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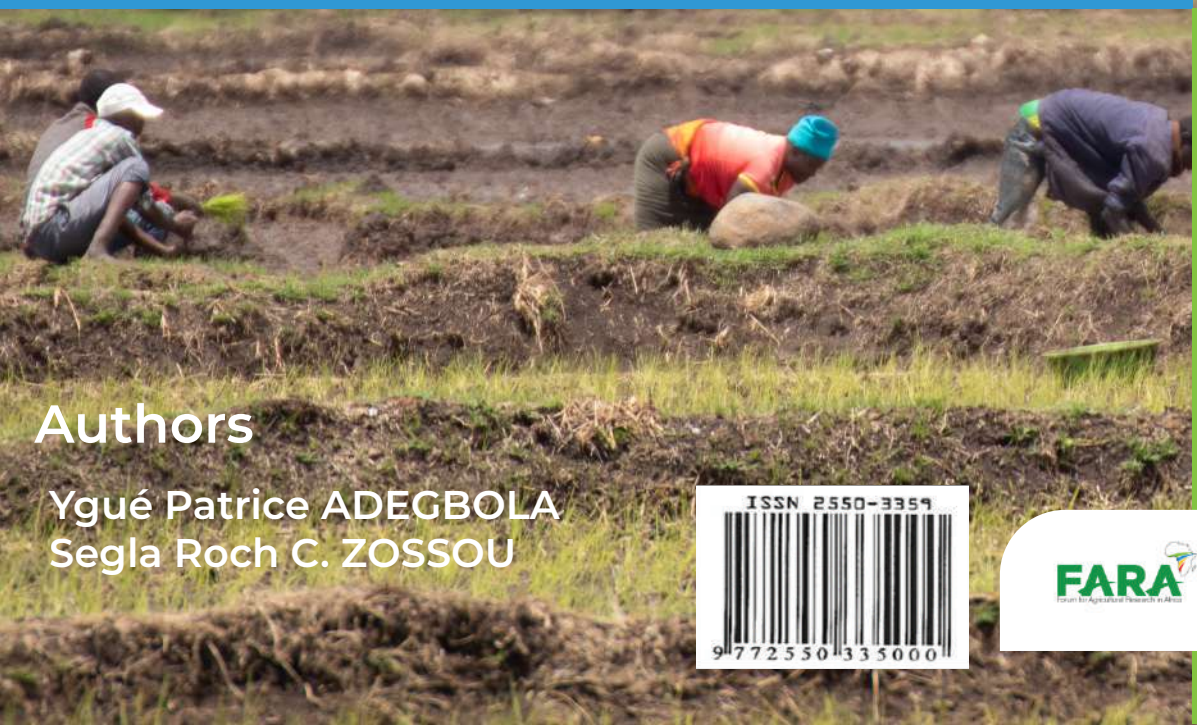

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FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector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

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Acronym	Definition
ABF	African Business Facility
ACMA	Communal Approach to the Agricultural Market in Benin Program
ADH	Agricultural Development Hubs
ATDA	Territorial Agricultural Development Agency
ATVET	Agricultural Technical and Vocational Education and Training
ARCN	Agricultural Research Council of Nigeria
AREE	Agricultural Research, Extension, and Education
CADER	Regional Action Centers for Rural Development
CBRST	Benin Center for Scientific and Technical Research
CIPCRE	International circle for the promotion of creation
COVID	Coronavirus Disease
CARE	Humanitarian Aid Association
CRA	Agricultural Research Center
CGIAR	Consultative Group for International Agricultural Research
DDAEP	Department of Agriculture Livestock and Fisheries of Mono
DEDRAS	Christian Non-Governmental Organization (NGO) for Humanitarian Development
DCAIFE	Direction of the Agricultural Council of Innovations and Entrepreneurial Training
DM	Swiss organization for Exchange and Mission
DPV	Direction of Plant Production
ENABEL	Development agency of the Belgian Federal Government
FA	Faculty of Agriculture - University of Parakou
FAO	Food and Agriculture Organisation
FARA	Forum for Agricultural Research in Africa
FIDA	International Fund for agricultural development, IFAD
FNDA	National Fund for Agricultural Development
GIZ	German International Development Cooperation Agency
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communications Technology
IER	Institute of Rural Economy
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
INA	Agricultural High School of N'dali
INRAB	National Agricultural Research Institute
IRC	Cotton Research Institute
KALRO	Kenya Agricultural and Livestock Research Organization
MAEP	Ministry of Agriculture Livestock and Fisheries

NARS	National Agricultural Research Systems
NGO	Non-Governmental Organization
NICHE	Program of Dutch Capacity Building in Post-secondary Education
PACOFID	Project to Support the Competitiveness of Agricultural Sectors and Export Diversification
PADEFA-ENA	Project of Support for the Development of the Cashew Nut Sector and Agricultural Entrepreneurship in Benin
PADMAR	Market gardening development support project
PAIVO	Project Support for Agricultural Infrastructure in the Ouémé Valley
PARI	Program of Accompanying Research for Agricultural Innovation
PDA	Agricultural Development Hubs
PNRA	National Agricultural Research Program
PNUD	United Nations International Development Program
PRoCAR	Program of Framework for IFAD Operations in Rural Areas in Benin
ProSOL	Project of Soil Protection and Rehabilitation to improve food security
PTA	Food Technology Program
PUM	Netherlands Organization Senior Experts
RAIL	Support Network for Local Initiatives
RNEC	National Grouping for Climate and the Environment
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SACO	Canadian Executive Service Organization
SDGs	Sustainable Development Goals
SEWOH	Ministry for Economic Cooperation and Development as part of the One World, No Hunger Initiative
SLM	Sustainable Land Management
SNEAB	National Strategy for e-Agriculture in Benin
SNV	Dutch Development Organization
SRI	Intensive Rice System
UNA	National University of Agriculture
UNFPA	United Nations Population Fund
TFP	Technical and Financial Partners
ZEF	Center of Development Research

1. Introduction

Agricultural transformation plays a key role in achieving 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" became a widely accepted framework for guiding public investments in these areas (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 roles of these institutions in improving agricultural productivity but hardly covered other sustainability goals (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 Benin by analyzing strategies within agricultural research, extension, and educational institutions aimed at meeting 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. Subsequently, 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 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 Benin and elsewhere embrace all dimensions of sustainability.

2. Insights from existing literature and data

NARS

Placed under the supervision of the Ministry of Agriculture, Livestock and Fisheries (MAEP), the NARS is made up of the National Agricultural Research Institute (INRAB), and the seven branches which are the Agricultural Research Centers (CRA); the Benin Center for Scientific and Technical Research (CBRST); International Agricultural Research Center and Institutes located in Benin, and NGOs; University; private agricultural research cabinet; and associations of independent researchers and endogenous innovators (Allagbe and Stads, 2014; PNRA, 2017).

The NARS presents several strengths and opportunities that contribute to its effectiveness and development potential, and functions as an inter-institutional mechanism for coordination and collaboration in the field of agricultural research. INRAB plays a central role as coordinator of NARS and is responsible for implementing the National Agricultural Research Policy (PNRA). It ensures the coordination of agricultural research activities carried out by the various member institutions of NARS.

The operation of NARS is based on a participatory approach, involving agricultural research stakeholders, policy makers, researchers, farmers, civil society organizations and development partners. Consultation and coordination mechanisms are put in place to facilitate the planning, implementation and evaluation of agricultural research activities. The results of research conducted by NARS are used to inform policy decisions, develop agricultural development strategies and improve agricultural practices on the ground. The system receives financial support from the government and other national and international partners. The availability of financial resources makes it possible to finance research projects, acquire equipment and develop infrastructure necessary to carry out quality research activities. Collaboration with international centers and partners facilitates access to knowledge and technologies developed on a global scale, strengthens the capacities of Beninese researchers and promotes scientific and technical exchanges. These different strengths and opportunities enable the generation of scientific knowledge, technological innovations and policy recommendations to support the growth of the agricultural sector, improve agricultural yields, strengthen farmers' resilience to climate change and contribute to food and nutrition security. Many relevant innovations have been generated and disseminated by the NARS (PNRA, 2017; INRAB, 2019; Coulibaly *et al.*, 2023).

Miscellaneous constraints hamper the development of innovation research (Allagbe and Stads, 2014; PNRA, 2017). They are related to:

- Non-functionality of certain consultation frameworks and precarious funding of research activities;
- Insufficient Human resources in terms of quantity and quality. There is an inadequacy (quantity and quality) of human resources and the working environment in relation to research needs;
- Weak level of dissemination and adoption of agricultural innovations;
- Weak productivity of plant and animal production systems due to low mastery of technical itineraries;
- Weak mechanization of agriculture;
- Insufficient public funding for agricultural research.
- Lack of measurement and improvement of research effectiveness. Research results are not communicated beyond the academic communities. They are simply used for authors' career progression;
- Formalization of structures and institutional frameworks;
- In research and teaching spaces, there are no documentation centers, even physical ones.

ATVET

The agriculture, technical and vocational education and training establishments (ATVET) in Benin bring together public and private universities; agricultural technical colleges; public and private professional training centers. ATVETs operate based on characteristics that are their strength which offer them opportunities. ATVETs emphasize hands-on learning and professional training (Triomphe *et al*., 2016; SNEAB 2020). This allows students to acquire practical and directly applicable skills in their chosen field, which increases their employability and enables them to meet the needs of the labor market. These training centers are designed to meet the specific needs of the labor market. They work with industry, business and employers to adapt their training programs to the requirements of the sector concerned. This ensures that graduates are prepared for available jobs, and promotes their professional integration (PNRA, 2017). ATVETs build strong partnerships with businesses and professional organizations. These partnerships provide opportunities for internships, on-the-job learning, and collaboration on real-world projects. Students can thus acquire relevant professional experience and establish contacts in their field of study. They also benefit from quality educational support. Teachers and trainers are competent and experienced in their respective fields. They monitor students individually, guide them in their learning and support them in their professional development.

In addition, the ATVETs have modern infrastructure and specialized equipment adapted to the fields of study. This allows students to put their theoretical knowledge into practice and become familiar with the tools and technologies used in their sector. The diplomas issued by the ATVETs are recognized on the labor market. The certifications obtained attest to the skills and qualifications of graduates, which facilitates their employability and professional mobility, both nationally and internationally.

The field of training is limited by:

- Inadequacy of the training given in relation to the professional demand;
- Lack of means of funding to support research in training centers;
- Lack of research and innovation laboratory in agricultural research centers (PNRA, 2017; Kirui and Kozicka, 2018).

AGRICULTURAL ADVISORY SERVICES

Agricultural extension structures in Benin bring people together: Territorial Agricultural Development Agencies, private agencies made up of accredited and non - accredited NGOs and private firms. The Territorial Agricultural Development Agencies (ATDA) are seven in number (07) under the control of the DDAEPs, and report to the Ministry of Agriculture, Livestock and Fisheries (MAEP). As management bodies for Agricultural Development Poles (PDAs), the ATDAs have legal personality and financial autonomy (PNRA, 2017; SNEAB, 2020). Their mission is to implement the policy for the promotion of sectors specific to the PDAs under their management, as well as to initiate actions aimed at achieving the government's objectives in terms of promotion of sectors and development of territories, thus generating results and visible impacts. Due to their positioning, their mission and their purpose, the ATDAs act as an interface between the National Fund for Agricultural Development (FNDA) and the targeted beneficiaries. They are positioned to easily reach the rural grassroots and are the starting point for the process of identifying and concretizing potential projects that can be financed by the FNDA at the level of the PDAs.
Agricultural extension structures in Benin operate according to specific modalities that give them strengths and opportunities.
Agricultural extension structures have local presence and are close to farmers. They build relationships of trust with farmers, understand their needs and realities, and provide them with advice and information tailored to their operations.

Their mission is to disseminate agricultural knowledge and best practices to farmers. They organize training sessions, field demonstrations and information sessions to share innovations, effective agricultural techniques and information on new varieties of crops or livestock. Also, agricultural extension structures facilitate farmers' access to modern agricultural technologies and the necessary resources. They direct them to sources of financing, suppliers of quality agricultural inputs and technical advisory services. It should be noted that agricultural extension structures take into account regional specificities, climatic constraints, available resources and local cultures. They offer solutions adapted to local contexts, thus promoting the sustainability and resilience of farms.

In addition, agricultural extension structures invest in building the capacity of farmers by providing them with technical training, management advice and skills in agricultural entrepreneurship. They help them improve their agricultural practices, optimize their production and increase their income. They benefit from a network of partners and collaborations with other players in the agricultural sector, such as researchers, training institutions, non-governmental organizations and development agencies. This collaboration promotes the exchange of expertise, the sharing of resources and the implementation of joint projects for agricultural development.

The field of extension has limitations:

- The problem relating to the adoption of ICTs is related to limited number of peasants or processors who have telephone, access to the GSM network and the internet;
- Extension coverage area are often not covered by networks, and when they are, these networks are too slow to be able to support intensive applications data exchange;
- Budgetary constraints : This is a recurrent and persistent challenge affecting both developed and developing countries. It poses serious problems to public extension services agriculture (Paget *et al*., 2022; PNRA 2017; SNEAB, 2020; Hinnou *et al*., 2022).

3. Methods and Sampling

3.1. Interviews with key stakeholders of AREE institutions

The qualitative survey was carried out with staff holding positions of responsibility (directors and key managers) in NARS, agricultural advisory services or extension, and ATVET, by the team from the University of Hohenheim (Prof. Birner Regina and Dr. Viviane Yameogo) and Benin (Dr. Patrice Adegbola and Ir. Roch S. C. Zossou) by appointment using an interview guide previously developed.

Given the large size of NARS and ATVET extensions institutions involved in agriculture in Benin exhaustively identified, the stratified random sampling of institutions was carried out using online interviews with the Program of Accompanying Research for Agricultural Innovation (PARI) team. This stratified random sampling considered institutions that work on a regional and national level focusing on crops only or crops and livestock (no livestock-only institutions); the aspect related to the private and public institutions. It was planned to conduct 30 interviews in total (10 qualitative interviews at the level of each type of institution). However, 14 interviews were conducted (five with NARS, three with ATVET and six with extension) (Table 1) out of 30, given the availability of key stakeholders of AREE institutions.

The interviews conducted addressed the experiences of the participants and their views regarding the strategies adopted within their institutions to achieve the multiple objectives of sustainability of the agricultural innovation system.

The list of institutions surveyed during the qualitative study is as follows in Table 1:

Table 1. List of AREE institutions and stakeholders surveyed during the qualitative study

	NARS	ATVET	Extension
Number of organizations	5	3	6
Names of organizations	-Agricultural Research Center (CRA) of Agonkanmey -CRA SOUTH Niaouli -CRA INA North EAST -CRA NORTH WEST -School of Management and Plant and Seed Production of the National University of Agriculture (UNA) of Ketou	-Agricultural High School of N'dali (INA) -School of Horticulture and Development of Protected Areas of the National University of Agriculture of Ketou -Songhai Center	-Territorial Agricultural Development Agency (ATDA) -1 -ATDA -4 -ATDA -7 -CIPCRE NGO BENIN -Support Network for Local Initiatives (RAIL) -DEDRAS NGO
Number of participants	2 ~ 5	2 ~ 5	2 ~ 5

3.2. Survey of staff from AREE institutions

The qualitative survey also made it possible to take an exhaustive inventory of the members of the staff of NARS, ATVET and extension institutions; and pre-testing the questionnaires for the quantitative survey with some members of NARS, ATVET and extension organizations.
It was planned to survey 300 staff members (100 researchers from NARS, 100 field officers from extension organizations and 100 trainers from ATVET) in total at the levels of the various institutions surveyed during the qualitative survey. Thus, they were sampled randomly from the exhaustive list provided by each institution selected using excel spreadsheet. Given the low number of staff members at the level of the various institutions, the surveys were continued at the level of other institutions of the same type to reach the quota of 300.
Finally, the staff survey covered a random sample of a total of 310 staff members, including 103 researchers surveyed at nine NARS; 101 field officers at the level of 6 ATVETs; and 106 at the level of 6 extension agencies (Table 2).

Table 2. Sample of staff members and list of membership of AREE of the institutions

	NARS	ATVET	Extension
Number of organizations	9	6	6
Names of organizations	- CRA INA - CRA SOUTH NIAOULI - CRA Agonkanmey - CRA SAVE - IITA - WORLD VEGETABLE - Cotton Research Institute (IRC) Cotonou- Parakou-Kandi - UNA School of Management and Plant and Seed Production - University of Abomey-Calavi	-N'dali Agricultural High School (INA) -Agricultural high school of Medji-Sekou -KIKA High School -FA University of Parakou -UNA School of Horticulture and Development of Protected Areas -Songhai Center	-ATDA-1 -ATDA-4 -ATDA-7 -DEDRAS -CIPCRE -Support Network for Local Initiatives
Number or respondents	103	101	106

3.3. Survey with students from ATVET institutions

The qualitative survey also made it possible to take an exhaustive inventory of the students of ATVET institutions; and pre-testing the questionnaires for the quantitative survey with some students in their final year of training.
Given the large size of students at the level of each ATVET institution, it was planned to survey 100 students (25 at each of the four randomly selected ATVET institutions). Thus, 100 students were randomly selected from the exhaustive list provided by the four ATVET institutions (Table 3), and surveyed on appointment. A survey among (former) students was conducted to better understand their perspective on the skills obtained and needed for sustainability transformation.

Table 3. Sample of staff members and list of membership of ATVET institutions

	ATVET
Number of organizations	4
Names of organizations	- Agricultural High School of (LAMS) - Agricultural High School of N'dali (INA) -University of Parakou (FA) -Songhai Center
Number of respondents	100

4. Results

4.1. Staff Survey

4.1.1. Staff characteristics and motivation

Table 4 presents the general background of the different stakeholders surveyed. The results show that the proportion of women involved in institutions was not very considerable, as they were estimated to be less than 16%. The differences observed according to the institutions show that the proportion of women at the level of extension organizations (22.64%) was higher than that of NARS (11.65%) and ATVET (11.76%).
The average years of experience of the staff members surveyed was estimated at 14 years. The heterogeneity of the responses observed showed that those who belonged to NARS (17 years) were more experienced than those of ATVET (13 years) and Extension (11 years).
The majority of staff members were between 31 and 40 years old (56.45%) and are from rural areas (62.90%). About 23.30% of NARS and 27.72% of ATVET staff studied abroad, while just 0.94% of Extension personnel did.

Table 4. General background

General background	NARS	ATVET	Extension	Average	Statistic test
Gender (share of females) (%)	11.65	11.76	22.64	15.43	6.30**
Work experience (years)	17.12 (7.11)	1 3 . 0 5 (7.38)	11.30 (5.19)	13.81 (7.03)	21.21***
Age (Years)					
20-30 (%)	2.91	7.92	13.21	8.06	24.15***
31-40 (%)	52.43	62.38	54.72	56.45	
41-50 (%)	25.24	21.78	29.25	25.48	
51-60 (%)	17.48	6.93	2.83	9.03	
61-70 (%)	1.94	0.99	0.00	0.97	
Origin (share rural) (%)	56.31	60.40	71.70	62.90	5.70**
Studied abroad (share yes) (%)	23.30	27.72	0.94	17.10	30.35***

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

Table 5 shows the professional background of the staff members surveyed. Majority of respondents had professional background in Agronomy/Plant breeding/Entomology (70.65%). The proportion of those with a background in Agronomy/Plant breeding/Entomology was higher in ATVET (72.28%) and NARS (70.87%) compared to Extension (68.87%). Those with a background in Social Sciences/Economics, Public Health/Educational Studies (9.35%), Livestock/Veterinary (7.42%), Engineering/Processing/Conservation of agri-food products (6.77%), Environmental sciences/ Biology (4.19%) had small proportion of the respondents.

Table 5. Professional background

Professional background	NARS	ATVET	Extension	Average	Statistic test
Agronomy/Plant breeding/Entomology (%)	70.87	72.28	68.87	70.65	19.82**
Livestock/Veterinary (%)	6.80	11.88	3.77	7.42	
Social Sciences/Economics, Public Health/Educational Studies (%)	8.74	2.97	16.04	9.35	
Environmental sciences/Biology (%)	6.80	4.95	0.94	4.19	
Management / Business/Public Administration (%)	0.97	1.98	1.89	1.61	
Engineering/Processing/Conservation of agri-food products (%)	5.83	5.94	8.49	6.77	
Others (%)					
Total (%)	100	100	100	100	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

Table 6 shows the level of education of staff members of the different institution. The results show that high proportion (66.99%) of those who were in NARS organizations had Ph. D. level and while 21.36% had master''s degree. In ATVET, 36.63%, 20.79% and 15.84% of the respondents had Ph.D., bachelor's degree and certificate in agriculture, respectively. Those of the extension organization mainly had bachelor''s degree (53.77%), vocational school certificate (19.81%), and master''s degree (15.09%).

Table 6. Education

Education	NARS	ATVET	Extension	Average	Statistic test
Primary school (%)	-	-	-	-	144.68***
Secondary school (%)	0.97	4.95	0.94	2.26	
Vocational school (%)	0.00	7.92	19.81	9.35	
Certificate in Agriculture (%)	2.91	15.84	8.49	9.03	
Bachelor's degree (%)	7.77	20.79	53.77	27.74	
Master's degree (%)	21.36	13.86	15.09	16.77	
Ph.D. level (%)	66.99	36.63	1.89	34.84	
Others (%)					
Total (%)	100	100	100	100	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The additional training declared by the staff members according to the types of institutions is presented on Table 7. More than 66% of NARS members received additional training besides formal training, while about 47% of ATVET were exposed to additional trainings Those of extension organizations (30.19%) received additional training mainly in digital tools, economic and social aspects.

Table 7. Additional training

Additional training		NARS	ATVET	Extension	Average	Statistic test
Additional training besides formal training (share yes) (%)		66.02	46.53	30.19	47.42	6.30**
Additional training aspects covered *(On a scale from 1=Not at All to 4=To a Great Extent)*	Agronomic aspects	3.30 (1.11)	2.95 (1.30)	3.27 (0.99)	3.18 (0.09)	1.40
	Economic aspects	2.97 (1.08)	2.69 (1.30)	3.60 (0.63)	3.02 (1.13)	6.70**
	Social aspects	2.65 (1.01)	2.81 (1.25)	3.53 (0.72)	2.90 (1.09)	7.56***
	Environmental aspects	3.24 (1.04)	2.85 (1.25)	3.23 (1.05)	3.11 (1.12)	1.82
	Digital tools	3.42 (0.76)	3.19 (1.05)	3.66 (0.68)	3.40 (0.86)	2.88*

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

Table 8 shows staff members' motivating factor to belong to a given type of institution. Main motivation factors of staff were personal fulfillment (21.02%), share/transfer of knowledge (20.37%), change in the country/for farmers (20.37%). The same trends were observed at the NARS and ATVET levels. The differences were observed at the levels of staff members belonging to the extension organizations. Indeed, their motivation was mainly linked to gain of experiences (21.21%) and job security (15.78%) apart from personal fulfillment.

Table 8. Motivations

Motivation (%)	NARS	ATVET	Extension	Average	Statistic test
Regular income (%)	8.69	7.26	12.75	9.61	2.98**
Job security(%)	13.92	6.88	15.78	12.26	7.13***
Prestige (%)	0.44	0.83	0.79	.68	0.18
Change in the country / for farmers (%)	25.52	25.20	10.76	20.37	20.55***
Personal fulfilment (%)	15.23	16.54	30.93	21.02	17.08***
Share / transfer knowledge (%)	25.26	28.58	7.78	20.37	30.20***
Gain experiences (%)	10.96	14.71	21.21	15.69	6.44***
Total (%)	100	100	100	100	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The main goals of the different organizations are summarized in Table 9. It shows that the main goal for all organizations was linked to increasing productivity. Apart from this aspect, the differences observed showed that the NARS gives more importance to improving food security (17.44%), Improving mitigation and adaptation to climate change (17.43%), reduction of poverty (13.44%), and contributing to biodiversity conservation (13.40%). At ATVET, aspects relating to improving food security (17.44%), reduction of poverty (14.97%), improvement of mitigation and adaptation to climate change (13.18%), fostering women and youth empowerment (10.08%) were prioritized. While extension organizations give attention to reduction of poverty (16.16%), improvement of food security (14.11%), improvement of mitigation and adaptation to climate change (12.39%), contribution to biodiversity conservation (7.98%), and improvement of access to financial services (7.71) %) and most importantly, increased productivity (21.08%).

Table 9. Perceived main goals of the different organizations

Perceived main goals of the type of organization	NARS	ATVET	Exten-sion	Average	Statistic test
Increase productivity (%)	20.50	19.20	21.08	20.28	0.53
Reduce poverty (%)	13.44	14.97	16.16	14.87	0.57
Improve mitigation and adaptation to climate change(%)	17.43	13.18	12.39	14.32	6.02**
Foster women‘s youth empowerment (%)	3.47	10.08	8.01	7.18	10.60***
Improve food security (%)	17.44	17.44	14.11	16.30	2.64*
Contribute to biodiversity conserva-tion (%)	13.40	9.50	7.98	10.28	6.67***
Integrate marginalized groups and the poorest (%)	1.87	5.21	6.82	4.65	9.06***
Improve access to financial services (%)	7.42	8.04	7.67	7.71	0.09
Foster the use and development of digital tools (%)	5.04	1.85	5.77	4.25	5.02***
Market access (%)	0	0.54	0	.18	2.92**
Total (%)	100	100	100	100	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The percentage at which the three different aspects of sustainability should be taken into account in the national agricultural budget is presented on Table 10. Economic Sustainability (reduction of hunger and poverty, improvement of living standards, etc.) (37.01%), Environmental Sustainability (integration of biodiversity goals, climate change mitigation, etc.) (35.65%) and Social Sustainability (gender aspects, integration of marginalized groups, youth, etc.) (27.33%) represents the prioritized sustainability aspects. The same trends were observed for NARS and ATVET. NARS personnel believe that Economic, Environmental and Social Sustainability should be budgeted at 39.84%, 33.56% and 26.60%, respectively. For ATVET, these aspects were estimated for budgetary consideration at 36.15% for Economic Sustainability, 34.79% for Environmental Sustainability, and 29.06% Social Sustainability. On the other hand, the prioritized elements according to the granted

share are Environmental (38.49%) Economic (35.09%) and Social (26.42%) Sustainability.

Table 10. Opinions of the members of staff of the three institutions on the national agricultural budgetary allocation to the proposed different aspects of sustainability

Percentage of the three different aspects of sustainability on the national agricultural budget (%)	NARS	ATVET	Extension	Average	Statistic test
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.) (%)	39.84	36.15	35.09	37.01	4.10***
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.) (%)	26.60	29.06	26.42	27.33	2.42*
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.) (%)	33.56	34.79	38.49	35.65	4.35**
Total (%)	100	100	100	100	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

4.1.2. Professional Networks

The background of colleagues that staff members mostly work with are presented on Table 11. The results show that the colleagues with whom they mainly collaborate within the organization had background in agronomy/plant breeding/entomology (more than 31%). Apart from this background, NARS also collaborated with those who had skills in social sciences/economics, public health/educational studies (16.93%), environmental sciences/biology (10.53%), and engineering/processing /conservation of agri-food products (10.13%). The same trends were observed at the levels of those working in extension organizations. At the ATVET levels, collaborations are mainly between engineering/processing/conservation of agri-food products (12.71%), livestock/veterinary (11.80%), social sciences / economics, public health/educational studies (11.67%) apart from agronomy/plant breeding/entomology (45.41%).

Table 11. Background of the colleagues of staff members

Background of the colleagues you mostly work with from within the organization	NARS	ATVET	Extension	Average	Statistic test
Agronomy / Plant breeding / Entomology (%)	55.28	45.41	30.97	43.75	21.80***
Livestock / Veterinary (%)	5.94	11.80	12.19	9.98	4.41**
Social Sciences / Economics, Public Health / Educational Studies (%)	16.93	11.67	18.55	15.76	4.59***
Environmental sciences / Biology (%)	10.53	8.83	14.42	11.30	4.11**
Management / Business / Public Administration (%)	1.20	8.60	5.19	4.97	11.43***

Engineering / Processing / Conservation of agri-food products (%)	10.13	12.71	18.68	13.89	8.74***
Others (%)					
Total (%)	100	100	100	100	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

Results regarding the number of times members of organizations met with national research organizations, members from CGIAR centers, other international research organizations, education institutions, extension service offices, private and third sector, NGOs, farmer organizations/ cooperatives, actors of the value chain during the last 12 months are presented on Table 12. More than half of the members of the organizations collaborated at least 5 times with all the aforementioned stakeholders. The differences observed according to the organizations show that the NARS staff members mainly collaborated (more than 10 times) with farmer organizations/ cooperatives (61.19%), extension service offices, including from private and third sector (43.28%), NGOs (43 .90%).

Medium infrequent collaborations (Between 5 and 10 times) were made with members of education institutions (vocational schools) (54.55%), actors of the value chain (input dealers, processors, retailers, consumers), national research organizations (including university staff) (30.68%), and those of the CGIAR centers (30.30%).

ATVET personnel had few meetings (up to 5 times) mainly with all the actors. More than a quarter of staff members had regular meetings (more than 10 times) with members from CGIAR centers, education institutions (vocational schools) and actors of the value chain.

At the extension level, they collaborated mainly (more than 10 times) with farmer organizations/ cooperatives (32.35%). Many others in extension collaborated with all other actors (up to 5 times).

Table 12. Frequency of meeting with other organizations

Frequency of meeting with staff members from ...	NARS (%)	ATVET (%)	Extension (%)	Average (%)	Statistic test
... national research organizations (including university staff) during the last 12 months					
Up to 5 times	39.77	68.00	93.33	57.74	36.18***
Between 5 and 10 times	30.68	28.00	6.67	25.60	
More than 10 times	29.55	4.00	0.00	16.67	
... members from CGIAR centers					
Up to 5 times	51.52	68.97	100.00	68.75	20.11
Between 5 and 10 times	30.30	3.45		13.75	
More than 10 times	18.18	27.59		17.50	
... other international research organizations					
Up to 5 times	78.95	81.25	76.47	79.31	3.76
Between 5 and 10 times	10.53	9.38	23.53	12.64	
More than 10 times	10.53	9.38	0.00	8.05	

… education institutions (e.g., vocational schools)					
Up to 5 times	30.30	50.00	80.77	51.55	20.18***
Between 5 and 10 times	54.55	23.68	11.54	30.93	
More than 10 times	15.15	26.32	7.69	17.53	
… extension service offices, including from private and third sector					
Up to 5 times	31.34	83.33	68.57	53.03	42.28***
Between 5 and 10 times	25.37	16.67	31.43	25.00	
More than 10 times	43.28	0.00	0.00	21.97	
… NGOs?					
Up to 5 times	45.83	73.08	75.00	67.02	8.00
Between 5 and 10 times	29.17	19.23	18.18	21.28	
More than 10 times	25.00	7.69	6.82	11.70	
… farmer organizations/ cooperatives					
Up to 5 times	26.87	72.73	38.24	42.46	38.86***
Between 5 and 10 times	11.94	18.18	29.41	20.11	
More than 10 times	61.19	9.09	32.35	37.43	
… actors of the value chain (e.g., input dealers, processors, retailers, consumers)					
Up to 5 times	31.71	64.86	58.82	50.89	13.43***
Between 5 and 10 times	43.90	13.51	32.35	30.36	
More than 10 times	24.39	21.62	8.82	18.75	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

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

Perceptions of staff members concerning the main challenges of farming are presented Table 13. The main challenges of farming from 10-20 years ago were mainly related in order of importance to finance issues (55.81%), low productivity (55.48%), inputs issues (40.97%), pests and diseases (38.39%), and roads and rural infrastructure (37.10%). But today, low productivity (74.52%), changing climatic patterns (73.55%), finance issues (48.39%), and low soil fertility (48.39%) constitute the challenges to be overcome today.

The variations in perceptions observed at the level of the different types of organization show that at the level of NARS, the main challenges raised 10-20 years ago were low productivity (74.76%), finance issues (69.90%), pests and diseases (55.34%), roads and rural infrastructure, and marketing issues (50.49%). Changing climatic patterns (86.41%), low productivity (74.76%), low soil fertility (60.19%) and finance issues (56.31%) were identified as the current main challenges to overcome in agriculture.

ATVETs personnel indicated that finance issues (65.35%), low productivity (44.55%), inputs issues (41.58%), pests and diseases (40.59%) were the main constraints 10-20 years ago. They considered finance issues (66.34%), low productivity (61.39%), changing climatic patterns (59.41%) as the current challenges to overcome.

Extension organizations' personnel indicated that low productivity (47.17%), poverty and inequality (47.17%) and education issues (35.85%) were the main problems encountered 10-20 years ago, while low productivity (86.79%), changing climatic patterns (74.53%) and low soil fertility (48.11%) as the current challenges of agriculture.

Table 13. Perceived main challenges of farming

Perceived main challenges of farming (%)	NARS			ATVET			Extension			Average		
	10-20 years ago (%)	To-day (%)	Test	10-20 years ago (%)	Today (%)	Test	10-20 years ago (%)	Today (%)	Test	10-20 years ago (%)	To-day (%)	Test
Low productivity	74.76	74.76	0.01	44.55	61.39	2.39***	47.17	86.79	6.13***	55.48	74.52	4.96***
Pests and diseases	55.34	25.24	-4.40***	40.59	16.83	-3.73***	19.81	39.62	3.15***	38.39	27.42	-2.90***
Livestock health and welfare	7.77	3.88	-1.18	12.87	6.93	-1.41	6.60	17.92	2.51***	9.03	9.68	0.27
Low soil fertility	15.53	60.19	6.60***	14.85	36.63	3.54***	13.21	48.11	5.51***	14.52	48.39	9.08***
Water issues	16.50	13.59	-0.58	26.73	13.86	-2.27**	22.64	20.75	-0.33	21.94	16.13	-1.84*
Low and unpredictable rainfall	13.59	9.71	-0.86	9.90	8.91	-0.24	7.55	28.30	3.93***	10.32	15.81	2.02**
Flooding	0.00	0.00	-	1.98	2.97	0.45	7.55	29.25	4.07***	3.23	10.97	3.75***
Changing climatic patterns	6.80	86.41	11.45***	8.91	59.41	7.56***	29.25	74.53	6.59***	15.16	73.55	14.63***
Inputs issues	47.57	38.83	-1.26	41.58	35.64	-0.86	33.96	39.62	0.85	40.97	38.06	-0.73
Poverty and inequality	9.71	3.88	-1.66*	13.86	12.87	-0.20	47.17	20.75	-4.06***	23.87	12.58	-3.64***
Roads and rural infrastructure	50.49	9.71	-6.37***	29.70	14.85	-2.53**	31.13	10.38	-3.72***	37.10	11.61	-7.39***
Marketing issues	50.49	33.01	-2.54***	32.67	35.64	0.44	14.15	13.21	-0.19	32.26	27.10	-1.40
Finance issues	69.90	56.31	-2.02**	65.35	66.34	0.14	33.02	23.58	-1.52	55.81	48.39	-1.84*
Extension service issues	1.94	3.88	0.82	0.99	3.96	1.35	16.04	4.72	-2.70***	6.45	4.19	-1.25
Education issues	27.18	5.83	-4.12***	28.71	20.79	-1.30	35.85	3.77	-5.85***	30.65	10.00	-6.38***
Digital tool issues	6.80	1.94	-1.70*	3.96	4.95	0.34	33.02	9.43	-4.19***	14.84	5.48	-3.85***
Electricity issues	0.00	0.00	-	1.98	0.99	-0.58	29.25	2.83	-5.24***	10.65	1.29	-4.91***
Network coverage	2.91	3.88	0.38	1.98	6.93	1.70*	31.13	0.00	-6.25***	12.26	3.55	-4.01***
- Access to land - Scarcity/expensive labor - Conflict between livestock farmers - Access to market - Professionalization of livestock farmers	29.13	35.92	1.04	15.84	25.74	1.73*	0.94	9.43	2.78***	15.16	23.55	2.64***

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The missions of the institutions are summarized Table 14. Considering the entire sample of members, nearly 36% believed that the mission of their institution had changed significantly in the last 10 years (Table 14). The differences observed showed that the missions had changed

significantly at the NARS (49.51%) and ATVET (35.64%) levels compared to that of the extension organizations (21.70%).

The main issues at NARS were mainly related to climate change, safe handling of agro-chemicals, crop yields and productivity, biodiversity-friendly agriculture and land degradation. Currently, they believe that their institution should place more emphasis on water management (76.92%), biodiversity-friendly agriculture (71.43%), climate change (66.67%), land degradation (60.00%) and gender (51.28%).

Compared to ATVET, safe handling of agro-chemicals, efficient input use, crop yields and productivity, climate change, gender, marginalized groups and/or the poorest were the order of importance of the issues considered. Staff members believed that institutions should place more emphasis on climate change (70.00%), marketing/commercialization (66.67%), microfinance (64.00%) and water management (59.46%).

Extensions organization attach particular importance to microfinance, marketing/ commercialization, safe handling of agro-chemicals, crop yields and productivity, gender, marginalized groups and/or the poorest. Staff members involved in organization extension organizations believe that they should give particular importance to water management (59.46%), climate change (37.50%), livestock productivity (36.21%), animal health (33.87%), and biodiversity-friendly farming (32.50%).

Table 14. Mission of institutions

		NARS	ATVET	Extension	Average	Statistic test
Change of the mission of institution in the last 10 years (Share yes)		49.51	35.64	21.70	35.48	17.65***
Importance of topics of institution *(On a scale from 1=Not Important to 4=Very important)*	Crop yields and productivity	3.78 (0.72)	3.69 (0.84)	3.67 (0.54)	3.71 (0.71)	0.64
	Efficient input use	3.71 (0.79)	3.71 (0.81)	3.60 (0.62)	3.67 (0.75)	0.71
	Safe handling of agro-chemicals	3.79 (0.70)	3.74 (0.74)	3.69 (0.58)	3.74 (0.68)	0.44
	Marketing/ commercialization	2.92 (1.13)	3.47 (0.94)	3.77 (0.44)	3.39 (0.94)	24.94***
	Microfinance	2.70 (1.21)	3.48 (0.97)	3.82 (0.43)	3.33 (1.03)	40.01***
	Land degradation	3.72 (.73)	3.36 (.95)	3.36 (.95)	3.60 (.85)	6.30***
	Climate change	3.90 (.43)	3.62 (.77)	3.62 (.77)	3.78 (.62)	5.73**
	Water management	3.36 (.94)	3.51 (.73)	3.51 (.73)	3.56 (.77)	12.38***
	Biodiversity-friendly agriculture	3.75 (.69)	3.36 (.92)	3.36 (.92)	3.65 (.77)	11.82***
	Livestock productivity	2.07 (1.28)	2.96 (1.08)	2.96 (1.08)	2.69 (1.29)	19.78***
	Animal Health	2.34 (1.39)	2.88 (1.09)	2.88 (1.09)	2.78 (1.29)	10.14***
	Nutrition	3.10 (1.21)	3.52 (.69)	3.52 (.69)	3.38 (1.02)	5.80**
	Gender	3.14 (1.18)	3.66 (.59)	3.66 (.59)	3.47 (.94)	8.31***
	Marginalized groups and/ or the poorest	3.06 (1.19)	3.66 (.58)	3.66 (.58)	3.40 (1.00)	10.14***
	-Mechanization -Digitalization -Waste recycling -Food processing -Post harvest management	1.00 (0.00)	2.00 (0)	2.00 (0.00)	1.44 (.70)	1.91

Institution should place more importance on this aspect (Share yes) %	Crop yields and productivity	30.00	38.46	12.50	21.82	4.13
	Efficient input use	35.71	38.46	8.57	20.97	7.48**
	Safe handling of agro-chemicals	30.00	46.15	11.54	24.49	5.82**
	Marketing/ commercialization	46.55	66.67	26.09	47.22	8.22***
	Microfinance	34.43	64.00	23.53	39.81	8.72***
	Land degradation	60.00	25.00	5.26	21.54	19.17***
	Climate change	66.67	70.00	37.50	50.00	3.76
	Water management	76.92	59.46	59.46	66.28	3.93
	Biodiversity-friendly agriculture	71.43	37.50	32.50	41.94	6.52**
	Livestock productivity	27.63	42.11	36.21	33.72	2.61
	Animal Health	23.44	44.44	33.87	32.10	4.80*
	Nutrition	27.50	26.32	20.51	24.49	0.56
	Gender	51.28	38.10	10.00	34.44	12.95***
	Marginalized groups and/or the poorest	48.89	22.73	20.00	34.02	8.30***
	Others	25.24	33.66	18.87	25.81	5.93**

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

4.1.4 Digitalization

Table 15 shows that almost all staff members used digital tools in their daily activities. The difference observed according to the institutions underlines that only 3.77% of extension organizations personnel did not use digital tools.

The devices used were phone/smartphone (99.67%), computers (85.29%), tablets (32.46%) and others such as drones, cameras, projectors and theodolites. Phones/smartphones and computers were mainly used regardless of the type of organization. The observed differences showed that the proportion of tablet users at the NARS (50.49%) and ATVET (29.00%) was higher than that of users at the extension organization levels.

These devices were used by NARS mainly for communication (e.g. WhatsApp) (100.00%), other social media (Facebook, Twitter, Instagram) (90.29%), teaching (63.11%), banking (62.14%) and research information on agricultural techniques (60.19%). Communication (e.g., WhatsApp) (95.00%), teaching (77.00%), social media (Facebook, Twitter, Instagram) (74.00%), research information on agricultural techniques (61.00%) represent, in order of priority, the purposes for which the devices were used by the ATVETs.

Those of extension organizations used these devices primarily for communication (WhatsApp) (98.04%), social media (Facebook, Twitter, Instagram) (80.39%), leisure (videogames, video clips, music) (66.67 %), and research information on agricultural techniques (54.90%).

Table 15. Digitalization aspects

		NARS (%)	ATVET (%)	Extension (%)	Average (%)	Statistic test
Use of digital tools in daily activities (Share yes)		100	99.01	96.23	98.39	5.05**
Kind of devices used	Phone/Smartphone	99.03	100.00	100.00	99.67	1.96
	Computers	93.20	85.00	85.29	87.87	4.15
	Tablets	50.49	29.00	17.65	32.46	26.02***
	Others (drone, camera; Projector, theodolite)	3.88	6.00	1.96	3.93	2.18
Utility of these devices (%)	Teaching	63.11	77.00	44.12	61.31	23.22***
	Communication (e.g., WhatsApp)	100.00	95.00	98.04	97.70	5.73**
	Social media (e.g., Facebook, Twitter, Instagram)	90.29	74.00	80.39	81.64	9.14***
	News (e.g., BBC, local TV or radio)	37.86	38.00	17.65	31.15	13.02***
	Banking	62.14	54.00	12.75	42.95	58.43***
	Weather forecast	3.88	8.00	10.78	7.54	3.54
	Farm management practices	15.53	17.00	29.41	20.66	7.23**
	Agricultural information/ advice/ training (crop, livestock, etc.)	43.69	28.00	32.35	34.75	5.89**
	Information/ advice/ training on other aspects (e.g., marketing, finance)	15.53	20.00	51.96	29.18	38.97***
	Price information	0.97	2.00	12.75	5.25	17.44***
	Transport options	0.97	3.00	4.90	2.95	2.76
	Research information on agricultural techniques	60.19	61.00	54.90	58.69	0.91
	Leisure (e.g., videogames, video clips, music)	44.66	52.00	66.67	54.43	10.35***
	Others (reporting, filming)	6.80	4.00	0.00	3.61	6.87**

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

4.1.5. Work Environment

The view of staff members on the following statements relating to job satisfaction are presented on Table 16. The results show that the majority of staff members received feedback about the quality of their work. The differences observed showed that the proportion of staff members of NARS (60.19%) who agreed that they received feedback was higher than that of ATVET (35.64%) and extension organizations (46.23%). The proportion of those who strongly agreed was higher at ATVET (53.47%) and extension organizations (49.06%) compared to NARS (37.86%).

The majority of staff members set a high personal standard of performance. The differences observed showed that the proportion of staff members of NARS (54.37%) and ATVET (44.55%) with high personal performance standards was higher than that of their counterparts in extension organizations (37.74%). The proportion of those who strongly agreed on having a high personal standard of performance was higher at the extension (61.32%) and ATVET (53.47%) compared to NARS (40.78%).

The majority of staff members were free at their stations to make decisions and solve problems about their work. The differences observed showed that the proportion of staff members of ATVET (64.36%) and NARS (57.28%) who agreed that they were free to make decisions were much higher than their counterparts in extension organizations (6.60%). The proportion of those who strongly agreed was higher for extension organization (33.96%) compared to NARS (24.27%) and ATVET (22.77%). Those who did not agree with this statement were small in proportion (11.29%) especially at NARS (16.50%) and ATVET (10.89%).

The majority of staff members felt recognized by their peers as hard workers. The differences observed showed that the proportion of staff members of NARS (67.96%) and ATVET (53.47%) who agreed that their peers considered them as hard working were more than in extension organizations (44.34%). The proportion of those who strongly agreed was higher for extension organization (50.00%) compared to those of ATVET (41.58%) and NARS (31.07%). Those who disagreed were small in proportion (3.23%) and were mainly extension personnel (5.66%).

The majority of staff members felt that their boss placed a great deal of confidence in their judgment. The differences observed showed that the proportion of staff members of NARS (76.70%) who agreed that their bosses reposed confidence in them was higher than that of their ATVET (53.47%) and extension (49.06%) counterparts. The proportion of those who strongly agreed with this position was higher for extension (46.23%) and ATVET (41.58%) compared to NARS (22.33%).

The majority of staff members believed that their job had made them gain experience in life, which would help them in future. Staff members of extension (40.57%) who agreed that experiences gained would help in the future were higher than that of their counterparts from ATVET (23.76%) and NARS (18.45%) organizations. The proportion of those who strongly agreed was higher at NARS (81.55%) and ATVET (76.24%) compared to extension (55.66%).

The majority of staff members felt satisfied with their job. The proportion of those who strongly agreed was higher at ATVET (70.30%) and NARS (60.19%) compared to extension (49.06%).

Table 16. View of staff members on job satisfaction related statements

View on the following statements related to **job satisfaction**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
You receive feedback about the quality of your work					
Strongly disagree	0.97	3.96	0.00	1.61	
Disagree	0.97	5.94	4.72	3.87	
Agree	60.19	35.64	46.23	47.42	
Strongly agree	37.86	53.47	49.06	46.77	
Non-applicable	0.00	0.99	0.00	0.32	20.40***
You have set for yourself a high standard of performance					
Strongly disagree					
Disagree	4.85	1.98	0.94	2.58	10.82**
Agree	54.37	44.55	37.74	45.48	

View on the following statements related to **job satisfaction**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
Strongly agree	40.78	53.47	61.32	51.94	
Non-applicable					
You are given the freedom at the station to make decisions and solve problems about your work					
Strongly disagree	1.94	0.99	0.00	0.97	11.95
Disagree	16.50	10.89	6.60	11.29	
Agree	57.28	64.36	6.60	60.32	
Strongly agree	24.27	22.77	33.96	27.10	
Non-applicable	0.00	0.99	0.00	0.32	
You feel recognized by your peers as a hard worker					
Strongly disagree	0.00	0.99	0.00	0.32	17.67
Disagree	0.97	2.97	5.66	3.23	
Agree	67.96	53.47	44.34	55.16	
Strongly agree	31.07	41.58	50.00	40.97	
Non-applicable	0.00	0.99	0.00	0.32	
Your boss places a great deal of confidence in your judgment					
Strongly disagree					
Disagree	0.97	2.97	4.72	2.90	0.65***
Agree	76.70	53.47	49.06	59.68	
Strongly agree	22.33	41.58	46.23	36.77	
Non-applicable	0.00	1.98		0.65	
Your job has made you gain experience in life, which will help you in the future.					
Strongly disagree					
Disagree	0.00	0.00	3.77	1.29	23.28***
Agree	18.45	23.76	40.57	27.74	
Strongly agree	81.55	76.24	55.66	70.97	
Non-applicable					
You are satisfied with your job					
Strongly disagree					
Disagree	7.77	0.00	9.43	5.81	15.22***
Agree	32.04	29.70	41.51	34.52	
Strongly agree	60.19	70.30	49.06	59.68	

View on the following statements related to **job satisfaction**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
Non-applicable					

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The view of staff members on issues relating to salary/payments satisfaction are presented in Table 17. Almost half of staff members believed that their salary encouraged them to work better. Staff members of ATVET (48.51%) and NARS (47.57%) who agreed that their income encouraged them to work better were more those of extension (32.08%). The proportion of those who strongly agreed was higher for extension (23.58%). Those who disagreed with this statement were many at extension organizations (39.62%).

Nearly half of staff members indicated that they were happy with the salary they received. ATVET (42.57%) and NARS (41.75%) staffs who agreed that they were satisfied with their pay larger in proportion those in extension (36.79%). The proportion of those who strongly agreed was higher for extension personnel (19.81%). Those who disagree with this statement were many amongst the extension personnel (38.68%) and NARS (35.92%).

The majority of staff members belimembers of staff in other departments/institutions with comparable tasks earned same income. The proportion of staff members of ATVET (70.30%) and NARS (69.90%) who agreed that this was true was higher than that of extension (50.94%) organizations. Those who disagreed with this statement are among extension staff (32.08%) were higher than in the other institutions.

Majority of staff members indicated that they received their salaries on time. Nevertheless, 13.21% of extension and 6.93% of ATVET disagreed with this statement.

More than half of staff members believed that they received salary increases as expected when they started the job. Those who disagreed with this statement were high in proportion among extension (37.74%) and NARS (36.89%) staff.

The majority of staff members believed that the pay scales reflected differences in workload and responsibility. The differences observed show that the proportion of ATVET staff members (69.31%) who agreed with this opinion was higher than that of extension (37.74%) and NARS (12.62%). Many extension personnel (32.96%) disagreed with this statement.

Table 17. View of staff members on issues related to salary

View on the following statements related to **payments**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
Your salary encourages you to work better					
Strongly disagree	9.71	22.77	4.72	12.26	35.01***
Disagree	32.04	20.79	39.62	30.97	
Agree	47.57	48.51	32.08	42.58	
Strongly agree	10.68	7.92	23.58	14.19	
Non-applicable					

View on the following statements related to **payments**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
You are happy with the salary you receive					
Strongly disagree	13.59	23.76	4.72	13.87	24.40***
Disagree	35.92	25.74	38.68	33.55	
Agree	41.75	42.57	36.79	40.32	
Strongly agree	8.74	7.92	19.81	12.26	
Non-applicable					
Staff is paid equally to staff in other departments/institutions in charge of comparable tasks					
Strongly disagree	0.97	3.96	4.72	3.23	24.71***
Disagree	21.36	10.89	32.08	21.61	
Agree	69.90	70.30	50.94	63.55	
Strongly agree	7.77	11.88	12.26	10.65	
Non-applicable		2.97	0.00	0.97	
Staff always receive their salaries on time					
Strongly disagree	0.97	3.96		1.61	20.21***
Disagree	0.97	6.93	13.21	7.10	
Agree	68.93	64.36	66.04	66.45	
Strongly agree	29.13	23.76	20.75	24.52	
Non-applicable		0.99		0.32	
You receive salary increases as you expected when you started this job					
Strongly disagree	5.83	22.77	2.83	10.32	49.06***
Disagree	36.89	16.83	37.74	30.65	
Agree	51.46	58.42	45.28	51.61	
Strongly agree	5.83	0.99	14.15	7.10	
Non-applicable	0.00	0.99	0.00	0.32	
The pay scales reflect differences in workload and responsibility					
Strongly disagree	2.91	2.97	3.77	3.23	38.77***
Disagree	12.62	9.90	33.96	19.03	
Agree	12.62	69.31	37.74	58.71	
Strongly agree	14.56	15.84	24.53	18.39	
Non-applicable	0.00	1.98	0.00	0.65	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The view of staff members on the following statements relating to hiring and promotion satisfaction are presented on Table 18. Majority of staff members believed that employees were hired purely based on merit. A large proportion of staff members of ATVET (53.47%) and extension (36.79%) strongly agreed with this position, and were more than those of NARS (20.39%). Those who disagreed with this statement were a very small proportion of NARS (11.65%).

Also, majority of staff members believed that promotion was purely based on merit (more than 56%). Staff members of ATVET (39.60%) and extension (36.79%) who strongly agreed were higher than those of NARS (18.45%). Very small proportion of NARS (14.56%) and ATVET (10.89%) did not agree with that position.

Less than half (around 42.90%) of staff members believed that promotion depended on how long you had served. Extensions personnel (26.42%) who strongly agreed with this position were more than NARS (4.85%) and ATVET (6.93) personnel. About 45.63% of NARS and 31.68% of ATVET disagreed with this position.

The majority of staff members believed that there were good opportunities for promotion. Only a few (9.71% of NARS, and 7.55% of ATVET) disagreed with this opinion.

The majority of staff members also believed that performance appraisals were fairly done. The differences observed showed that those who did not agree with this statement were a small proportion, especially the extension personnel (22.64%).

More than half of staff members believed that the majority of people employed were well-qualified to do their jobs. Staff members of extension (42.45%) and ATVET (46.53%) who strongly agreed were more than those of NARS (20.39%). Those who disagreed with this statement were few. only 7.77% of NARS personnel belonged to this category.

The majority of staff members believed that the male and female staff had equal opportunities in getting promoted. About 47.17% of extension personnel who strongly agreed with this position were more than those of NARS (29.13%) and ATVET (29.70%). Those who did not agree with this statement were small proportion, 12.26% of extensions personnel were in this category.

Nearly half of staff members believed that the staff members had to be worried about losing their jobs in the near future. Staff members of extension organizations (26.42%) who strongly agreed were more than those of NARS (7.77%) and ATVET (8.91%). Those who disagreed with this statement were a considerable proportion especially amongst NARS (33.01%) and ATVET (56.44%) organizations.

Table 18. View of staff members on the following statements related to hiring and promotion

View on the following statements related to **hiring and promotion**	**NARS (%)**	**ATVET (%)**	**Ex-ten-sion (%)**	**Aver-age (%)**	**Statistic test**
Staff is hired purely based on merit					
Strongly disagree					
Disagree	11.65	2.97	6.60	7.10	28.61***
Agree	67.96	42.57	56.60	55.81	
Strongly agree	20.39	53.47	36.79	36.77	
Non-applicable		0.99	0.00	0.32	
Staff is promoted purely based on merit					
Strongly disagree	0.00	2.97	0.00	0.97	26.63***
Disagree	14.56	10.89	6.60	10.65	
Agree	66.99	44.55	56.60	56.13	
Strongly agree	18.45	39.60	36.79	31.61	
Non-applicable	0.00	1.98	0.00	0.65	
Promotion depends on how long you have served					
Strongly disagree	11.65	10.89	0.94	7.74	44.50***
Disagree	45.63	31.68	29.25	35.48	
Agree	37.86	47.52	43.40	42.90	
Strongly agree	4.85	6.93	26.42	12.90	
Non-applicable	0.00	2.97		0.97	
There are good opportunities for promotion					
Strongly disagree	0.97	1.98	0.00	0.97	24.18***
Disagree	9.71	2.97	7.55	6.77	
Agree	73.79	73.27	57.55	68.06	
Strongly agree	15.53	18.81	34.91	23.23	
Non-applicable	0.00	2.97	0.00	0.97	
Performance appraisals are carried out fairly					
Strongly disagree	0.97	1.98	0.94	1.29	26.83***
Disagree	5.83	9.90	22.64	12.90	
Agree	70.87	47.52	49.06	55.81	
Strongly agree	22.33	39.60	27.36	29.68	
Non-applicable	0.00	0.99	0.00	0.32	

View on the following statements related to **hiring and promotion**	**NARS (%)**	**ATVET (%)**	**Ex-ten-sion (%)**	**Aver-age (%)**	**Statistic test**
The majority of people in this office are well-qualified to do their job					
Strongly disagree					
Disagree	7.77	1.98	3.77	4.52	19.46***
Agree	71.84	51.49	53.77	59.03	
Strongly agree	20.39	46.53	42.45	36.45	
Non-applicable					
Male and female staff have equal opportunities in getting promoted					
Strongly disagree	0.00	3.96		1.29	29.56***
Disagree	2.91	8.91	12.26	8.06	
Agree	67.96	56.44	40.57	54.84	
Strongly agree	29.13	29.70	47.17	35.48	
Non-applicable	0.00	0.99		0.32	
Staff has to be worried about losing their jobs in the near future.					
Strongly disagree	33.01	56.44	10.38	32.90	105.803***
Disagree	30.10	6.93	18.87	18.71	
Agree	29.13	14.85	44.34	29.68	
Strongly agree	7.77	8.91	26.42	14.52	
Non-applicable		12.87		4.19	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

The views of staff members on issues about level of satisfaction in respect of overall support are presented in Table 19. The results show that the majority of staff members indicated that their programs/duties had specified targets. Staff members of ATVET (46.53%) and extension (44.34%) strongly agreed on having specified target, compared to 27.18% of NARS who indicated same.

Almost half of staff members believed that they were provided with enough resources to carry out their duties as required. However, some extension personnel (36.79%), NARS (26.21%) and ATVET (19.80%) did not agree that they were adequately equipped with resources. Up to 47.74% of staff members believed that the Inputs and resources for their work were supplied regularly and on time, some NARS (37.86%), extension (39.62%) personnel did not agree with this position. About 20.79% of ATVET staff also disagreed.

Nearly half (46.45%) of staff members believed that the mobility to their operational area was easy. The heterogeneity of the answers observed showed that those who did not agree with this statement were a considerable proportion especially amongst NARS (19.42%) and extension (34.91%), compared to those of ATVET (5.94%). Extension (20.75%) and ATVET (14.85%) staff members strongly agreed with this statement.

Table 19. Views of staff members on overall support

View on the following statements related to **overall support**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
The programs you have to implement office have specified targets					
Strongly disagree					
Disagree	1.94	1.98	1.89	1.94	9.80**
Agree	70.87	51.49	53.77	58.71	
Strongly agree	27.18	46.53	44.34	39.35	
Non-applicable					
Staff has enough resources available to carry out their work as required by professional norms					
Strongly disagree	20.39	19.80	2.83	14.19	30.88***
Disagree	26.21	19.80	36.79	27.74	
Agree	47.57	55.45	46.23	49.68	
Strongly agree	5.83	3.96	14.15	8.06	
Non-applicable		0.99		0.32	
Inputs and resources for your work come regularly and on time					
Strongly disagree	13.59	12.87	4.72	10.32	22.62***
Disagree	37.86	20.79	39.62	32.90	
Agree	40.78	61.39	41.51	47.74	
Strongly agree	7.77	4.95	14.15	9.03	
Non-applicable					
Mobility to your operational area is easy					
Strongly disagree	10.68	24.75	12.26	15.81	50.26***
Disagree	19.42	5.94	34.91	20.32	
Agree	58.25	49.50	32.08	46.45	
Strongly agree	11.65	14.85	20.75	15.81	
Non-applicable		4.95		1.61	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

Table 20 shows opinion of members of staff of the different institutions as regard their perception of their supervisors' attitudes towards them. Most of the staff members were of the opinion that their supervisors motivated them and thus increased their job satisfaction. Respondents gave a wide range of responses, the proportion of staff members of ATVET (41.58%) and extension (40.57%) who strongly agreed were more than those of NARS (19.42%) who also strongly agreed.

Less than half of the staff members indicated it was difficult to please their supervisor. Those who strongly agreed with this position were more in extension organizations (32.08%). On the other hand, those who disagreed with this statement were a considerable proportion, especially NARS

(55.34%) and ATVET (45.54%) personnels compared to those of the extension (16.98%).

The majority of staff members (more than 55%) reported that their supervisors their work. The proportion of those who strongly agreed with this statement were concentrated in ATVET (50.50%) and extension organizations (43.40%) compared to NARS (30.10%). The same trends were observed regarding that their opinions of their supervisors' competence and availability. Those who disagreed with this statement were a small proportion (less than 5%).

The majority of staff members (over 66%) reported that their supervisors did not exhibit favoritism. The proportion of those who strongly agreed with this statement was concentrated in extension organizations (40.57%) compared to NARS (14.56%) and ATVET (9.90%).

The majority of staff (over 57%) reported that their workload was adequate. Those who strongly agreed with this statement were also many in extension (43.40%) and ATVET (39.60%) organizations than those of the NARS (20. 39%). On the other hand, those who did not agree with this statement were not so few, especially in NARS (10.68%).

The majority of staff members (over 57%) indicated that they had clear and structured work plan. Members of staff who strongly agreed with this statement were more concentrated in ATVET (46.53%) and extensions (40.56%) than at NARS (33.01%).

Table 20. View of staff members on the following statements related to supervision

View on the following statements related to **supervision**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
Your supervisor has increased your job satisfaction					
Strongly disagree		0.99		0.32	24.28***
Disagree	7.77	7.92	2.83	6.13	
Agree	72.82	47.52	56.60	59.03	
Strongly agree	19.42	41.58	40.57	33.87	
Non-applicable		1.98		0.65	
It is hard to please your supervisor					
Strongly disagree	5.83	4.95	7.55	6.13	58.69**
Disagree	55.34	45.54	16.98	39.03	
Agree	30.10	36.63	43.40	36.77	
Strongly agree	8.74	7.92	32.08	16.45	
Non-applicable		7.92		1.61	
Your supervisor praises good work					
Strongly disagree		0.99		0.32	17.57**
Disagree	1.94	4.95	1.89	2.90	
Agree	67.96	42.57	54.72	55.16	
Strongly agree	30.10	50.50	43.40	55.16	
Non-applicable		0.99		0.32	
Your supervisor knows the job well					

View on the following statements related to **supervision**	**NARS (%)**	**ATVET (%)**	**Extension (%)**	**Average (%)**	**Statistic test**
Strongly disagree			2.83	0.97	25.54***
Disagree	5.83	2.97	3.77	4.19	
Agree	72.82	48.51	51.89	57.74	
Strongly agree	21.36	47.52	41.51	36.77	
Non-applicable		0.99		0.32	
Your supervisor is always around when needed					
Strongly disagree					
Disagree	4.85	4.95	4.72	4.84	14.35**
Agree	67.96	50.50	48.11	55.48	
Strongly agree	27.18	42.57	47.17	39.03	
Non-applicable		1.98		0.65	
Your supervisor does not show favoritism					
Strongly disagree	3.88	8.91		4.19	46.93***
Disagree	8.74	7.92	3.77	6.77	
Agree	72.82	70.30	55.66	66.13	
Strongly agree	14.56	9.90	40.57	21.94	
Non-applicable		2.97		0.97	
Your workload is adequate					
Strongly disagree	0.97			0.32	21.02***
Disagree	10.68	6.93	4.72	7.42	
Agree	67.96	51.49	51.89	57.10	
Strongly agree	20.39	39.60	43.40	34.52	
Non-applicable		1.98		0.65	
You have a clear, structured work program					
Strongly disagree					
Disagree	1.94	0.99	4.72	2.58	9.244
Agree	65.05	51.49	54.72	57.10	
Strongly agree	33.01	46.53	40,56	40.00	
Non-applicable		0.99		0.32	

Note: * significant at the 1% level (p< 0.01); ** significant at the 5% level (p< 0.05); * significant at the 10% level (p<0.10).**

4.2. Students Survey

4.2.1. Student Characteristics and Motivation

Table 21 shows the socio-demographic characteristics of the students surveyed. Majority of the students were men (64%), with average age estimated at 22 years. Over 59% of the respondents were from a rural area and few (33.00%) came from farming families. Most were in their third

year of training and the motivation to start the course was linked in order of priority to secure job (72%) and knowledge to bring about change in farming (55.00%). After graduating, respondents (students) indicated to be engaged as (in order of importance), agro-entrepreneur (59.00%), private, public, or third-sector extension service personnel (23.00%), agricultural research Institute officer (11.00%).

Table 21. Student Characteristics and Motivation

		Average
Gender (share of females) %		36
Age		22.78 (0.16)
Origin (share rural) (%)		59.00
Origin (share farming) (%)		33.00
Own cultivation (share yes) (%)		31.00
Year of training		3.18 (2.63)
Motivation to start the course (%)	Secure job	72.00
	A job with a regular income	17.00
	Representative (prestigious) job	15.00
	Knowledge to bring about change in farming	55.00
Objective after graduation? (%)	Private, public, or third-sector extension service	23.00
	Jobs in the Ministry of agriculture	0.00
	Agricultural Research Institute	11.00
	Academia	0.00
	Independent Consultant	7.00
	Agro-entrepreneur	59.00
	Others	

Table 22 shows the opinions of students on the share of the national agricultural budget that should be allocated to the three different aspects of sustainability In their opinion, students suggested that they should be prioritized in this order: economic (e.g., reduction of hunger and poverty, improvement of living standards, etc.), environmental (e.g., integration of biodiversity goals, climate change mitigation, etc.), social sustainability (e.g. gender aspects, integration of marginalized groups, youth, etc.). Out of 100% of the national agricultural budget, they estimated that 45.2% of the budget should be allocated to economic sustainability, 30.35% to environmental sustainability and 24.45% to social sustainability.

Table 22. Students' perspective on allocation of the national agricultural budget to the three aspects of sustainability

Percentage on the three different aspects of sustainability of the national agricultural budget	Average %
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.)	45.2 (16.12)
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.)	24.45 (11.65)

Percentage on the three different aspects of sustainability of the national agricultural budget	Average %
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.)	30.35 (13.14)
Total	100

Table 23 presents where the student wished to make the greatest contribution in the future. They wished to contribute the most at the end of their training, in order of importance, to increase productivity (46.00%), reduce poverty (44.00%), improve food security (36.00%), and foster women's empowerment (14.00%).

Table 23. Perception of student on the greatest contribution in the future

Greatest contribution in the future (%)	Average
Increase productivity	46.00
Reduce poverty	44.00
Improve the adaptation to climate change	13.00
Foster women's empowerment	14.00
Improve food security	36.00
Contribute to biodiversity conservation	9.00
Integrate marginalized groups and the poorest	12.00
Improve access to financial services	3.00
Foster the use and development of digital tools	4.00

4.2.2 Perceptions of Challenges in the Agricultural Sector

Table 24 presents the perceptions of students on the main challenges of farming. The results show that the main challenges of farming indicated by the students were related in hierarchical order to extension service issues (79.00%), changing climatic patterns (65.00%), low productivity (50.00%), low soil fertility (49.00%), pests and diseases (38.00%), and water issues (34.00%).

Table 24. Perception of main challenges of farming

Perception of main challenges of farming (%)	Average
Low productivity	50.00
Pests and diseases	38.00
Livestock health and welfare	13.00
Low soil fertility	49.00
Water issues	34.00
Low and unpredictable rainfall	25.00
Flooding	-
Changing climatic patterns	65.00
Inputs issues	22.00
Poverty and inequality	8.00
Roads and rural infrastructure	7.00

Perception of main challenges of farming (%)	**Average**
Marketing issues	15.00
Finance issues	21.00
Extension service issues	79.00
Education issues	25.00
Digital tool issues	16.00
Electricity issues	-
Network coverage	-
Funding (e.g., for research and development, education, rural infrastructure	9.00

4.2.3. Perceptions of Training

Table 25 shows the view of the students on their training/course of study. Students agreed that the courses they had chosen accommodated their needs. The responses showed that more than 30% strongly agreed with this statement. The same trends were observed with regard to the fact that the objectives of the courses were clearly defined; participation and interaction were encouraged; the topics covered were considered relevant.

Nearly half of students (48%) were satisfied, and over 33% were completely satisfied with course contents/topics, flow and manner of organization of the training. The same observations were noted for the fact that the contents met their expectations, the materials distributed were helpful and relevant. The majority of students (over 72%) strongly agreed that the course experience will be useful in their work.

Almost half of the students strongly agreed that the trainers were knowledgeable about the course topics, and that their quality of responses to their questions were good. They believed that the trainers were well prepared, and the course objectives were met. More than 44% believed that the time allotted for the course work was sufficient. About 34.00% of the students fully agreed with this position. However, 10% of the respondents disagreed.

More than 34.00% of students stated that the periods allotted for practical works were sufficient, but more than 20% did not fully agree with this statement.

Only 13% of students believed that the lecture rooms and facilities were adequate and comfortable. Similarly, a small proportion (25.00%) fully agreed that the courses offered capacity in digital tools.

A considerable sample (39%) believe that the courses included visiting farms and or/interacting with farmers. Almost half (48.00%) of students fully agreed with this claim.

Table 25. Views of students on their training/courses

View on the following statements related to the course	**Average (%)**
The course you have chosen accommodates well to your background needs	
Cannot tell	5.00
Strongly disagree	3.00
Disagree	8.00
Agree	54.00

View on the following statements related to the course	Average (%)
Strongly agree	30.00
The objectives of the course were clearly defined	
Cannot tell	3.00
Strongly disagree	2.00
Disagree	3.00
Agree	53.00
Strongly agree	39.00
Participation and interaction were encouraged	
Cannot tell	10.00
Strongly disagree	2.00
Disagree	4.00
Agree	55.00
Strongly agree	29.00
The topics covered were relevant to me.	
Cannot tell	2.00
Strongly disagree	
Disagree	3.00
Agree	58.00
Strongly agree	37.00
The content was organized and easy to follow.	
Cannot tell	5.00
Strongly disagree	3.00
Disagree	11.00
Agree	48.00
Strongly agree	33.00
The content meets expectations.	
Cannot tell	9.00
Strongly disagree	1.00
Disagree	10.00
Agree	47.00
Strongly agree	33.00
The materials distributed were helpful and relevant.	
Cannot tell	6.00
Strongly disagree	4.00
Disagree	10.00
Agree	43.00
Strongly agree	37.00
This course experience will be useful in my work.	
Cannot tell	
Strongly disagree	

View on the following statements related to the course	Average (%)
Disagree	
Agree	28.00
Strongly agree	72.00
The trainers were knowledgeable about the course topics.	
Cannot tell	4.00
Strongly disagree	
Disagree	2.00
Agree	44.00
Strongly agree	50.00
The quality of the answers to the questions was good	
Cannot tell	4.00
Strongly disagree	
Disagree	
Agree	49.00
Strongly agree	47.00
The trainers were well prepared.	
Cannot tell	9.00
Strongly disagree	
Disagree	1.00
Agree	40.00
Strongly agree	50.00
The course objectives were met.	
Cannot tell	14.00
Strongly disagree	5.00
Disagree	7.00
Agree	47.00
Strongly agree	27.00
The time allotted for the course work was sufficient.	
Cannot tell	6.00
Strongly disagree	6.00
Disagree	10.00
Agree	44.00
Strongly agree	34.00
The time allotted for the practical works was sufficient.	
Cannot tell	3.00
Strongly disagree	20.00
Disagree	15.00
Agree	28.00
Strongly agree	34.00
The course rooms and facilities were adequate and comfortable.	

View on the following statements related to the course	Average (%)
Cannot tell	18.00
Strongly disagree	29.00
Disagree	26.00
Agree	13.00
Strongly agree	14.00
The course offers capacity in digital tools	
Cannot tell	16.00
Strongly disagree	28.00
Disagree	27.00
Agree	25.00
Strongly agree	4.00
The course allows visiting farms and or/interacting with farmers	
Cannot tell	3.00
Strongly disagree	4.00
Disagree	6.00
Agree	39.00
Strongly agree	48.00

Table 26 summarizes statistics regarding students' perception relating to time and teaching of the courses for economic, social, and environmental sustainability aspects. The results show that students rated the time allotted to and teaching of sustainability issues in their courses in order of importance to aspects relating to economic (43.18%), environmental (32.46%) and social sustainability (24.36%).

Table 26. Perception of the time and teaching the courses devoted for sustainability aspects

Perception of the time and teaching the courses devoted for sustainability aspects	**Average %**
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.)	43.18 (16.47)
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth etc.)	24.36 (11.36)
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.)	32.46 (14.28)
Total	100

Table 27 summarizes the perception of students in respect of the coverage of important aspects of their courses. More than half of the students (58%) agreed that crop yields and field productivity were sufficiently addressed by the course/program, while 28% of the students strongly agreed with this position. The same trends were observed for the aspects of efficiency of input use (e.g., using fertilizer or pesticides more efficiently) been sufficiently addressed by the course/program. The same was true for the aspects of efficient and safe handling of agro-chemicals (e.g., avoid inappropriate use of pesticides by following the safety instructions to reduce negative effects on the environment and human health) been sufficiently addressed by the course.

Less than half of the students (about 45%) indicated that aspects of marketing have been sufficiently addressed by the course. The same trends were observed for the aspects of prices, quality standards, value creation, and cost-saving techniques. The same was true for the aspects of microfinance opportunities as saving and credit options; increasing livestock productivity (e.g., improving meat and /or milk and/or skin and/or horns).

The majority of students (53%) agreed that the aspects of reducing land degradation (e.g., due to overgrazing, or reduced fallow periods) through practices aimed at conserving or enhancing soil health and rehabilitating degraded soils, had been sufficiently addressed by the course. The same was true for the aspects of improving agricultural water management (e.g., water harvesting, irrigation, flood prevention).

Almost half believed that the aspects of integrating climate change had been sufficiently addressed by the course.

The majority of students showed that the aspects of biodiversity-friendly measures in the agricultural landscape (e.g., diverse crop rotation and/or intercropping and/or agroforestry techniques and/or use of different varieties of one crop, etc.) had been sufficiently addressed by the course.

Over 29% of students disagreed that aspects of animal's health, while reducing the use of veterinary drugs and preventing animal losses due to disease and injuries had been sufficiently addressed by the course. Only 20% fully agreed on this aspect. Thus, this aspect was insufficiently covered in the course. The same goes for the aspects regarding improving livestock; improving nutrition; integrating marginalized groups and/or the poorest when promoting and/or designing agricultural activities and/or practices.

More than half of the students believed that the gender aspects had been sufficiently addressed by the course. The same remarks were observed for the aspect related to integrating youth when promoting and/or designing agricultural activities.

The majority of students believed that their courses included training on the use of digital tools (54%), the use of digital tools for research information, write seminar papers or produce other material relevant to the course completion (64%).

Table 27. Aspects of studies sufficiently covered in courses of study

Aspects sufficiently covered	Average (%)
Crop yields and productivity_ crop yields and field productivity been sufficiently addressed by the course program	
Not applicable	2.00
Cannot tell	3.00
Strongly disagree	1.00
Disagree	8.00
Agree	58.00
Strongly agree	28.00
Efficient input use _ Aspects of efficiency of input use / (e.g., using fertilizer or pesticides more efficiently) been sufficiently addressed by the course program	
Not applicable	3.00
Cannot tell	2.00
Strongly disagree	7.00

Aspects sufficiently covered	Average (%)
Disagree	55.00
Agree	33.00
Strongly agree	
Safe handling of agro-chemicals_ Aspects of efficient and safe handling of agro-chemicals (e.g., avoid inappropriate use of pesticides by following the safety instructions to reduce negative effects on the environment and human health) been sufficiently addressed by the course	
Cannot tell	2.00
Strongly disagree	2.00
Disagree	17.00
Agree	51.00
Strongly agree	28.00
Marketing/ commercialization_ Aspects of marketing been sufficiently addressed by the course	
Not applicable	1.00
Cannot tell	5.00
Strongly disagree	4.00
Disagree	30.00
Agree	45.00
Strongly agree	15.00
Aspects of prices, quality standards, value creation, and cost-saving techniques been sufficiently addressed by the course	
Not applicable	1.00
Cannot tell	3.00
Strongly disagree	4.00
Disagree	26.00
Agree	44.00
Strongly agree	22.00
Aspects of microfinance opportunities as saving and credit options been sufficiently addressed by the course	
Not applicable	1.00
Cannot tell	5.00
Strongly disagree	8.00
Disagree	27.00
Agree	43.00
Strongly agree	16.00
Aspects of reducing land degradation (e.g., due to overgrazing, or reduced fallow periods) through practices aimed at conserving or enhancing soil health and rehabilitating degraded soils, been sufficiently addressed by the course	
Not applicable	

Aspects sufficiently covered	Average (%)
Cannot tell	4.00
Strongly disagree	
Disagree	6.00
Agree	53.00
Strongly agree	37.00
Aspects of integrating aspects that relate to climate change been sufficiently addressed by the course	
Not applicable	
Cannot tell	9.00
Strongly disagree	1.00
Disagree	23.00
Agree	49.00
Strongly agree	18.00
Aspects of improving agricultural water management (e.g., water harvesting, irrigation, flood prevention) been sufficiently addressed by the course	
Not applicable	
Cannot tell	1.00
Strongly disagree	2.00
Disagree	11.00
Agree	56.00
Strongly agree	30.00
Aspects of biodiversity-friendly measures in the agricultural landscape (e.g., diverse crop rotation and/or intercropping and/or agroforestry techniques and/or use of different varieties of one crop, etc.) been sufficiently addressed by the course	
Not applicable	
Cannot tell	1.00
Strongly disagree	1.00
Disagree	5.00
Agree	61.00
Strongly agree	32.00
Aspects of increasing livestock productivity (e.g., improving meat and /or milk and/or skin and/or horns) been sufficiently addressed by the course	
Cannot tell	8.00
Strongly disagree	5.00
Disagree	1.00
Agree	27.00
Strongly agree	38.00
Aspects of animal's health, while reducing the use of veterinary drugs and preventing animal losses due to disease and injuries been sufficiently addressed by the course	

Aspects sufficiently covered	Average (%)
Not applicable	12.00
Cannot tell	
Strongly disagree	1.00
Disagree	29.00
Agree	38.00
Strongly agree	20.00
Aspects of improving Livestock been sufficiently addressed by the course, according to you	
Not applicable	10.00
Cannot tell	6.00
Strongly disagree	3.00
Disagree	29.00
Agree	29.00
Strongly agree	23.00
Aspects of improving nutrition been sufficiently addressed by the course, according to you	
Not applicable	2.00
Cannot tell	5.00
Strongly disagree	3.00
Disagree	27.00
Agree	38.00
Strongly agree	25.00
Gender aspects been sufficiently addressed by the course	
Cannot tell	7.00
Strongly disagree	7.00
Disagree	22.00
Agree	50.00
Strongly agree	14.00
Aspects of integrating marginalized groups and/or the poorest when promoting and/or designing agricultural activities and/or practices been sufficiently addressed by the course	
Not applicable	2.00
Cannot tell	7.00
Strongly disagree	11.00
Disagree	31.00
Agree	39.00
Strongly agree	10.00
Aspects of integrating the youth when promoting and/or designing agricultural activities and/or practices been sufficiently addressed by the course	
Cannot tell	10.00

Aspects sufficiently covered	Average (%)
Strongly disagree	5.00
Disagree	11.00
Agree	50.00
Strongly agree	24.00
Course included training on the use of digital tools %	54.00
Course included the use of digital tools research information	64.00

Table 28 shows other aspects that the students wished the courses should focus more on to better address the country's challenges. The other aspects in order of priority were extension service issues (63.00%), water issues (limited access to water) (41.00%), digital tool issues (lack of access to digital tools) (39.00%), low soil fertility (34%), low productivity (30.00%), education issues (lack of education) (21%).

Table 28. Others aspects that the courses should focus on

Other aspects the course focused more on to even better address the country's challenges (Share yes) (%)	Average
Low productivity	30.00
Crops Pests and diseases	12.00
Livestock health and welfare	11.00
Low soil fertility	34.00
Water issues (Limited access to water)	41.00
Low and unpredictable rainfall	14.00
Flooding	4.00
Changing climatic patterns	17.00
Inputs issues (Availability and cost of inputs)	7.00
Poverty and inequality	8.00
Roads and rural infrastructure	13.00
Marketing issues (Limited options for marketing)	18.00
Finance issues (Lack of access to finance (e.g., access to credit/ savings, etc....)	14.00
Extension service issues	63.00
Education issues (Lack of education)	21.00
Digital tool issues (Lack of access to digital tools)	39.00
Electricity issues	1.00
Network coverage (Unreliable/lack of network coverage)	6.00

Table 29 shows challenges which students faced in their chosen courses. The results show that the majority of students (67%) faced challenges in their chosen courses such as insufficient access to the internet (89.55%), access to computers (68.66%), access to modern materials for practical lessons (53.85%), access to relevant literature (41.79%), few practical lessons (30.77%).

Table 29. Challenges students faced in their chosen courses

		Average (%)
Any challenges facing in the course (Share yes)		67.00
Challenges (%)	Insufficient access to computers	68.66
	Insufficient access to internet	89.55
	Insufficient access to relevant literature	41.79
	Not easy access to consult with teachers/lecturers	8.96
	Insufficient access to modern materials for practical lessons	53.85
	Insufficient laboratory	15.38
	Few practical lessons	30.77
	Others	0.00

4.3. Qualitative Insights from Interviews with Agricultural Advisory Service Organizations Managers

4.3.1. Overall Mission and Changes in Missions

4.3.1.1. Overall Mission

In Benin, there are private and public local extension organizations. The public extension organizations (ATDA, DDAEP) were created after the new reforms at the level of each Agricultural Development Hubs (ADH) focusing on priority commodities in order to efficiently execute the reforms. The ATDAs promote the commodity chains, disseminate innovations to the actors (producers, processors, breeders, traders) and ensure their structuring; and the Departmental Direction of Agriculture, Livestock and Fisheries (DDAEP) carry out monitoring. Some of the local private extension organizations are not approved and while some are approved. The latter have a better chance of finding project opportunities or government contracts as private providers of agricultural advice with public extension organizations (ATDA). These organizations work with field agents who are specialized as technicians and advisors who are in contact with producers. The existence of these institutions, especially the private ones, depends on donor funding. They work with enterprising communities until they are empowered by helping them to get out of poverty for their development. "*We work more with enterprising communities so that they are autonomous*" isthe mission of one of such organizations. The main targets are women, children and youth; and the areas of intervention are generally:

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- preservation of the environment (water and sanitation; management of the biodiversity of forests and waste management of the living environment, etc.) which is a key area.
- development of agricultural value chains,
- vocational training and employment of youth and women, management of animal resources;
- education and protection of children;
- community and reproductive health and nutrition;
- promotion of human rights and humanitarian action and peace;

With regard to the development of agricultural value chains, these different institutions play a much greater role in the key sectors such as maize, cashew nuts, rice, soybeans, market, gardening, cowpeas, etc. They are mostly involved in capacity building of grassroots actors on:

- best agricultural production practices (agroecology, adaptation measures for climate change, etc.);
- supporting the supply or donation or subsidy of inputs (e.g. improved seed), equipment, etc. to motivate target actors "*For example, in Kessounou, there is a 50% increase in maize yields, thanks to the improved seeds subsidized by the State*";
- agricultural entrepreneurship;
- The structuring of actors (organization of farmers into groups/cooperatives to have access to various services or support for the professionalization of family farms), support for the marketing of quality products (grouped sales), and business relations (contractualization, online sales platform, creation of consultation frameworks for dialogue, etc.) with market actors, particularly traders or even processing companies/plants;
- promoting nutritional security;
- supporting communes in local environmental governance and participatory and sustainable management of natural resources in their territories.

The research results identified on the internet, the collection of technologies and technical documents produced through research (INRAB, research offices, etc.) are widely used for

extension. "*There are research results already available, and we use them to train and monitor producers. For example: the manufacture and use of organic pesticides based on neem leaf, papaya for preventive control of flies and helicoverpa*.

4.3.1.2. Changes in missions and challenges of the extensions

The objectives have changed through reforms that have led to the creation of ATDAs at the level of each ADH for the promotion of specific sectors, and DDAEPs that carry out the monitoring of the implemented extension activities, whereas the ex ATDA (i.e. CARDER) played both roles together in the past. Also, the objectives have changed with the planning and coordination of sector development actions according to the ADHs with the support of the Total factor productivity(TFP) and NGO partners program projects. In terms of TFP support, for example, GIZ supported the NGO DEDRAS in the development of contract farming to promote market access for cashew nut producers and processors and other sectors; and in the fight against climate change.

Many reorientations have been made following the failure factors of previous interventions. These new directions are related to:

- the implementation of the agricultural service, only qualified national or international private service providers, recruited through tenders under the new governmental reform;
- the recruitment of sector specialists and qualified experts;
- staff participation in capacity building workshops;
- the application of the results or directions recommended through research to meet the needs of rural communities;
- the renewal of specifications;
- compliance with principles and contract with the targets (producers and processors involved)
- the provision of the means of production and the required resources for the staff;
- regular contact of field agents with producers and permanent evaluation of work done "*evaluations are carried out to check whether the objectives are being achieved at the level of the field staff in contact with the producers*".

The technical documents, and technical and economic catalogs produced or the research results on the sectors are highly valued by the extension organizations for agricultural advice in the field (training, promotion, etc.). The facilitation or reorientation of objectives leads some extension organizations to translate technical documents into local languages for use by actors (producers, processors etc.).

"*The technical documents produced by INRAB in local language on the technical directions of the System of Rice Intensification (SRI) and grafted cashew nuts have been translated and used by DEDRAS to accompany the actors in capacity building with the support of GIZ, Private extension".*

The integration of ICT has also favored the change in missions. Indeed, video spots edited in French and local languages and animated by producers themselves with the support of NGOs (Access Agriculture, ACMA2 Project, Technoserve), are currently used by extension workers as training aids or channels to communicate on innovations in order to prove to stakeholders the effectiveness of a given technology or operation. WhatsApp groups are created and used by technical agents

in the field to promote information sharing (video spots) and communication on concerns of farmers who have Android phones.

"*A soybean farmer, for example, explains through a video how he harvests or sows soybeans. These videos are also disseminated through WhatsApp or downloadable on websites for those who have Android phones. They are also disseminated at the community level through screenings to promote information sharing*".

The number of supervised producers has increased, and varies between 400 and 20,000 producers per type of extension. "*In 2021, DEDRAS mentored nearly more than 20,000 producers*". The supervision of more than 65,000 rice producers in 2025 is expected by the local public extension organization of ADH 1.

For each project, a technical director, a team in charge of monitoring and evaluation for the supervision of activities, and technicians to provide agricultural advisory to the target groups (producers, processors, etc.) is set up by the private extension organizations. These technical agents are trained according to the theme, and supervision missions are carried out regularly to ensure the smooth running of activities in the field to adapt to the reform. Recommendations are often made based on the data collected and analyzed by the monitoring and evaluation team. Measures are taken to ensure that field agents are close to producers (especially the most vulnerable) through frequent visits for advice, and even via telephone. The number of farms to be monitored/covered by each technical field agent recruited and deployed in the field sometimes exceeds the number recommended by the national agricultural advisory statistics (around 100). Thus, reorientations are often defined by adopting the strategy of gathering farmers, and working directly with groups of farmers or focus groups, and not individually. Afterwards, the technician selects a few farmers to visit and accompany for support and further information, and motivates them to share their knowledge with their peers. This strategy has caused the technicians to exceed 200 producers in the coaching sessions, and the expected results are achieved. The disseminated information is used by the farmers involved and other local actors readily engage in the practice when they note that producers are benefiting from the program.

To achieve mission objectives, roles are sometimes assigned to some pro-leading actors in the dissemination of technologies in their community. Also, actors are sometimes asked to contribute financially to the installation of some technologies or facilities to motivate them. "*Actors or cooperatives are sometimes required to contribute up to a certain amount to the acquisition of a particular equipment to benefit from the support for a defined technology. In order to benefit from the support and promotion of improved chicken breeding, actors are required to build their own pens according to the standards we have set before we give them free broodstock*".

The inclusion of gender and environmental protection aspects (recycling of farm waste for renewable energy production, measures for climate change adaptation, water and soil conservation, integration of livestock farming and agroforestry measures or plantation rehabilitation, etc.) constitutes changes that have been observed in the implementation of the projects and programs of the organizations. Also, the different missions have varied and changed over time considering the needs or different difficulties faced by the communities through reference studies conducted or research orientations.

In terms of actions, awareness sessions on the harmful effects of the abusive and uncontrolled use of herbicides and pesticides for weeding and treatment of crops, given the scarcity of manpower, have been performed. Alternative solutions (land clearing, use of bio-pesticides) have been proposed, and contracts have been signed with the beneficiaries regarding the non-use of chemical products. This awareness-raising and follow-up program has helped to reduce the use of chemicals in the community. In addition, to facilitate the achievement of the objectives, a

monitoring system has been set up where producers monitor each other, especially with regard to the respect of agroecology.

Also, extension organizations (e.g., DEDRAS) have accompanied producers, processors and traders in connecting with microfinance institutions to access credit. But the model did not work too well because the microfinance institutions were very reluctant to provide financing given the quality of the business plans. They had to build the capacities of the different actors in developing well-structured business plans to reduce the rejection of credit applications or rationing.

Given the major changes that are occurring, the extension organizations feel that they can adapt the overall mission of their organization by updating and responding to the needs of the stakeholders, disseminating sustainable solutions adapted to local contexts and proposed by research. For this reason, strengthening collaboration with NARS and ATVET is considered very important.

4.3.2 Innovation system

4.3.2.1 Perception of the Research System and Perspectives

The extension organizations believe that the research system is gradually evolving in Benin through the development of innovations and techniques adapted to each crop and zone. The government is making enough effort, but there is a lack of financial resources for research in NARS and ATVET. The State must invest permanently in agricultural research given the local context that changes over time. *"For example, there is a need for new varieties that are tolerant to drought or flooding compared to those that were developed, because the climatic context changes over time".*

Nevertheless, a lot of research work is carried out by researchers (INRAB, research firms, etc.) and students, especially in the field of plant and animal production and the environment, but the majority of the results are under exploited. This problem is related to insufficient publication of research results in journals and university websites, sharing of results with extension organizations and end users of these results. There is also a lack of organization of workshops for the presentation of innovations, etc.

However, the application of some innovations has been successful. Today, women are trained in the use of the steaming kits developed by INRAB, which have been very successful and work very well compared to archaic methods. The kits are offered or subsidized to certain women's groups to motivate them. The facilitation of the sustainability of the adoption of this technology has led INRAB, for example, to train welders on the manufacture of these kits, and to direct the parboilers to these welders as needed. Also, the extension of the soybean inoculum set up by the research has been successful.

In addition, the areas for improvement are related to the increased use of digital tools in agricultural research. Digital tools are gradually becoming part of researchers' habits through the development of applications to detect pest attacks on farms with drones, the conduct of meetings or working sessions online, communication through WhatsApp groups and the realization of transactions via cell phones. In addition, today some tractors are equipped with GPS that allows remote monitoring of activities (distance traveled, area worked, amount of fuel, etc.). However, the problem related to the adoption of ICTs is linked to the limited number of farmers or processors who have a telephone, access to the GSM network, let alone the internet. This also represents a major challenge for the extension system.

Other areas for improvement include:

- Development of lower-cost technologies;
- Climate change adaptation technology, water management.

4.3.2.2 Perception of the education system and perspectives

The training strategy for students must be reviewed so that their training is in line with the solutions to the realities of the field. The training must be much more oriented towards entrepreneurship, practical sessions to bring young people to undertake after their training to reduce the unemployment rate. In recent years, the government has taken this problem to heart, and there are specific training centers that are being created to strengthen vocational training.

4.3.2.3. Perception of the extension system and perspectives

The reforms that have been introduced recently, notably the national agricultural advisory strategy, have reframed many elements to promote extension services and the agricultural system. The fact that the government is beginning to give accreditation to institutions (NGOs, firms, farmers' associations etc.) that provide agricultural advisory services, the requirement to prepare annual reports on the implementation of the agricultural advisory strategy by public and private extension organizations, and the monitoring by the DDEAP is appreciated, since the private extension organizations created previously for agricultural advisory services were not well monitored. However, some private extensions organizations feel that the DDEAPs do not play their roles sufficiently in monitoring the activities carried out by the NGOs in the field. They state that regular, not periodic, monitoring should be carried out by the DDEAPs to ensure that the works carried out by the NGOs in the fields are properly executed.

The local extensions had difficulty promoting certain innovations such as certain soil water conservation techniques like *zaï* given the arduousness of the operations; the adoption of mucuna because this technology did not allow producers to have additional benefits (non- edible seed, etc.) apart from generating soil fertility. These difficulties are presented in the reports and discussed during sessions and workshops with decision-makers (management, the Ministry, researchers) to define new orientations in the agricultural system.

The public and private extension organizations think difficulties in mobilizing financial resources and the rejection of project funding for extension are affecting the agricultural system in Benin. Another aspect is the strengthening of collaboration with research and training institutions to facilitate information sharing. All of these elements constitute challenges to be overcome.

In addition, the areas for improvement are related to the increased use of digital tools to provide agricultural advice or its digitalization. Digital tools are progressively entering the daily life of the organizations' staff (online meetings, online work by several people on the same document or model, etc.) and producers in the sharing of information (prices of agricultural inputs and products, technologies, transactions, etc.). *"In terms of communication, these channels are used to pass a lot of messages and reach certain actors".* Indeed, applications that make available data sheets and videos on the measures of sustainable practices techniques have been developed and successfully disseminated within the framework of certain projects (the NET DATA application of the ACMA2 project with the NGO for example). With the support of an expert from the Netherlands, DEDRAS is setting up, since the advent of COVID, a multilingual digital platform for the provision of remote agricultural advice on Android phone, which is already highly appreciated by some users. However, the problem with the adoption of ICT is related to the limited number of farmers

or processors who have a phone, access to the GSM network, let alone the internet. This is also a big challenge for the extension system.

Other areas for improvement include:

- environmental problems (climate change, water control), *"in the Ouémé valley, the environmental problems that farmers are facing are mainly the lack of control of rainfall patterns during flood and drought periods, which is unstable";*
- the rehabilitation of plantations requiring financing to assist the producers;
- the fight against pests, transhumance causing damages to crops;
- more awareness on the harmful effects of the abusive and uncontrolled use of herbicide and pesticide for weeding and treatment of crops given the scarcity of manpower.

4.3.2.4 Partner network or collaboration and observed changes in collaboration

Changes have been observed with the different organizations over time. Before, it was donations that were made for the benefit of poor communities. But today, work is done to bring the communities to undertake, and boost their activities.

NARS partner networks are based on the areas of intervention. Partnerships are developed with ATVETs and NARS also to facilitate the engagement of students in organizations for practical or professional internship purposes. More collaboration needs to be developed with ATVETs to facilitate the application of the recommendations resulting from the research conducted by the students.

Collaboration is maintained with INRAB and the ATVETs through their involvement in the development of the sectors and consultation meetings to share information. Indeed, the research works on themes and develops technical sheets that consider the needs of the actors, and that it makes available to the ATDAs to facilitate the execution of protocols. "Everything we use comes from research. It is research that provides innovations for agriculture in Benin. *For the FOREVA and PAIVO projects, INRAB was involved in training, monitoring of field activities and data collection to better guide actions - ATVET".*

Permanent collaboration is maintained by private extension organizations (civil society actors, research firms, NGOs, professional organizations) with those of the public sector (ATDA DDEAP), in order to obtain contracts for private agricultural advisory services according to the new reform of the agricultural advisory strategy. The constraint encountered with the ATDA was due to the delay in the establishment of financial resources, thus affecting the planning or the experimental device. There are several levels of collaboration between private extension organizations and the public sector. In addition, there is the level where meetings are organized by the communal cells to review the activities carried out and the future planning of the protocols implemented, as the field agents of the private extension organizations work directly with the communal cells of the ATDAs. Monthly meetings involving all actors involved in the agricultural sector in each commune are also organized. The ATDA provides support on given orientations, and is involved in the realization of missions or given activities of the private extension organizations' projects. They are also solicited to train the staff of the latter, or the realization of a given activity when the staff does not have the required skills for the execution of the activity.

Also, collaborations are carried out with the DDAEP for the elaboration of quarterly reviews through workshops that also allow sharing of experiences with extension workers and actors of the agricultural world. Periodic monitoring missions are carried out by the public extension (ATDA

DDEAP) to observe whether the actions carried out by the NGOs are in line with the national agricultural advisory strategy. The private extension organization recommends that the public ones make regular visits for advice support.

Quarterly meetings are held with local actors (the town hall) where all actors involved in the environmental and agricultural sector are invited to discuss the needs of the community.

Collaboration in carried out with projects according to the sectors. Collaborations are carried out with international donors or TFPs for the financing of extension projects in the environmental field such as Pain Pour Le Monde (PPLM), the Swiss organization, D'échange et Mission (DM), GIZ, United Nations Development Programme (UNDP).

Very close collaboration is developed with other TFPs such as:

- GIZ; Canadian foundation Paul Gérin La Joie, Calisio jeunesse emploi; Evêque sans frontière, OIF, in the framework of school education and youth integration.
- GIZ and CGIAR institutions (AfricaRice, International Institute of Tropical Agriculture: IITA) through the establishment of contracts to train producers on agricultural entrepreneurship, and women on rice parboiling; good production practices for rice, cashew nuts and soybeans in some communes in the North and Collines.
- SNV, World DAAD, Pain pour le monde, Technoserve, the Procajou project CNFA, Benin Caju for the cashew nut sector.
- the CARE program, ENABEL, FIDA, PADMAR, and PRoCAR for the development of the maize, cassava and market gardening sectors.
- PADEFA-ENA, PACOFID, Technoserve, for the training of staff on environmental protection, gender, and the rehabilitation of plantations. Thanks to these projects, producers have benefited from training, plantation maintenance services, and subsidies for the purchase of seedlings and plantation rehabilitation.

Projects are easy to finance when they are well written according to the recommendations of the sponsors. However, funding opportunities are more accessible for the cashew nut sector, and climate change.

Today, the extensions organizations would like to develop more collaboration or have partners on projects on climate change, irrigation. Many projects have been developed and submitted in this sense without a favorable response or waiting for a response, or rejected. Because donors feel that they receive a lot of applications to consider, and sometimes the projects are not well packaged. "*CIPCRE has applied for RNEC (National Grouping for Environment and Climate) calls for projects without getting a favorable response*". One of the orientations defined to better find markets or financing after the various failures is the recruitment of specialists in the assembly of projects for specific fields.

4.3.3. Sustainability aspects

4.3.3.1. Perception of the organization's contributions to addressing sustainability and productivity issues

The organizations believe that the population is increasing significantly, and the need to increase productivity is necessary to feed the Beninese people in quantity and quality, and improve the living conditions of the vulnerable. They believe that it is up to research to develop efficient and sustainable technologies (short-cycle varieties, practices, etc.) that are certified and that respect environmental and ecological protection issues. These sustainability actions are embedded in current agricultural policies, and promoted at all levels (research, training and extension).

All organizations show that they integrate sustainability aspects (gender, social, environmental) into project/program planning.

As for the gender aspect, issues concerning the involvement of women, youth or vulnerable people in the projects are taken into account, but fewer actions are carried out in favor of disabled people. But collaborations and trainings are currently being carried out (for example DEDRAS with a German CDM project) to take into account this aspect in the actions.

To promote gender, a gender focal point is often set up under recommendations from the Ministry and projects. *"ATDA has subsidized the purchase of cashew seedlings for the rehabilitation of plantations, and men must have at least 1ha to have access while women must have 0.25ha"*.

"*ATDA, with the support of Angélique Kidjo's NGO, has made pleas to the town halls to help women gain access to land*". Gender is an indicator in many project programs. Very often, projects set a quota of 35% which is necessarily taken into account in the interventions of extension organizations. This has led some extension organizations to define gender promotion in their institutional policy. *"Collaboration with international organizations has led to the definition of an institutional policy on gender promotion in our strategic plan, where we have set the rate at 40% at least, so that 40% of women are covered by our interventions*." The extension organization believes that women apply technology better than men. "*We have given training on the breeding of Goliath chickens, and it is women who have given more results*."

DEDRAS has interested women who did not have access to land to cultivate, in agri-food processing. They are trained in good practices for processing cashew apple and pineapple juice; they are supported in terms of materials (equipment support) and in promoting or accessing the juice market through fairs organized locally or abroad to expand their network of partners and promote export opportunities. They have also facilitated the connection of processors with microfinance institutions to access credit.

"*The pineapple juices that we promote with the women who are in the Zè and Toffo areas, we make them participate in the fairs that we sometimes organize ourselves to promote them, and foster relationships with other actors.*"

"We make them travel to Burkina-Faso and Niger to go and present these products as well, and today they have many partners at the level of these countries where they export their products directly."

Other aspects related to the environment are integrated into the activities carried out in the field, especially with projects to achieve sustainability objectives through the involvement or recruitment of an environmental protection officer. *"Aspects related to biodiversity are currently taken into account in the new strategic plans of organizations."*

Good management practices for soil and water conservation and yield increase have been promoted and monitored within the farms. "*Collaboration has been conducted with the GIZ ProSOL project, for example, to promote integrated fertility management practices (composting; bat droppings, etc.) and soil and water conservation for better productivity*." However, there were difficulties in adopting certain technologies, such as the use of compost by producers with large areas, because it requires sufficient financial and human resources for coverage. Thus, other techniques recommended by research (crop residue) have been promoted to these large producers to facilitate the adoption of the technologies.

The manufacture and use of bio-pesticides based on plant extracts (Neem extracts) instead of insecticides for pest control has been popularized. But the producers felt that manufacturing is a bit cumbersome, so measures have been taken to get some producers to convert only to manufacturing, and others to sell bio-pesticides. There is a national plant protection service that prohibits the use of unregistered chemicals (pesticides, insecticides, etc.). In this way, extension campaigns are carried out at the level of the actors to prove the danger of chemical products, and this gradually raises their awareness.

Other support to increase productivity has been provided through the respect of itineraries without destroying the soil in the lowlands for the adoption of the intensive rice-growing system; the use of seeds of short-cycle varieties such as maize in the fight against climatic risks; the practice of crop rotation. The agricultural calendar is produced and disseminated to help producers master the cultivation and harvesting periods, etc. "*In our interventions, we take measures to resist climate change, whatever the crop*."

Most of the projects support the cashew nut sector, which is a form of promotion of agroforestry that is a source of environmental protection (fight against soil erosion, wind erosion or water erosion), and of additional income for farmers.

In addition, the fight against climate change (drought, abundant rainfall) is part of the ambitions of the extension organizations, as these problems are regularly raised by farmers. The realization of nurseries for rice production and early sowing are means that have been successfully disseminated, for example, to fight against climatic hazards such as the scarcity of rainfall.

Other actions have been carried out for sustainability and concern the promotion of:

- renewable energy through the manufacture and use of energy efficient improved stoves.
- conservation or management of animal resources in forests
- environmental education

The impact of the extension organizations' interventions with the targets facilitates the motivation of other producers to adopt the extended practices. *"Producers who were not in our targets are approaching those who have applied the extended technologies to learn about the process; and this has happened in all villages."*

4.3.3.2. Key stakeholders for achieving greater sustainability

The main stakeholders that should be involved in the process are primarily the researchers who need to develop effective sustainable technologies or strategies that are productive according to the needs of the stakeholder segments and the local context. Sustainability aspects must be integrated in all actions. There are also the trainers who should train the young entrepreneurs who are high school and university students by developing more practical sessions. Extension agents must perform their role of providing agricultural advice by being in constant contact with farmers.

Local authorities (town halls, village councilors, etc.) are called upon to encourage extension activities or the promotion of sustainable strategies or practices. The public extensions have the role of looking for financing, projects to accompany the NGOs to exercise the agricultural advice. The financing of projects must be favored by the PTF, NGOs, agricultural banks (FNDA, etc.).

Actors or their groups (cooperatives or associations) should express their needs and follow the recommendations of the extensions, and advise each other.

4.3.3.3. Major constraints and perspectives in the achievement of the paradigm shift

The major constraints in the achievement of this paradigm shift are related to:

- Rejection or non-adoption of good sustainable practices disseminated by the community, or development of forms of resistance or difficulties in bringing the community together to advance the project around a consensus. Solutions to environmental problems and issues, for example, represent new approaches and new knowledge for the community. Collaboration with local authorities (mayors, village chiefs, etc.) and resource persons, and the implementation of experiments and dissemination campaigns would eventually motivate the community. The definition of roles for actors in the conduct of extension activities would promote technology transfer or behavioral change.
- Low number of staff recruited for coverage or target tracking. More agents will be needed.
- Low financial resources or budget, and lack of materials. It will be necessary to seek funding by submitting projects, and strengthen collaborations with institutions;
- Delayed delivery or access to innovations and resources to adopt behavioral change (e.g., improved seeds, etc.). Research organizations need to promote access to innovation by producing enough. Procurement processes must be accelerated by recruiting more qualified staff.

4.3.4. Staff and Sustainability Aspects

4.3.4.1. Staff profiles and status

The number of technicians employed in the field and their remuneration depend on the number and budget of the projects. The technical specialists and advisors employed usually hold a Bachelor's, Master's, engineering or agricultural technician degree, and are assessed on a regular basis.

The number of supervisory staff recruited in the field is insufficient due to the lack of resources to pay them. "*By commune, we should have about twenty but we have five to ten agents who are found at the level of each commune to address all the concerns of the actors*".

The profiles of people working in extension have changed over the last 5 to 10 years through their participation in capacity building workshops in the country or in foreign countries. Training sessions are also organized internally for capacity building, especially for technical staff. For specific projects, staff benefit from capacity building opportunities *"through the PROSOL project, GIZ trained us on sustainable land management measures and climate change adaptation. So we train our technicians before sending them to the field."*

"Currently we have a project that is scheduled to run for three years, which trains our technical officer on agro-ecological issues on a discontinuous basis, NGO RAIL."

4.3.4.2. Difficulties in getting the right profiles

Difficulties do not arise in finding good profiles for the work, but payment for all these people is a limiting factor due to the problems associated with insufficient financial resources. To overcome this, the State requires that agricultural advisory services are carried out by service providers recruited through calls for tender over a given period.

4.3.4.3. Essential expertise and solutions to meet the organization's mission and sustainability goals

The private extensions organization calls on experts from the public extensions and NARS organization when its staff lacks expertise on some topics. Participants share their knowledge with other staff members. Research is conducted using resources on the internet to better understand certain concepts and to organize training.

Also, staff members are enrolled in specific additional training sessions with firms or training centers when there is a lack of expertise. Others travel to foreign countries for capacity building when resources are available. "*For example, I attended a three-week training course in Senegal on rice, and I passed on the knowledge gained from this training to our organization's technicians*."

"The technicians that we have deployed in the field are taken as agricultural advisors, but also intervene in other fields, thanks to their enrolment in specific complementary short courses. If the resources were available, we would take one technician per sector and per commodity chain, because that is what is recommended."

At the level of organizational extensions, additional skill needs are required especially in:

- Agroecology, organic agriculture;
- the use of ICT in agriculture (to better advice producers on the weather for example);
- At the ATDA level, the need for cassava and soybean specialists is recommended.

To increase the consideration of sustainability aspects in extension, other elements to be touched are related to:

- Needs of means for the organization of workshops to inform and improve the capacities integrating the aspects of sustainability;
- Supporting youth projects;
- Reinforcement of practical sessions at ATVET level
- Capacity building and specialization of facilitators;
- Reduction of interest rates and financing modalities (e.g. possession of a guarantee, etc.) of projects at the level of MFIs and agricultural banks (FNDA);
- Winning projects to support actors in market access, technology adoption, production of quality products, etc.;
- Researchers need to update research in light of the changing local context.
- Resource needs to increase supervisory staff.

4.4. Qualitative Insights from interviews with NARS managers

4.4.1.1. Overall mission

The mission of the research institutions is to support regional and specialized agricultural research centers and other actors in the agricultural sector (producers, breeders, processors, etc.) by providing them with resources, knowledge or the transfer of technological innovations for the promotion of agriculture in Benin.

These innovations are made available to projects, organizations involved in extension (ATDA, NGOs etc.) and end users (producers, breeders, processors, etc.). *"Our work stops with the development of techniques, it is up to ATDA to come and get the technologies to carry out the transfer, NARS."* Each research institution specializes in specific sectors and, by extension, in specific areas (in the case of the CRA). The surface area of the various research centers is not fully exploited given the experimentation of certain technologies that recommend isolation. The maximum funding for public NARS (INRAB CRA) comes from the national budget for activities. The private NARS (IITA, World Vegetable, etc.) comes from donors CGIAR, World Bank, etc.

In the research management cycle, constraints or needs are identified with producers; and development, experimentation, and validation of tests of innovations are conducted at the research stations and sites with the involvement of experimenters (producers, etc.). Subsequently, scientific workshops are organized to present and validate the innovations or research results with other NARS, extension and ATVET organizations, and end-users. Technical sheets or technical-economic reference materials or compendia are developed and made available to extension workers and end-users. *"The feed was produced by a woman using the formulas and itineraries developed in the technical sheets developed by INRAB."*

The innovations that have been successful are related to the sustainable management of land and attacks (diseases, pests):

- Several varieties of maize resistant to diseases and environmental stress developed together with the ITTA;
- production of seeds of soil fertility improving plants *Cajanus Cajan*;
- Early burial of the mucuna legume before the dry season to avoid the destruction of the fields by cattle and cattle herders especially in the North of Benin;
- manufacture of maggot-based feed for poultry;
- feed formulation for fish; tilapia and other fish species.

Knowledge was also generated. This includes the adaptation of the community-based approach to the management of animal diseases; the inoculum plus half-dose fertilizer system to boost yields in Atacora.

One-year programs of internal competitive funds or grants have been piloted at the level of the CRA. These programs have allowed for the inventory and collection of peanut cultivars; the participatory selection of elite shea trees from which seeds are collected to produce shea seedlings; the multiplication of fodder, fodder pellets, and mulch for animal feed.

In addition, the technologies that have not been successful are the production of rice with farmyard manure and improved fonio, due to difficulties in accessing pre-basic seed.

4.4.2. Innovation system

4.4.2.1. Changes in the missions and challenges of the research

The missions have more or less changed over the last 5 to 10 years as a result of the reforms. Today, effort is being made through the establishment of research laboratories, consultation frameworks to improve relations and communication with stakeholders (ATDA, technology users such as producers, breeders, etc., Ministry; DEKAIF, university, etc.).

Taking into account the failures of past interventions, the planning of production or development of innovations is elaborated taking into account the perceptions or demand of ATDAs and end-users (producers, etc.) during sessions or workshops. The different actors of the agricultural world (ATDA, end-users, etc.) are invited for training; scientific days, open days, seminars for proposals for improvement, validation, dissemination or sharing of knowledge on innovations, research results. "*We hold annual seed production planning sessions with producers, seed companies and ATDAs to identify their demand, for example, on varieties resistant to stress*. But it is noted that these workshops are less organized at present due to a lack of financial resources *"For a while now, this activity has not been done regularly due to lack of means."*

The other dissemination channels used are the NARS websites. Most of the events (scientific workshops, major meetings, symposiums) are published on the website. Also, radio and television broadcasts, commercials, and information sharing on WhatsApp are done for high visibility. *"A catalog that presents innovations in agri-food transformation by sector with processes, has been developed with the Agri-food Technology Program (ATP) of INRAB, and has proven successful after dissemination during workshops and on INRAB website."*
CRA in Benin recently participated in the International Agricultural Technology Market to showcase innovations and technologies internationally and to gain knowledge. Researchers believe that there has been more attention in the last five years due to efforts to scale up innovation. *"Currently, what is being sold at a high price is the production of maggot-based feed for poultry because it stimulates egg-laying, the daily weight gain is enormous. The device to produce this food is also available; CRA."*
Nowadays, documents or technical-economic references, etc. are used by banks, producers or entrepreneurs to process loans, since the contents of these documents show that the activity is economically profitable.

The missions also changed over time with the different collaborations carried out, and which integrate aspects related to sustainability (gender, environment, agroecology one Half medicine, etc.) in the activities as challenges. *"The challenges at the level of the CRA North West are numerous, such as the environmental challenges because it is an area with environmental problems (erosion, wind, etc.)*". Another example is that the gender aspect has been respected and integrated in the programs for about ten years, and the evaluation of the projects and programs takes into account this aspect as well as during the training of researchers.

On the other hand, despite the reforms, there is the lack of qualified human resources, and delay in the public procurement processes slowing down the work, which are critical problems, and which affect the research centers. More and more researchers are retiring and there is no replacement of staff. There is delay in recruitments in public organizations. *"The result at the level of the research centers is not achieved because of lack of staff."*

Also, all agricultural research institutions in Benin are under the National Agricultural Research System (NARS) and theoretically are supposed to work together, but the system is not well managed for lack of funding.

A document entitled National Agricultural Research Program (PNRA) with the budgetary support of the World Bank, has been developed for research for all stakeholders and partners, but the major problem for the implementation of this PNRA is the lack of funding or insufficient financial resources to date.

Other difficulties observed in the implementation of the missions are related to:

- reforms that do not include administrative management. The public procurement process (launching of fertilizer purchases, etc.) is long and causes delays in the implementation of activities;
- delay in the provision of financial resources for the implementation of activities;
- delay in the recruitment of human resources;
- lack of research infrastructure (genetic and biotechnology laboratories) and equipment (materials, vehicles, etc.)
- lack of staff, but efforts are made with the few existing ones to more or less meet the objectives;
- difficulties in securing funding;
- lack of seed of certain species/crops for the multiplication and the provision of the seed producers;
- delay in the certification of innovations (improved seeds) by the DPV due to limited financial resources
- capacity to accommodate trainees is low (maximum 10).

The main challenges are related to the improvement of a well-developed research program funded by the government and TFPs, the recruitment of qualified staff, and the construction of infrastructure. Other areas to be improved through research are:

- setting up of equipment and funding to develop hybrid seeds, facilitating the process of certification of innovations in time;
- regular organization of workshops, fairs to inform end-users and extensions of the research products.
- Need for artificial intelligence *"With all these phenomena (diseases, climate change, decreases in yield) today, we really need to have models that will take us towards development and sustainable agriculture."*

4.4.2.2. Perception of the education system and perspectives

Researchers believe that there is a gap between training and the need in the field. They show that students do not have sufficient knowledge of the agricultural systems because of the lack of employment at the end of their training. *"They show that students are less aware of understanding agricultural systems because of the lack of employment at the end of their training*. Also, they do not do enough research to be up to date. "*The learners do not make enough effort; they expect the teacher to provide everything."*

The important aspects that should be integrated in the educational system is entrepreneurial

training according to the needs of the market, to devote a lot of time to practice, and to equip the training centers with modern materials, equip laboratories for practical session purposes. The State has a role to play in technical training. It is necessary to multiply the number of technical centers and to promote these centers. Also, teachers should also strengthen their capacity by taking advantage of workshops. Reforms are being adopted progressively in some public ATVET (the University of Agriculture of Ketou (UNA) for example) where students have to practically defend their dissertation or thesis in order to interest them. "*At the UNA of Ketou, the defenses are no longer done between the four walls of the rooms, the students in animal production defend their thesis in the field in order to motivate them; it was great*."

4.4.2.3. Perception of the extension system and perspectives

With the reform, the extension services are better organized and play an essential role in the agricultural system through technical support provided by the ATDAs, and control of activities by the DDAEP. Whereas in the past, the former ATDA, i.e. the CARDERs, played both roles. In the current system, ATDAs makes resources available to approved private extension providers who in turn ensure the transfer of innovations to producers, via a tendering process.

Research and ATDAs work together to ensure end users have the information and skills they need. There is also a consultation framework which is developed, animated following periodic meetings (once or twice a year), and involves all the actors (ATDA, producers, universities, etc.) for bodies of reflection around a sector.

"*We think in terms of the sector; we do not work on all sectors at the same time. When the management team meets, they focus only on one sector*." But through Focus group sessions, some CRA reveal that farmers are not well informed about the innovations developed, "*We had a working session with ATDA agents who underlined that the information is not properly passed on, so users are not well informed."*

Researchers believe that few studies have been done on the adoption rate of the technologies that have been developed, as the results are less published. Thus, statistics are not really available. "*An inventory of developed technologies is available and few adoption studies have been conducted. As long as there are not enough studies published in journals, it is difficult to make a statement about the statistics."* The adoption of technologies, especially those related to local agricultural equipment, is constrained by high costs. Mass production would reduce costs and facilitate adoption. "*There is this problem where mass production is low, causing equipment to be expensive for end users. But as far as seeds are concerned, the adoption rate is high because it is not expensive at all*."

4.4.2.4. Partner network or collaboration and observed changes in collaboration

Collaborations are made by researchers with all components of NARS and ATVET, extensions and producers. Precisely, they are carried out with:

- Private and public research institutions (INRAB, World vegetables, IITA, etc.) for knowledge sharing, technical and financial support, drafting, submission and implementation of projects, etc. INRAB coordinates the national agricultural research system in Benin "*We collaborate with all the components of NARS."*
- grassroots actors (producers, seed growers, processors, breeders, etc.) to evaluate their needs, experiment with technologies, transfer technology by training them and inviting them to workshops with the support of extension workers (ATDA, NGOs, etc.).

- Close collaboration with extensions (DDAEP, DECAIF, ATDA, NGOs, etc.) for the provision of innovations through technical sheets or collection of technologies; validation of innovations; training on the innovations developed; exchange sessions. "*We are forging relationships with ATDA and they are invited to participate in scientific days for the dissemination or sharing of knowledge on innovations or research results*. Relationships are increasingly improved as a result of the consultation framework developed with the new reforms. "*Research and ATDAs work together so that users can have the necessary information.*"

- CGIAR organizations such as AfricaRice, IITA for financing the production of improved maize and rice varieties with other countries such as Mali, Nigeria and Niger; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for millet and sorghum varieties;

- ATVETs (universities, high schools, etc.) to teach courses, support the validation of thesis defenses and the professional integration of students through internships, recruitments, and academic or research grants. The constraints observed are that researchers have less time to teach courses. Researchers in the CRA laboratories work with those in the universities or use the laboratories for research purposes;

- NGOs that intervene in extension to train technical staff in relation to certain technology;

- The Centre National de Specialisation Sur Les Fruits et Legumes (CNSL) of Burkina to train young entrepreneurs;

- TFPs: TFPs do not fund NARS Public Research Activities (CRA). Rather, the TFPs have objectives to achieve in their various programs, and agreements are signed with them for particular activities, and reports are prepared. For example*, "they ask us to produce a given quantity of improved seeds that they will make available to producers, CRA*." The country must be able to finance its research, determine its priorities, and the donors must be involved.

- the GIZ PROSOL project in the development and promotion of SLM; ACMA in the development of fertilizer formulas for maize production;

- UNFPA AND IRC for the implementation of One Health environment approach at the ARC levels. It focuses on the importance of a better collaboration between the medical world (human medicine) and the veterinary world. This collaboration is necessary to better understand, detect, monitor and control emerging infectious diseases. *"There is an ongoing project in collaboration with the IRC on soil health, animal health, human health. A pre-diagnosis has already been made."*

4.4.3. Sustainability Aspects

4.4.3.1. Perception of the organization's contribution to addressing sustainability and productivity issues

Institutions have realized that a major paradigm shift is needed to achieve greater sustainability. The contribution of NARS to sustainable agriculture is the development of efficient technologies that improve productivity, respect environmental conservation standards, and resist climate change. Many efforts are being made in this direction through the development and promotion of SLM (based on legumes, biochar, early burial of mucuna and crop residues, combination of organic fertilizers etc.) with the GIZ PROSOL project; varieties that are tolerant to environmental stresses, water stress, climate sensitivity, good yield and disease resistance (pests, etc.), etc.

In addition, organic agriculture is a little less valued in Benin due to the uncontrolled use of fertilizers, herbicides and pesticides. However, many actions are being taken to progressively eradicate the use of chemicals for the sustainability and health of consumers, and the demand for organic products (organic soybeans, corn) exists especially at the international level.

Another aspect that is linked to the consideration of gender in the development and execution of protocols, the organization of training, recruitment, etc. has been effective for 10 years. "*INRAB has a gender manual document, which clearly tells us how to integrate gender in our research activities*."

"The number of women recruited is difficult to find, but we find them and we proceed. In fact, two women out of eight people are directors of research centers in Benin." Gender has become an inescapable aspect in the execution of project activities. "*In the INRAB protocol projects, it is requested that the gender aspect be respected*." In the development of innovations, the preferences or needs of women are taken into account, for example. Indeed, all the researchers reveal that the technologies developed are segregated according to women and men in the different zones. "*Women's needs have been taken into account in the development of improved maize varieties. Thus, varieties which are easy to grind, tender, nutritious and rich in pro-vitamins have been developed and successfully disseminated among women*."

The One Half approach to human and animal medicine and the environment is being developed at the level of the CRA in collaboration with UNFPA and the IRC. It focuses on the importance of better collaboration between the medical world (human medicine) and veterinary medicine. This collaboration is necessary to better understand, detect, monitor and control emerging infectious diseases.

Another aspect is related to the use of digital tools. ICT is gradually becoming part of the researchers' habits. *"The technicians on the RD sites have tablets to collect data using the KoboCollect application."*

4.4.3.2. Key stakeholders for achieving greater sustainability

The stakeholders that should be involved for a major paradigm shift needed to achieve greater sustainability in the process are:

- End users who express their needs, participate in experiments, adopt sustainable technologies, and share information with their peers;
- Extension (ATDA, NGOs, etc.) to promote better technology dissemination;
- the State, TFPs, NGOs, investors for the financing of training, research projects, dissemination, entrepreneurs;
- universities to motivate and train students in the development or improvement of agricultural innovations,

4.4.3.3. Major constraints and perspectives envisaged in the realization of the paradigm shift

The major constraints to the realization of paradigm shifts could be due to insufficient funding, equipment and infrastructure (laboratory, etc.), inadequate staff, training in universities that is not in line with the realities of the field, and non-compliance with the sustainability aspect (gender, environment, etc.).

The most important thing is to take the long view by prospecting effectively, and looking for ways to achieve effective results. To help make this change happen, you will need to:

- work all the time with the producers and take into account their needs for research and development;
- Apply constantly to calls for projects in order to win funding;
- produce technologies in harmony with the environment. This is the mission of NARS, and to achieve the objectives, regular project funding is needed from the State, from TFPs and NGOs. Some researchers believe that research in Benin must stop depending on external funding. They believe that foreign donors will impose what must be done as research after having provided funding.

You will also need to:

- multiply and create large laboratories, and equip research centers;
- encourage the processing and consumption of local agricultural products from sustainable agriculture;
- thoroughly use documents that promote gender in order to favor the economy. In this respect, women who integrate the research functions must think that they have the same status as men;
- use ICT in different areas (use of drones, application design, etc.);
- It will also be necessary to include more and more the one Half medicine approach, and the concept of ecology in the research activities.

4.4.4. Staff and Sustainability Aspects

4.4.4.1. Staff profiles and status

The members of staff recruited are researchers with a doctorate degree; research assistants and attachés with a master's or doctorate degree or a license according to particular specialties (nutrition, plant production, animal and animal health, economist, sociologist, rural development); technicians with A-Level diploma and bachelor's degree. Occasional field agents are recruited for field data collection. Consultants or experts with a master's degree or PhD are recruited periodically for studies or for specific assignments or expertise, due to lack of human resources.

The profile of NARS staff has changed due to participation in internal and external training workshops, scientific workshops, and publication of research results in impact factor journals. Some have enrolled in master's and PhD programs, but reforms are underway to provide scholarships and research grants to staff. "*There are reforms in progress where it is planned to reimburse all employees who have paid for their training with their own money*." Opportunities are offered to complete the bachelors, masters and doctorate degrees through protocols or projects.

4.4.4.2. Constraints and essential expertise, solutions to meet the organization's mission according to sustainability objectives

The problem of lack of staff is important at the level of research laboratories. It was noted that there is a lack of human resources for specialties (nutrition, seed or breeding, especially for yams and cassava). "*There is a need for more staff at the research level, at least 500 researchers. These problems are linked to insufficient financial resources, delays in recruiting staff",* and the impossibility for public CRA to recruit staff due to their dependence on INRAB.

Sometimes there is a mismatch between the training and the profiles sought in the field, i.e. researchers with experience in methodological research, artificial intelligence, physio-technicians, breeders, and researchers with doctoral rank. There is a great need to retrain researchers in these fields.

Also, the existing staff needs urgent training. Those who have a bachelor's degree need to be trained for a master's degree. The same goes for those with master's degree to complete the Ph.D degree.

4.5. Qualitative insights from interviews with ATVET managers

4.5.1. Overall mission

The overall mission of ATVET is to train learners to be professional, with capability to conduct scientific research, bring about improvement, and innovate in specific agricultural areas to solve problems in communities. Students are trained in training centers such as agricultural high schools, universities and, public and private vocational training centers in different fields. Also, these centers are positioned as a response to the challenges that the world is currently facing, namely, the challenge of poverty, climate, and preservation of the environment, food security, and problem of precarious employment of youth. Opportunities for partial or full scholarships at the level of local private and public training centers (universities, high schools, etc.) are granted to students to encourage and motivate them.

University and high school students are supported in executing research topics through laboratory, real-world or farm/field experiments with the involvement of farmers, to develop innovations.

Collaborative opportunities are being discussed with extension institutions for certification and dissemination of student-generated technologies.

The best technologies developed by ATVETs are:

- sustainable soil fertilization technology based on ecological and sustainable methods, composts devoid of synthetic products with the support of the project - ecologically sustainable cassava and cowpea plant protection;
- biological control (against bio-aggressors, diseases, etc.) for phytosanitary protection with plant extracts;
- cloning of flowers.

4.5.2. Innovation System

4.5.2.1 Changes in missions and challenges of the educational system

The ATVET believe that there has not been a great change in the missions, but the number of students increases every year and some of them manage to be engaged/employed. *"We can say that our objectives have been reached, but we expect more than that."* The system has evolved, especially at the level of universities and vocational training centers, as the means and methods of teaching or curricula have been improved, taking into account the changes or current challenges and projections in the agricultural world. *"The challenges for which the curricula were written 15 years ago are not necessarily the same as those of today - University".*

The little change observed is linked to the support provided by certain projects that have strengthened the training curricula of certain universities (e.g., Dutch cooperation through the NICHE project with the UNA of Ketou) based on market needs. They recommended 70% practical training and 30% theoretical training, to make the trained students professional. This curriculum is dynamic, and the annual planning changes and is validated by the scientific and pedagogical council to adapt to the market needs. These achievements have been supported by the government, and are applied today to make the university students enterprising at the end of their training, taking job market into account. Thus, the universities have the free hand to modify these curricula, unlike the Agricultural High Schools that do not have this autonomy or freedom to make changes. However, the teachers of these high schools admitted that the curricula needed to be updated in order to respond to current and future issues. We can talk about institutional difficulties in the technical high schools. *"Today, there is a mismatch between the training offered by the high schools and the market needs. Because the level of employability of our learners is low, because the training is not updated,- Technical high school."*

"*Before 2014, we were developing curricula, we weren't thinking about students' entrepreneurial profile after their training, but now those are things we consider - University."*

"Today, students carry out short internships or research each semester within the university or outside with active professionals (farmers, research institutions, NGOs, etc.)"

"Trained students can set up or undertake new things, taking into account today's world where we have new technologies that allow us to do agriculture differently."

"With my 13 years in this training center, I think I have almost 40% of professional engagement/ employment of students at the end of the training. Some are now doing their Master's degree in France, some are working, and others already have their farm. Of course, there are some others who are still seeking their way, but the situation is changing anyway."

In the vocational training centers, the same actions involving more practical sessions in order to make students enterprising is done. *"At Songhai, the training is 80% practical".*

In addition, ATVET have good collaboration with institutions to promote the integration of students.

Also, the integration of renewable energies and ICT is an element that has revitalized the educational system at the level of students and teachers, by facilitating communication, transactions, research on the internet, the creation of applications to solve a given problem, "*We have created applications like* TUNAMI*,* NOURU *that identify diseases that we try to use from time to time*. Information (innovation, tips, etc.) is shared by students on websites (university, or other, etc.) for knowledge sharing on particular topics. They also write articles on innovations and research results published in scientific journals. Statistical software is also used for data collection and analysis.

The integration of gender, environment and poverty dimensions in the programs, taking into account globalization, climate change, environmental protection, food security etc., represent the different changes made in the missions.

In addition, the lack of financial resources is a limiting factor for investment in improving the working environment by equipping the ATVETs with laboratories, equipment (means of transport to take students to the practice sites, modern materials, kits for identifying plant and animal diseases etc.), facilities etc., to facilitate the practical sessions for students. "*We do not have a functioning irrigation system for the practical sessions for students*.

"Professional training involves a lot of practical sessions. We need to put a lot of resources into equipping the training centers to facilitate practicals."

"We are in dire need of equipment".

This difficulty linked to the lack of financial resources also limits the payment of temporary teachers, funding educational outings, teaching or practical training although the State subsidizes and the students pay the tuition. The alternative developed to strengthen the financial capacity is the writing and submission of projects (to Bill Gates, RUFORUM etc.), and the strengthening of collaborations. Some projects are accepted, and others rejected for competitive reasons.

Other difficulties encountered in the system must be reviewed so that the training received by the learners is in line with the realities. The other difficulties encountered are:

- The geographical location of the universities limits the enrolment of students in training programs. "*It is noted that given the achievements of our university, many people wish to be trained at our level. However, the distance that separates the University of Kétou for example from the big cities constitutes a handicap for them. They are thus obliged to stay in the universities located at the periphery of the big cities. However, the different sensitizations that the school has carried out, as well as the opportunities of scholarships encourage them to come to our University*."

- lack of qualified staff. The training centers do not have sufficient human resources to succeed in their mission. The mobility of teachers from one university to another allows to fill this gap "*Thus, teachers from the UAC, the University of Parakou, researchers from INRAB and professionals who come to support those of the National University of Agriculture*." The government is making efforts to recruit the necessary staff, "*the State makes the effort to recruit each year, but the number of staff is insufficient*."

- Some funding obtained does not cover both research and development of innovations. They only cover research and it is difficult to get funding for the development of the innovation. "*The funding is initiated for a given research, and there is no continuum until the technology matures*."

- revitalization of partnerships

All ATVETs believe that they can adapt to future challenges, as their mission is to provide well-trained professionals equipped to meet future challenges. These challenges can be addressed by updating teaching methods and tools or curricula, and infrastructure. However, there will be a need for material support.

4.5.2.2. Perception of the research system and perspectives

The new agricultural policy has made it possible to have ADH and extension, research and development is oriented towards the needs of vulnerable stakeholders in sectors prioritized by each ADH. The actors surveyed believe that the research system is evolving considerably in Benin and takes into account the social realities and climatic conditions of each environment.

At the end of each year, research is conducted by researchers at research centers, so that students would defend their write-ups resulting from those research work. Also, collaborations are carried out between the ATVETs and the research centers for the execution of protocols or given research. This is the case of the partnership between the University of Parakou and the N'dali Agricultural High School on local innovations (cabbage pests; production of cabbage) and the participatory development of innovation. Also, ICT is more valued by the teacher-researchers and students for research and innovation development purposes.

However, the application or valorization of research results or innovations remains limited, as they are rarely disseminated to the general public, and few scientific articles are produced and published in scientific journals. But the problem of insufficient financial resources, material and equipment is common to all institutions. This limits the conduct of research activities, nevertheless efforts are made with the limited means available.

4.5.2.3. Perception of the dissemination system and perspectives

Dissemination services play an essential role in the agricultural system. They are carried out by private providers approved with the reforms, and the rate of adoption of technologies, especially those that integrate sustainable aspects, has increased. Today, the extension services are closer to the producers and performs their services well, and the sharing of experiences among producers in the communities has increased, with the investments deployed by the State to improve the system.

Nevertheless, lack of financial resources is a weakness for successful extension in Benin. It is important that this problem is mitigated so that the results of research are well publicized and applied by the end users. This led students to create websites and web TV to share the activities of the school, as well as the results of researches conducted. This is the case of the site PLUME VERTE developed by the students of UNA.

4.5.2.4. Partner networks or collaboration and observed changes in collaboration

Among the institutions with which the agricultural training centers collaborate, we can mention the collaboration with:

- Research (INRAB) to experiment and develop technologies related to agroecological and organic agriculture with students and researchers from the university;
- Research (INRAB) and extension organizations (ATDA, DDAEP, etc.) for the validation of protocols; interventions (training, research, extension, monitoring etc.), knowledge sharing, evaluation of students, student internships, and the job market. "*With ATDAs, collaboration consists of regular sharing of experiences, problems encountered and solutions in the conduct of different activities. The ATDA often has periods of exchange to ask us for the results of our various researches, especially at the level of fruit production and production plans. They also ask us to train producers at the grassroots level.*"
- Government for funding and policy development;
- Universities with the Dutch NICHE Ben Project for institutional and academic strengthening

- Virtual Machine System (VMS) for Gender Training
- Collaboration between ATVET (public and private universities, high schools etc.) for the drafting of projects, the organization of conferences, workshops, knowledge sharing.
- pilot producers to train them on modules;
- the World Bank, the FAO for the financing of projects (on fruit flies, the armyworm with Public ATVET)
- CGIAR institutions such as IITA, AfricaRice for research development innovation in laboratories, project writing, employment/engagement/internship and postgraduate scholarship opportunities for students. "*The IITA laboratories help us provide practical and technical content* - CORAF"
- RUFORUM in Uganda "UNA *is in the process of moving towards funding with RUFORUM* "
- ATVET with FARA for scientific conferences,
- Collaboration of private ATVET with PUM, SACO which brings together experts to provide courses to students;
- Public ATVET with the Brazilian Alliance of Cooperation, Japanese Partner of Yamagata University for the development of a project;
- Public ATVET for laboratory construction
- GIZ on African Business Facility (ABF). These different collaborations consist of capacity building, extensions.
- PADMAR, PROCAR.

The missions with partners or institutions have changed over time due to the phenomena of globalization, environment, gender mainstreaming etc.

4.5.3. Sustainability aspects

4.5.3.1. Perception of the organization's contribution to addressing sustainability and productivity issues

The notion of sustainability is a complex one, nevertheless it is taken into account at the level of training curricula.

With regard to the environmental sustainability dimensions, the ATVETs believe that production without synthetic products has limited yields. However, in the current context, the size of production is increasing and it will be necessary to implement technologies that facilitate increased productivity while integrating sustainability aspects to safeguard the environment. Sustainable agriculture allows the use of synthetic chemicals to a certain extent, but at a limited rate. "*Sustainable agriculture, as defined earlier, it is the use of minimum amount of synthetic chemicals, which minimizes the harm done to the environment, and the residues released*."

This is why the training centers include compost making, soilless production, organic farming, and agroecology in their training modules. Also, the themes developed by the students during their research for the practical work and the writing of their thesis take the aspects of agroecology, gender, economy, renewable energy, etc. into account. The different themes deal with technologies like soilless production, GDT by combining elements to compose formulas (compost, etc.); the

use of plant extracts (neem, papaya, hyptis, jatropha) to protect crops. An experimentation of agroecological methods with the combination of plants such as cowpea, pigeon pea, jatropha in the fight against army worm has been carried out through the project with FAO.

Teachers also reported having been involved in many projects integrating agroecology "*We are in many projects now where we talk about agroecology. Even yesterday, we submitted a project related to agroecology*.

"*SONGHAI private agricultural training center trains students on integrated and diversified agricultural production, development of innovations and marketing of products that align with ecological visions*."

Sustainability in agriculture means being able to control energy as well. Energy saving or the promotion of renewable energy (biogas manufacturing, solar equipment, etc.) is also integrated in the training of the students.

With regard to the social dimensions of sustainability, gender and marginalized people are taken into account at all levels (strategic plan, project, recruitment etc.). "*Before, there was one woman out of eight male teachers, and I was the only woman. But now there are about ten women*". People with disabilities are well accepted in the training centers, but they are in a small proportion and benefit from the support. "*When we say gender, it is not only women, it is not only disabled. It is a set of things. So, compared to the disabled, we receive very little and they are accepted*. The same is true for women who become pregnant during their training; they are motivated to continue their training. "*For example, there are rooms available for the care of children of women who are breastfeeding or who have children in the University of Kétou*."

"*The school has made a lot of progress on gender. The toilets that are built are gender sensitive. There are girls' toilets and men's toilets. There is positive discrimination nowadays even in favor of girls. We fight against gender-based violence through sensitization within the school, both for teachers and learners. The watchword here is zero pregnancy in schools. This contributes to the reduction of school dropout rate in the establishment. Mixed soccer tournaments are also organized in this sense*.

"The private training center, ATVET Songhai accepts the application of out-of-school youth from family farming environments."

In order to ensure that these aspects of sustainability are taken into account, the State, through its institutions and private partners, must subsidize and equip training centers with financial, human (a sufficient number of competent teachers), materials (modern equipment, laboratories etc.) and technical resources (opportunities for capacity building of teachers). All these actions deserve to be encouraged so that the professionals on the market are better trained to face the challenges of agricultural production. Above all, equipping of the centers would motivate students to be interested in training. "*The agricultural training center is to be able to provide reliable answers to the questions of producers, and this requires the availability of a quality laboratories that meet international standards. Equipping the centers would motivate many young people to entrepreneurship*."

4.5.3.2. Key stakeholders for achieving greater sustainability

Key stakeholders who should be involved in the process are:

- Agricultural stakeholders expressing their needs and willing to adopt technologies;
- NARS who are responsible for developing the technologies and making them available to Extension and end users;

- ATVET who are to train future entrepreneurs;
- NGOs and PTFs for technical, financial and social support etc.

4.5.4. Staff and Sustainability Aspects

4.5.4.1. Staff profiles and status

The profiles of people working with ATVETs has changed over the last 5-10 years, as they have benefited from opportunities to do PhDs, and participate in conferences.

4.5.4.2. Constraints and essential expertise, solutions to meet the organization's mission according to sustainability objectives

There are no difficulties in finding qualified persons for the work, but it is the payment of all these people that is a limiting factor given the problems related to the lack of financial resources. However, in almost all the agricultural training centers, there is a lack of expertise that required to achieve the missions and the set objectives. Thus, the training centers (UNA for example) call upon other teachers (from the UAC, the University of Parakou, research centers and professionals) with expertise to support the students on the themes.

The need for teaching staff is desired especially in the areas of genetics, crop protection, and soil management. Capacity building is also desired in the areas of:

- artificial intelligence
- use of drones for diagnosis
- new ways to fight against bio-aggressors, insects and diseases
- new technologies and tools for use in agriculture
- water control, planning
- virus management (identification of specific resistant actions against a given pathogen)
- Horticulture and landscaping
- the production of vegetable seeds

5. Discussion and policy recommendations

Most staff members are men, but there is a high proportion of women involved in decision-making positions, especially at the extension organization levels. According to Belli (2019), taking women's decision-making power into account facilitates the equity and relevance of actions. Most of the staff are from a rural area and have studied in Benin, but those who studied the most outside the country are in NARS and ATVET. Learning and teaching outside accords one the opportunity to learn in a different way. Ayotte-Beaudet (2021) posited that it promotes cognitive, social and physical development.

The NARS and the ATVETs are composed mainly of staff members who possess PhD and master's degree, compared to those of the extension organizations who generally possess bachelor's, master's, and vocational school certificates in different fields.

These staff members of the AREE institutions are mainly agronomists, and work essentially with their counterparts with expertise in social sciences / economics, public health / educational studies, environmental sciences / biology, engineering / processing / conservation of agri-food products, livestock / veterinary medicine/science. They have received additional training, especially on digital tools, agronomic, environmental, economic and social aspects. Their motivation for joining the different organization is to bring about changes especially for the improvement of food security, and reduction of the persistently growing poverty of the population, through increased agricultural productivity in a sustainable manner (PNRA, 2017).

Actions aimed at sustainability are rooted in current agricultural policies, and promoted at all levels, encouraging the gradual change in research, training and extension system. But some agents revealed that operators are not well informed of the innovations developed, considering the fact that results of researches and innovations are not well disseminated. And, the lack of financial and material resources at the level of the AREE institutions also poses challenges. This report is similar to those of Mama *et al*. (2014) and Sambieni (2018) who submitted that scientific research in Benin was very weak due to lack of funding and publication, and the few results produced were under exploited.

Nevertheless, the aspects of sustainability are taken into account at the levels of all organizations, such as adaptation to climate change, biodiversity conservation and soil fertility, gender, digital, access to financial services and to the market considering the main challenges in agriculture. The integration of ICT, for example, has prompted all staff members to use digital tools such as phones/ smartphones, computers, tablets in their daily activities for communication (on innovations, farmers' concerns, etc.), social media interactions, teaching, banking, research information on agricultural techniques, and leisure. These results are consistent with those of Gouroubera and Moumouni (2020) and SNEAB (2020).

As a result of advancements of ICT, drones are used today to detect diseases. But the problem rate of adoption of ICT is linked to the limited number of farmers or processors etc. who have cell phones, access to the GSM network, and the internet. This also represents a big challenge for the extension system, which could be solved by strengthening literacy.

As for the gender aspect, the involvement of women, young people or vulnerable people in the projects are taken into account, but fewer actions are carried out in favor of disabled people. This result is consistent with that of Belli (2019) which showed that vulnerable groups or actors with specific needs, particularly people with disabilities, are largely marginalized. This has to be addressed, and capacity building is strongly desired by all the AREEs in its implementation.

The economic, environmental and social aspects of sustainability represent, in order of priority, the aspects that are important for NARS and ATVET. But the aspect concerning the environmental sustainability is more decisive for the extension organizations, because this aspect has a significant impact in the fight against climate crisis.

In order to achieve this objective, the collaborations of public extension outfits with those of the private sector, approved as private service providers be prioritized to provide agricultural service/

advice.
The NARS and public private extension organizations collaborate permanently on research development and the transfer of innovations. With the new reforms, they now interact more closely with farmers and their organizations for the purposes of participatory research, transfer of technologies and skills. As a result, the number of growers mentored by extension agents has increased.
The NARS and the extension organizations now meet frequently (between 5 to 10 times a month during the last 12 months) with all the stakeholders (NGOs, CGIAR centers, other international research organizations, education institutions, actors of the value chain). They also collaborate with microfinance institutions and banks to promote access to finance for operators.
On the other hand, the ATVETs meet a few times with stakeholders outside the education institutions with which whom they collaborate. They collaborate with institutions to promote practical or professional internships for students, and on writing proposals and financing of projects.
All the AREEs believe that they can adapt the general mission of their organization with regard to major changes by updating and responding to the needs of the actors, by popularizing sustainable solutions adapted to local contexts and those recommended by research.
Currently, NARS attach great importance to water management, biodiversity-friendly agriculture, climate change, land degradation and gender. In addition to these, the ATVETs add marketing and microfinance. Those of the extension organizations in addition to the above, attach great importance to livestock productivity, animal health, gender and marginalized groups and/or the poorest.
Furthermore, the profiles of people working in extension organizations have changed over the last 5 to 10 years through their participation in capacity building workshops internally, at the national level or in foreign countries. These results are similar to those of PNRA (2017) and Mama *et al*. (2014).
Work environment is deemed to be satisfactory in terms of the recruitment process, promotion and collaboration with supervisors by members of staff. While extension and NARS organization's staff acknowledge prompt salary payment, they consider their salary conditions unsatisfactory.
This finding is consistent with that of Allagbe and Stads (2014).
Staff reported the fact that their job description and set targets are known, however, many are dissatisfied with the general support system, this applies particularly to NARS and extension personnel as they lack resources, and inputs required are not regular and prompt, and the fact that personnel transportation arrangement is poor.

Also, it is not difficult to get qualified personnel to fill available positions, but funding for their salaries and allowances is the limiting factor. This is also consistent with findings of Allagbe and Stads (2014).

At the ATVET level, most students are in their final year of training, and a high proportion of women are enrolled in the ATVETs. This result is consistent with that of UNICEF (2021) which showed that the enrollment rate for women has increased in recent years.

The most important motivation of the students is to secure a job, and to acquire knowledge to bring about change in farming. After graduation, they desire to be agro-entrepreneurs, work in the private, public, or third-sector extension service, and agricultural research Institutes, so as to contribute to increased productivity, poverty reduction, improved food security, and to foster women's empowerment. In their opinion, the main challenges of farming are linked in hierarchical order to extension service issues, changing climatic patterns, low productivity and soil fertility, pests and diseases and water issues.

The students also indicated that the national budget should prioritized and fund their training,

with adequate attention given to economic, environmental and social sustainability.

Students are convinced of the relevance, appropriateness and the alignment of their chosen courses to their aspirations. They are satisfied that the objectives of the courses were clearly defined; and that participation and interaction were encouraged; topics covered were relevant. The course contents were organized and easy to follow, and the course experience considered useful The trainers were knowledgeable about the course topics, and responses offered by teachers to students' enquiries were considered good. The trainers were well prepared, and the course objectives were met.

A considerable proportion felt that the lecture rooms and facilities were not adequate and comfortable, and the time allotted for practicals were inadequate. These reports are consistent with those of Kirui and Kozicka (2018) and PNRA (2017). Nevertheless, some feel that the courses offered them opportunity to visit farms and or/interact with farmers, and also built capacity in digital tools in them.

Crop yields and field productivity, efficiency of input, efficient and safe handling of agro-chemicals are sufficiently addressed in the training program. The same goes for reduction of land degradation through practices aimed at conserving or enhancing soil health and rehabilitating degraded soils; improvement of agricultural water management; integration of climate change issues, and biodiversity-friendly measures in the agricultural landscape. The courses took cognizance of gender and youth issues while promoting and/or designing agricultural activities. The courses also exposed students to the use of digital tools for research, writing of seminar papers or other activities relevant for the course completion. Also, marketing, pricing, standardization (of quality), value creation, and cost-saving techniques, microfinance opportunities (saving and credit options), increasing livestock productivity were also taught to some extent. Animal health, livestock improvement; improving nutrition, integrating marginalized groups and/or the poorest integration in agricultural activities and/or practices were inadequately addressed by the courses.

The students listed extension service, water, digital tool, low soil fertility and productivity, and education issues, in order of priority that the courses should entail to adequately address the country's challenges.

Lack of access to, the internet, computers, modern materials for practical lessons, relevant literature, and inadequate practical exposures were listed as the challenges of their training programmes for the different courses. These points were also observed by Rolland (2016), and Kirui and Kozicka (2018) as challenges which needed to be overcome to strengthen agricultural training system in Benin, and Africa.

Policy recommendations

The research-training-extension system is evolving gradually as a result of the reorientation or significant changes at the level of the administration, the organization of the interventions of the AREE based on factors responsible for previous failures, the needs of the actors, and the evolution of the changing context.

However, the lack of funding at NARS and certification centers (DPV, etc.), ATVETs and extension organizations is a factor limiting investment and the paradigm shift desired for sustainable agriculture despite the efforts of the State (PNRA, 2017; Mama *et al.*, 2014; SNEAB 2020). Mobilization of more intensive state support for agricultural research and development (R&D), the harmonization of development aid contributions with national priorities, the promotion of regional cooperation and the private sector are all required to achieve positive change. It is also important to design appropriate institutional arrangements, aimed at encouraging the internal

mobilization of financial resources, as a basis for mobilizing external support. Mobilization of long-term funding can be done through regular subscription to calls for program/projects on sustainability agriculture. Opportunities exist for the financing of the cashew sector, for example, which is a form of promotion of agroforestry, a form of protection of the environment; which also addresses climate change issues. Some researchers believe that research in Benin must stop depending on external funding. This perception is consistent with affirmation of Sambieni (2018) which showed that institutions in Benin do not always operate in logic of research funding autonomy regarding their dependence on the agendas and ideas of partners of foreign countries. The contribution of the NARS through the implementation of the PNRA will ensure economic development, well-being, social prestige of the populations and their resilience to climate variability and change.

The challenge at the NARS level is the requirement to engage other actors in the process of developing sustainable innovations (SLM technologies; high-yielding varieties tolerant to stress, disease, etc.) that fit with the realities These factors will allow inventiveness and scientific creativity in all fields. This would require strengthening the institutionalization of the IAR4D approach of innovation systems.

The timely recruitment of sufficient qualified human resources; and the multiplication of equipped infrastructure (genetic and biotechnology laboratories, libraries, etc.), and the provision of equipment (materials, vehicles etc.) are necessary at the NARS and ATVET levels to to achieve the objectives of sustainability. Opportunities for strengthening the academics, increasing the participation rate of NARS and ATVET staff in regional development programs (training and scientific workshops, etc.), publication of research results in scientific journals are recommended to improve staff profiles. The country should also initiate policies and programs that promote the retention of a limited pool of qualified personnel, rather than precipitating brain drain from the country. However, retraining is desired to facilitate the match between the training and the quality of personnel required to improve the capacity of the NARS staff in the field of artificial intelligence/ICT, methodological research, integration of the One half medicine and ecological approach, nutrition, technical physio, breeders or seed company.

The public procurement process should be improved to facilitate the provision of the necessary resources to facilitate the process of development, timely certification, and dissemination of innovations.

NARS researchers, ATVET teachers, students are encouraged to make information about innovations / research results in physical and digital format, more accessible to the public (extension, end users, etc.). This should be done through increased publications via the different channels (scientific journals, websites, scientific workshops and fairs or spaces for scientific exchanges). The journals in the dissemination channels would also facilitate knowledge of the statistics concerning the use of innovations.

Also, gender issue must be thoroughly taken into consideration at all levels (recruitment, development of technologies, construction of infrastructure).

At the ATVET levels, the means and methods of teaching or the curricula must be dynamic such that the training received by the learners is in line with realities or current challenges and projections, by developing more practical sessions. Training must be much more oriented towards entrepreneurship to encourage young people to be self-employed/reliant after their training in order to reduce the unemployment rate.
Also, taking renewable energy, ICT, gender, the environment into account in the training modules, and in the themes developed by the students during their research writing and practicals would strengthen the education system. To facilitate the practical sessions, financial support needs

are crucial in improving the working environment by equipping the ATVETs with laboratories, equipment (means of transporting students to the fields, modern equipment, kit to identify plant and animal diseases etc.), infrastructure developments (irrigation, etc.).
In order to increase the financial autonomy of the ATVETs, there is the need to revitalize partnerships and draft project proposals to attract funding. Capacity building needs of teachers is desired in the field of artificial intelligence; the use of drones for carrying out diagnostics; new methods of combating bio-aggressors and insect diseases; new technologies and tools that can be used in agriculture; water control; in development; virus management (identification of specific resistant actions against a given pathogen); horticulture and landscaping; the production of vegetable seeds.
The close collaboration of ATVETs with the private and public sectors would eventually allow them through partnerships to interact with the public where their services are demanded, to set up tailor-made training, and make trainees employable/self reliant. Rolland (2016) suggested that this is a condition for the relevance of training and the sustainability of the system.
The multiplication and promotion of ATVET technical training centers is becoming a necessity for the State to promote access to training. The increase and sharing of academic and research scholarship opportunities for students constitute incentives to motivate them. It is also necessary to give them logistical support, including exposure to English language (a universal language of communication) training, for greater access to scientific outputs. This view is consistent with that of Sambieni (2018).

For the extension organisations, awareness campaigns must be carried out to urge private extension agencies that are not approved to seek approval, in order to access project opportunities or service provision contracts with the state. This would allow the government to better control agricultural advisory activities in Benin.
The public extension agencies have the role of seeking funding, projects to support NGOs to carry out agricultural advisory services. Timely provision of resources to the private sector would allow them to respect the planning, and the number of farms to be covered by each technician according to the standards of the national statistics of agricultural councils. DDEAP must step up supervision operations.
The use of national languages as the main (even unique) language for training and support for grassroots agricultural and rural actors, the availability of training materials and technical sheets, video spots in the national language would promote the smooth running of agricultural advice. SNFAR (2014) submitted that the use of national languages cannot therefore be done by ignoring the opportunities offered by ICT. Roles can be assigned to certain Pro leader actors and local authorities to facilitate the popularization of sustainable practices in their communities.
A system can be put in place where producers interact and exchange ideas, especially regarding the respect for the principles of sustainability and agroecology.
Also, the actors can contribute towards the material/financial plan, the acquisition of certain technologies or installations to motivate their adoption.
The extension agencies must collaborate more closely with NARS and ATVET to be aware of new innovations.
Areas for improvement include increasing the use of digital tools to provide agricultural advice through digitalization, information sharing, environmental issues and transhumance. More awareness campaigns must be carried out on good practices (biopesticides based on plant extracts etc.) as an alternative solution to the abusive and uncontrolled use of herbicides and pesticides. Also, the national plant protection service must increase monitoring to prohibit the use of unapproved chemicals (pesticides, insecticides etc.). More extension sessions should be conducted on renewable energy through the manufacture and use of energy efficient improved cooking stoves; conservation or management of animal resources in forests; environmental education, market access, production of quality products.

Extension organizations require additional skills especially in agroecology, organic farming and use of ICT in agriculture. In addition, actions (promotion, support etc.) must be carried out to encourage the processing and consumption of healthy local agricultural products from sustainable agriculture to encourage demand.

In view of all these recommendations the agricultural policy will provide an important orientation needed in the improvement of sustainable agricultural productivity in the West African sub-region.

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