Research (ZEF).
- Plucknett, D.L., and Smith, N.i.H. 1984. Networking in international agricultural research. Science,

Reich, J., Paul, S. S., & Snapp, S. S. (2021). Highly variable performance of sustainable intensification on smallholder farms: A systematic review. *Global Food Security*, 30(June), 100553. <https://doi.org/10.1016/j.gfs.2021.100553>

Seck, P. A., Agboh-Noameshie, A., Diagne, A., & Bamba, I. (2013). Repackaging Agricultural Research for Greater Impact on Agricultural Growth in Africa. *Journal of Food Security*, 1(2), 30–41. <https://doi.org/10.12691/jfs-1-2-4>

Spielman, D., & Birner, R. (2008). How Innovative Is Your Agriculture? Using Innovation Indicators and Benchmarks to Strengthen National Agricultural Innovation Systems. Retrieved from <http://siteresources.worldbank.org/INTARD/Resources/InnovationIndicatorsWeb.pdf>

Sokona, D.S. 2020. Gendered assessment of Science, Technology and Innovation ecosystem: Case study of Agricultural Research and Training Institutions in Mali. *African Journal of Rural Development* 5 (1): 63-78.

Soumaré, M. (2006). Zonage Agro-écologique, pp. 73. Programme d'Amélioration des systèmes d'exploitation en zone cotonnière du Mali, Projet Caractérisation, Bamako.

UNESCO (2022). Technical and Vocational Education and Training Mali Country Profile.

World Bank (1999). Agricultural Services Project (Credit 2235-MLI) Implementation Completion – Republic of

Mali, Report No. 19323 - ML

World Bank. (2012). *Agricultural Innovation Systems - An Investment Sourcebook*. Washington, D.C.: World Bank.



Forum for Agricultural Research in Africa (FARA)

No. 7 Flower Avenue, New Achimota Mile 7, Accra, Ghana

Tel: +233 302 772823 / 302 779421 Fax: +233 302 773676

Email: info@faraafrica.org

Website: www.faraafrica.org | www.datainforms.faraafrica.org