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

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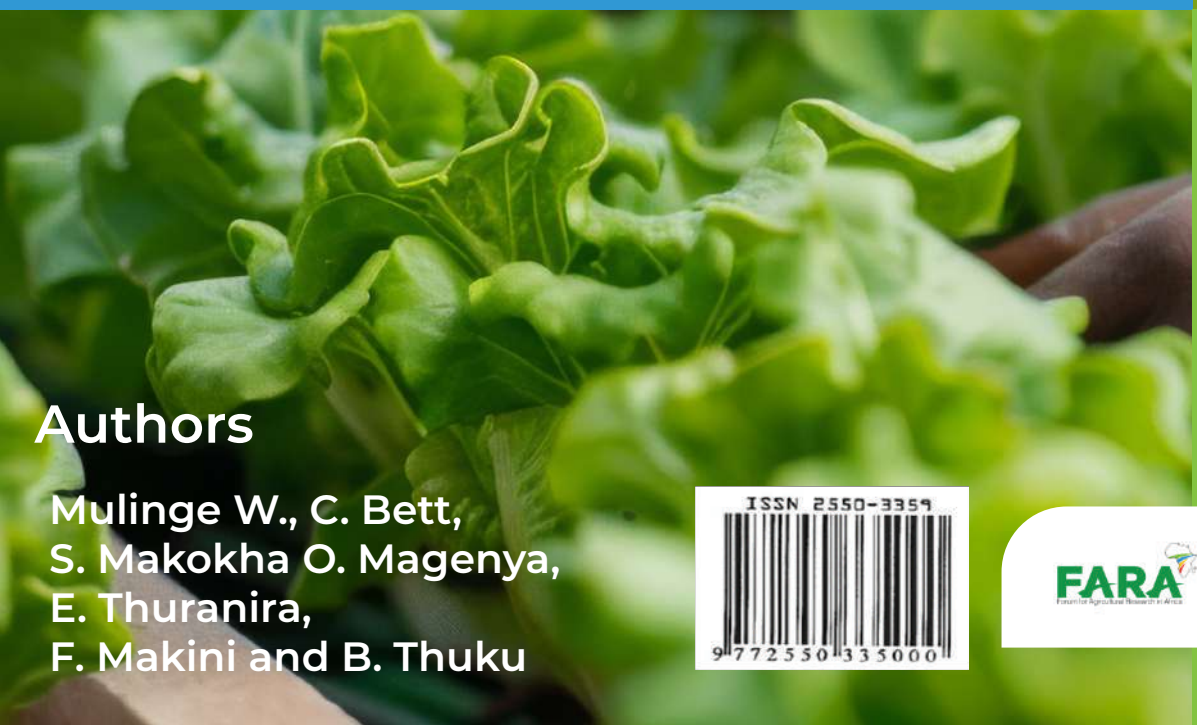

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List of abbreviations

AREE	Agricultural Research, Extension, and Education
ARLRI	Arid Lands Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASDSP	Agriculture Sector Development Support Programme
ATVET	Agricultural Technical and Vocational Education and Training
BETA	Bottom-Up Economic Transformation Agenda
CBK	Central Bank of Kenya
CGA	Cereal Growers Association
CGIAR	Consultative Group for International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FCRI	Fluid Control Research Institute
GEFRAS	Global Forum for Rural Advisory Services
GDP	Gross Domestic Product
GoK	Government of the Republic of Kenya
ICT	Information and Communications Technology
KALRO	Kenya Agricultural and Livestock Research Organization
KENAFF	Kenya National Farmers' Federation
KII	Key Informants Interview
NARS	National Agricultural Research Systems
NAVCDP	National Agricultural Value Chain Development Project
NEPAD	New Partnership for Africa's Development
NGOs	Non-Governmental Organizations
NRF	National Retail Federation

PARI	Program of Accompanying Research for Agricultural Innovation
PI	Principal Investigator
SDGs	Sustainable Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organization

1.0 Introduction

1.1 Background

Agricultural transformation plays a key role for meeting the Sustainable Development Goals (SDGs). Governments can support agricultural transformation by promoting innovations and skills development. An important strategy in this regard is investing in agricultural research, extension, and education (AREE). In the past two decades, the "agricultural innovation system" has become 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 that aimed to consider multiple sustainability goals within their agricultural innovation systems. Examples include research projects within the National Agricultural Research Systems (NARS) or projects within agricultural advisory services that focus on developing farmers' skills for sustainable agricultural practices. There are, however, major knowledge gaps on what can be learned from such efforts. One reason for this knowledge gap is the fact that past studies have mostly focused on the role of these institutions in improving agricultural productivity but hardly covered other sustainability goals (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 Kenya by analyzing strategies within agricultural research, extension, and educational institutions that aim to meet multiple sustainability goals and exploit the potentials 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 the AREE, including exploring digitalization efforts, working environments, and staff satisfaction, and examining to what extent AREE institutions are linked with each other (for instance between NARS and agricultural advisory services) and with international research partners such as CGIAR. The goal is to better understand how to make sure that the AREE institutions promoting agricultural development efforts in Kenya and elsewhere embrace all dimensions of sustainability.

1.2 Insights from existing literature and data

The agriculture sector continues to play a critical role in Kenya's economy accounting for 20 percent of Gross Domestic Product (GDP). The sector also employs over 40 percent of the total population and more than 70 percent of the rural populace (CBK, 2023). Over sixty percent of Africa's estimated 1.2 billion people are under the age of 25; yet with little job creation currently in the rural areas where the majority of the population resides, there is a growing uncertainty over the continent's preparedness to tap this resource. Tens of millions of jobs will have to be created each year in rural areas for Africa to harness the dividends of this youthful population (FAO, 2018). In Kenya, about 13.7 million youth who account for 35.4% of the total population and constitute 60% of the total labour force of which 10% are directly participating in the agricultural sector. It is estimated that 64% of unemployed Kenyans are youth with majority moving away from the agricultural sector to fast growing non-agricultural sectors in urban areas. This results in rural-to-urban migration consequently reducing the labour force in rural areas to work in the agricultural sector. Two ways by which agriculture contributes to employment is both on farm and off the farm, in the larger agri-food systems. With the demand for aggregation, storage, processing, logistics, food preparation, restaurants and other related services becoming increasingly important, many employment opportunities will emerge off the farm, in the larger agri-food systems (Christiansen, 2017).

Agricultural Research, Extension, and Education (AREE) institutions will play a strategic role in helping to prepare Kenya and indeed Africa's rapidly growing youth populations for productive careers in the growing segments of the agri-food system. However, a review of the ATVET in selected Sub-Saharan Africa countries shows that there are far too few training opportunities for young people and that often, the training offered does not match the needs of the private sector and of local administrations (Kirui & Kozicka, 2018). The ATVET trainings focus primarily on production skills and on producers themselves with too little practical training. ATVET needs to be adapted to the context of increasingly commercial and technical 21st century agricultural systems. According to a study by NEPAD (2013), the specific challenges faced by the ATVET systems in Africa are numerous:

- Unlike Technical and Vocational Education and Training (TVET) systems, ATVET has only received marginal attention coupled with lower enrolment rates.
- ATVET has been criticized for having few linkages between private and public efforts and between ATVET and agricultural universities and research.
- The fragmented and scattered technical and vocational training offered does not meet the needs of the fast growing agricultural and food sector.
- ATVET systems suffer from low capacity, inadequate and outdated training materials and equipment, and lack of skilled and qualified trainers in training institutions.
- Teachers and trainers lack practical, pedagogical and didactic skills, and lack technology knowledge and the competencies for curriculum development.
- There is a perception that vocational training is inferior to academic studies.
- In general, professional work in agriculture has a negative image compared to technical or white-collar jobs (Kirui & Kozicka, 2018).

2.0 Methodology

2.1 Mapping of AREE institutions

Before data collection was done, mapping of institutions to be covered was undertaken. The institutions were classified into, National Agricultural Research Systems, International agricultural research systems, agricultural advisory services and agricultural technical and vocational educational training institutions (Figure 1). Further analysis revealed that NARS comprise national research organizations and universities whose roles complement CGIAR's. While the NARS mandate of agricultural research was national, the mandate for CGIAR transcends the international borders. Similarly, the universities core mandate of knowledge transfer, to smaller extend transcends the international border but the mandate of NARS was confined to the country.

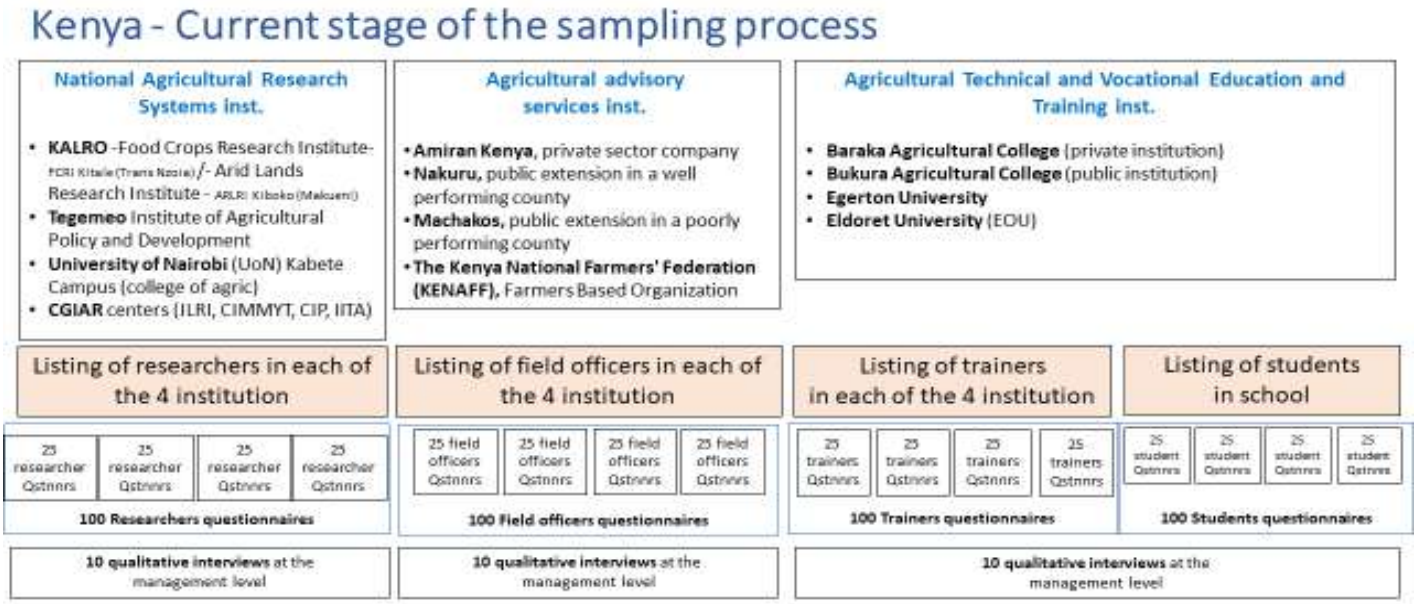

FIGURE 1. MAPPING OF INSTITUTIONS COVERED IN THE SURVEY

2.2 Sampling strategy

A multi-stage sampling procedure was employed in each of the four countries (Benin, Kenya, Mali, and Nigeria) to select the sample for this research.

1. In the first stage, a comprehensive list of institutions including (a) National Agricultural Research Systems, (b) agricultural advisory services, and (c) Agricultural Technical and Vocational Education and Training institutions, was compiled. From this list, institutions working on a regional and national level focusing on crops only or crops and livestock were purposefully sampled.

2. From this subsample, depending on group size, between two and four institutions per group were randomly selected.

3. Once the institutions were identified, a list of all of the staff members working in the areas

of agricultural research, extension, and training, as well as students from the training organizations, were randomly selected for a quantitative questionnaire-based survey.

4. In each of the institutions identified, around 30 key-informant interviews (KII) were held with the directors and key managers.

In Kenya the total number of respondents, which was proportionately selected from the three groups of institutions mentioned above was 154 professionals actively working in the agricultural sector. Additionally, 100 students from professional agriculture training courses were randomly selected. A total of 254 respondents were interviewed through a quantitative survey. In addition, 30 qualitative key-informant interviews were conducted.

2.3 Approach

To shed light on the research questions, a comparative survey-based study approach was undertaken, employing a mixed-method research design.

1. In each of the institutions identified, a staff survey was conducted where participation was voluntary. The survey included a set of standardized questions that refer to all types of institutions as well as sets of questions that were specific to NARS, advisory services, and ATVET institutions.
2. In addition, in selected agricultural advisory and ATVET institutions, a quantitative questionnaire-based survey among students was conducted to better understand their perspectives on the skills obtained and those needed for sustainability transformation.
3. The quantitative surveys featured a choice experiment. The choice options presented were a reflection of realistic options of fictional projects. Respondents were asked to select a project featuring different levels of each sustainability dimension.
4. In each of the institutions, qualitative data was collected through key-informant interviews (KIIs) with the directors and key managers using interview guidelines. All interviews were held in person or where possible and appropriate telephone interviews.

2.3.1 Research approach

a. The study was led by principal investigator (PI) who was the overall supervisor during the data collection, assisted by two supervisors covering western Kenya and eastern Kenya.

b. Mapping of the AREE institutions was conducted based on expert interviews and available data such as the ASTI database (see https://www.asti.cgiar.org/) and the GFRAS database. Earlier work by PARI, such as the mapping of ATVET institutions by Kirui & Kozicka (2018) were considered. Policy and strategy documents that refer to AREE institutions (e.g., Kenya's National Agricultural Research System Policy) were reviewed for more information.

c. In each of the institutions identified by the mapping, interviews were held with the directors and key managers in person. Thirty key-informant interviews were held using interview guidelines.

d. In each of the institutions identified by the mapping, a staff survey was conducted where permission was sought from the institutional management through a letter from the Director General, KALRO. Further permission to participate was sought from the individual staff/respondents. The survey covered a random sample of the staff members of the respective institutions. A set of standardized questionnaires jointly developed by the PARI partners of the four participating countries through a workshop was used. The University of Hohenheim developed the draft preliminary version of the questionnaire with the input of the PIs and study teams. After incorporating the respective changes, the PIs and the study teams pre-test the survey instrument and share their experiences. The questionnaires had sets of questions that referred to all types of institutions as well as sets of questions that were specific to NARS, advisory services, and ATVET institutions.

2.4 Data collection

Data collection was carried out by a team of researchers from the PARI partner organizations with the support of the Hohenheim team. The PARI partner organizations who were involved in the earlier studies managed the process of data collection.

2.4.1 Interviews with key stakeholders of AREE institutions

All interviews were held in person across the AREE Institutions. Table 1 presents a summary of AREE institutions where data was collected. The institutions included, national research organizations, CGIAR organizations, Universities, public extension, agricultural extension and farmer-based organizations.

Table 1: AREE Institutions Sampled for Key Stakeholders

	AREE Institutions
Number of organizations	Thirteen (13)
Names of organizations	· KALRO Food Crops Research Institute- FCRI Kitale (Trans Nzoia) /- Arid and Range Lands Research Institute - ARLRI Kiboko (Makueni) · Tegemeo Institute of Agricultural Policy and Development · University of Nairobi (UoN) Kabete Campus (College of Agric) · CGIAR centers (CIMMYT and CIP) · Cereal Growers Association (CGA), Farmers Based Organization · Nakuru, public extension in a well performing county · Machakos, public extension in a poorly performing county · The Kenya National Farmers' Federation (KENAFF), Farmers Based Organization · Bukura Agricultural College (public institution) · Egerton University · Eldoret University (UoE)
Number of respondents	· 100 Trainers questionnaires · 100 Students questionnaires · 10 qualitative interviews at the management level

2.4.2 Survey of staff and students from AREE institutions

At the ATVET organizations, quantitative data was collected from staff while qualitative data was collected from representatives of management (Table 2).

Table 2: AREE Institutions Sampling of Staff and Students

	ATVET
Number of organizations	Eight (8)
Names of organizations	· KALRO -Food Crops Research Institute - FCRI Kitale (Trans Nzoia) /- Arid and Range Lands Research Institute- ARLRI Kiboko (Makueni) · Tegemeo Institute of Agricultural Policy and Development · University of Nairobi (UoN) Kabete Campus (College of Agric) · CGIAR centers (CIMMYT and CIP) · Cereal Growers Association (CGA), Farmers Based Organization · Nakuru, public extension in a well performing county · Machakos, public extension in a poorly performing county · The Kenya National Farmers' Federation (KENAFF), Farmers Based Organization
Number of respondents	· 100 Trainers questionnaires · 100 Students questionnaires · 10 qualitative interviews at the management level

2.4.3 Survey with students from ATVET institutions

To understand the quality of training and skill acquired, the survey covered students undertaking agriculture-based units and those who were in the final year. The institutions where students' surveys were conducted are presented in Table 3.

Table 3. ATVET Institutions Sampled

	ATVET
Number of organizations	Four (4)
Names of organizations	· Baraka Agricultural College (private institution) · Bukura Agricultural College (public institution) · Egerton University · Eldoret University (EU)
Number of respondents	· 100 Trainers questionnaires · 100 Students questionnaires · 10 qualitative interviews at the management level

2.5 Data processing (cleaning, entry and analysis)

Data was collected using a web-based platform, Survey CTO and uploaded in a database at KALRO headquarters. The data was later downloaded in Microsoft Excel spreadsheet where initial cleaning was done by a statistician. Data cleaning and analysis was carried using Microsoft Excel and SPSS software. The study team provided the statistician with the research questions which was then used to generate tables and graphs for the report. Analysis was done using descriptive statistics and correlations to understand the relationships between different variables.

3.0 Results

3.1 Staff Survey

3.1.1 Staff Characteristics, Motivation, Institutional Goals and Budget Allocation to Pillars of Sustainability

Respondents' characteristics were determined using gender, work experience, age, origin[1], professional background and education (level and additional training). Except for extension staff where male and female respondents were evenly distributed, the National Agricultural Research Stations (NARS) and Agricultural Technical and Vocational Education and Training (ATVET) institutions had only about one-third of the respondents as females (Table 4). The even distribution of males and females among the extension staff may be explained by the fact that county governments which are constitutionally in charge of agriculture have been employing extension staff recently, therefore staff are relatively young (average of about 35 years). Also, county governments have also tried to balance male/female ratio as required by the constitution. In terms of area/region/country of study, few respondents studied abroad (<10%) and a majority of the workforce were from the rural areas. Overall, the gender balance in terms of sex seems to be moving towards even distribution attributable to governments' efforts at complying with the provisions of the affirmative action. The three categories of institutions seemed to have a relatively young work workforce with an overall average age of 41 years and work experience of 7 years. Disaggregated by institution, extension department has the youngest workforce which is evenly distributed by gender implying a balanced sustainable succession strategy.

Education is an important variable that empowers an individual to make decisions and pass on knowledge to others. In this study, majority of the respondents attained first degree level (28%). While this may be sufficient for middle level colleges and extension, educational level for NARS institutions was expected to be higher, at least post graduate level because of the nature of their jobs.

Table 4. Characteristics of the respondents

General background	NARS (%)	ATVET (%	Extension (%)	Average (%)
Gender (share of females)	30.4	30.4	54.8	38.5
Work experience (years)	12.5	7.7	1	7.1
Age	43	45	35	41
Origin (share rural)	94.6	94.6	81	90.1
Studied abroad (share yes)	8.9	8.9	9.5	9.1
Education Level				
Bachelor's degree	26.80	30.40	26.20	27.80
Master's degree	8.90	8.90	14.30	10.70
Others	64.29	60.70	59.50	61.50

1 Local or abroad

3.1.1.1 Professional background

Table 5 presents percent share of different professional backgrounds at the NARS, ATVET and extension department in Kenya. Ideally, agricultural training institutions should be multidisciplinary in nature in order to address all the farming needs and satisfy departments involved in dissemination of technologies such as research institutions and extension agents. In this study, respondents in the three institutions were asked to indicate their professional background. Results reveal that agronomy, plant breeding had the largest share of about 47.8% overall with social sciences, economics, public health and educational studies combined, has the lowest share (6.4%), a similar pattern was observed when disaggregated by institution. The result suggests that the share of social and behavioral sciences should increase because these professionals are important in the diffusion of agricultural technologies.

Table 5. Workforce professional background by institution

Professional background	NARS (%)	ATVET (%)	Extension (%)	Average (%)
Crop Science (Agronomy, Plant breeding, Crop health, Horticulture/extension)	37.6	37.6	68.1	47.8
Livestock Science (Veterinary, Production Dairy management and technology)	16.4	18.4	9.6	14.8
Social Sciences (Economics, Public Health, Educational Studies, Community development)	5.4	9.0	4.8	6.4
Environmental sciences and Biology	8.1	8.1	-	5.4
Management (Business, Administration)	3.6	3.6	7.2	4.8
Engineering (Processing, Conservation of agri-food products)	5.4	5.4	2.3	4.4
Information Communication Technology (ICT)	1.8	1.8	-	1.2

3.1.1. 2 Additional Training

Further to the professional background and education level, respondents were asked to indicate whether they had been trained in other professional courses apart from formal training. Overall, 62% of the respondents had additional training, extension officers had more training exposures than NARS and ATVET (Figure 1). Additional training is usually offered in specialized fields and more often organized by projects to fill gaps not covered in formal training or as refresher courses. Respondents were asked to indicate whether the additional trainings had covered agronomic, economic, social, environmental or digital tools aspects. On a scale of "1=not at all to 4= to a great extent", the response was overwhelmingly "to a greater extent" for all the five aspects.

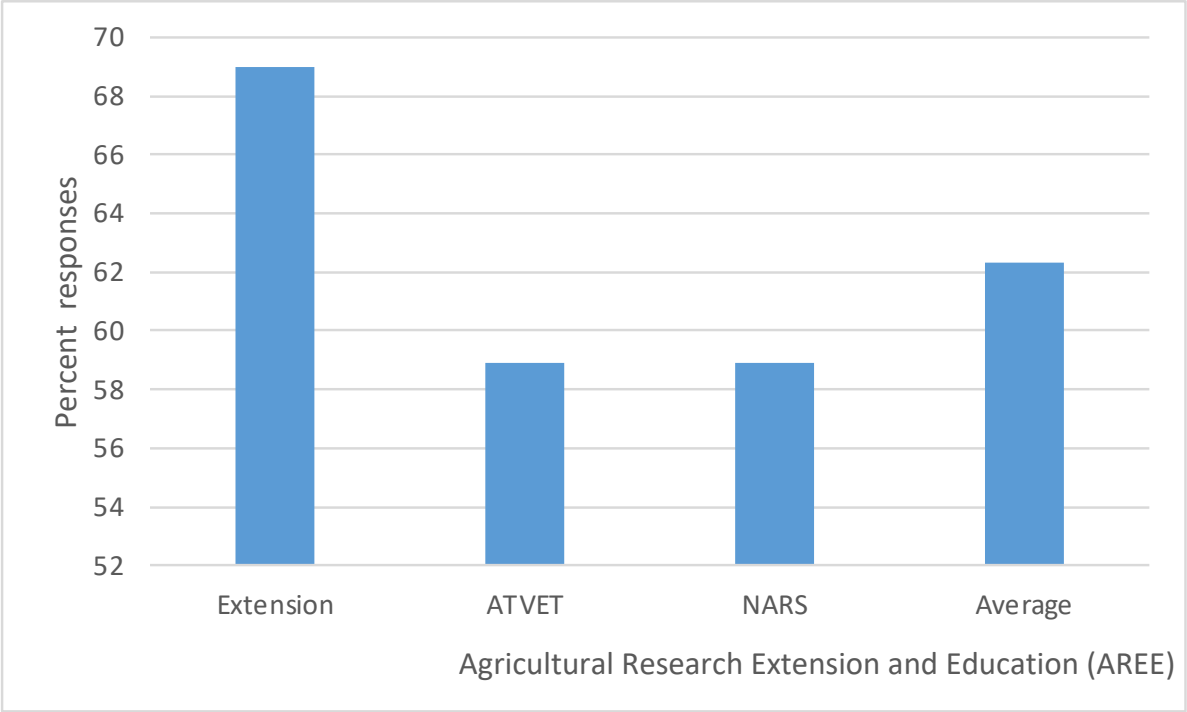

Figure 1. Need for Additional Training

3.1.1.3 Motivation to work for the institution

Indicators used to measure motivation were income, job security, incentive to influence change, personal fulfilment, motivation to share and transfer knowledge and experience enhancement (Table 6). The three most important indicators were regular income (19.2%), job security (18.7%), change in the country/for farmers (16.8%) and gaining of work experience (15.8%).

Table 6. Drivers of motivation to work for institution

Motivation	Percent (%) responses from institutions			
	NARS (n=56)	ATVET (n=56)	Extension (n=42)	Average
Regular income	18.7	18.4	20.5	19.2
Job security	16.4	16.1	23.5	18.7
Prestige	10.3	10.1	0	6.8
Change in the country / for farmers	13.1	12.9	24.5	16.8
Personal fulfilment	10.3	10.1	4.1	8.2
Share/transfer knowledge	14	13.8	14.2	14
Gain work experience	17.2	17.1	13.2	15.8
others	0	1.5	0	0.5

3.1.1.4 Goals of the organization

The goals of ATVET and NARS were similar with no variations across all the enumerated goals. This finding is surprising, but this may be due to the fact both are involved in research. However, when all the institutions were compared using percent responses from respondents, the ranking were similar: productivity (32%), food security (23%) and poverty reduction (13%) (Table 7). Mitigation and adaptation to climate change and biodiversity conservation were also important goals for NARS and ATVET.

Table 7. Goals of the organization

Main goals of the organization	NARS (n=56) (%)	ATVET (n=56) (%)	Extension (n=42) (%)
Increase productivity	19.5	19.5	31.7
Improve food security	14.9	14.9	22.5
Reduce poverty	16.4	16.4	12.5
Mitigation and adaptation to climate change	11.1	11.1	7.5
Contribute to biodiversity conservation	11.8	11.8	5.8
Integrate marginalized groups and the poorest	9.5	9.5	5.8
Improve access to financial services	5.3	5.3	5
Foster the use and development of digital tools	5.7	5.7	4.2
Foster women's empowerment	4.6	4.6	1.7
Total	100	100	100

3.1.1.5 Budget allocation to pillars of sustainability

Three important pillars of sustainability are economic, social and environment. Respondents were asked to estimate the national percentage budget allocation to these pillars of sustainability and the results showed that economic (43%) and environmental (36%) sustainability aspects were given high priority than social aspects (21%) (Table 8). A similar pattern was observed when the results were disaggregated by institution.

Table 8. National percent budget allocation to economic, environmental and social aspects of sustainability

National budget allocation pillars	NARS (%)	ATVET (%)	Extension (%)	Average (%)
Economic Sustainability	45.0	45.0	37.5	42.5
Social Sustainability	20.0	20.0	23.2	21.1
Environmental Sustainability	35.0	35.0	39.3	36.4
Total	100.0	100.0	100.0	100.0

3.1.2 Professional Networks

3.1.2.1 Background of professional colleagues

Across the three institutions (NARS, ATVET and Extension), the staff working with the respondents were majorly from crop science, livestock and social sciences (Table 9). The other disciplines were agricultural engineering, environmental sciences and management. Disaggregated by institution, majority of professional colleagues of the respondent were form the livestock sciences (31%), while for ATVET, 26% were from the social sciences and for NARS, 30% were from crop sciences. With these results it seemed that professionals were balanced across the disciplines which a positive finding for overall skills development.

Table 9. Background of Colleagues in the Institutions

Professional background of colleagues	Percent response per institution			
	NARS (n=56)	ATVET (N=56)	Extension (N=42)	Average
Crop Science (Agronomy, Plant breeding, Crop health, Horticulture and extension) (%)	29.8	20.8	23.4	24.7
Livestock Science (Animal health, Animal production and Dairy management (%)	12.2	16.8	30.8	19.9
Social Sciences (Economics, Public Health, and Community development) (%)	25.5	25.5	17.6	22.9
Environmental sciences / Biology (%)	11.2	12	3.3	8.8
Management (Business and Public Administration) (%)	10.7	12.8	5.8	9.7
Engineering (Agricultural engineering, Processing and Conservation of agri-food products) (%)	10.5	11.6	7.5	9.9
Information Communication Technology (ICT) (%)	0	0	11.6	3.9
Others (%)	0	0.5	0	0.2
Total (%)	100	100	100	100

3.1.2.2 Staff Interactions

NARS, ATVET and extension staff work with various stakeholders in their daily activities. Engagements may take different forms but they are mainly either to implement activities jointly, share experiences, conduct trainings and transfer of knowledge activities. To determine the level of engagement with other major stakeholders the respondents were asked to indicate the frequency or number of times they meet with other stakeholders. Majority of NARS, ATVET and extension staff indicated that meetings were up to five times per year. Some indicated that they had more interactions of between 5 to 10 times and more than ten times as shown in Table 10, 11 and 12).

Table 10. Frequency of staff interactions between ATVET and other stakeholders annually

Institution	Frequency of interactions (%)		
	Up to 5 times	Between 5 and 10 times	More than 10 times
National research organizations	92.1	5.3	2.6
Members from CGIAR centers	100.0	-	-
Other international research organizations	100.0	-	-
Education institutions (e.g., vocational schools)	72.0	13.6	13.6
Extension service offices, including from private and third sector	76.0	20.7	3.4
Non-Governmental Organizations (NGOs)	66.0	28.1	6.3
Farmer organizations/ cooperatives	83.9	16.1	-
Actors of the value chain (e.g., input dealers, processors, retailers, consumers)	84.0	8.0	8.0

Table 11. Frequency of staff interactions between extension and other stakeholders annually

Institutions/no. Of times met	Frequency of interactions (%)		
	Up to 5 times	**Between 5 and 10 times**	**More than 10 times**
National research organizations	79.4	5.9	14.7
Members from CGIAR centers	76.9	23.1	-
Other international research organizations	94.7	5.3	-
Education institutions (e.g., vocational schools)	100.0	-	-
Extension service offices, including from private and third sector	64.7	20.6	14.7
Non-governmental Organizations (NGOs)	88.5	3.8	7.7
Farmer organizations/ cooperatives	86.8	7.9	5.3
Actors of the value chain (e.g., input dealers, processors, retailers, consumers)	81.8	12.1	6.1

Table 12. Frequency of staff interactions between NARS and other stakeholders annually

NARS Institutions/no. Of times met	Frequency of interactions (%)		
	Up to 5 times	Between 5 and 10 times	More than 10 times
National research organizations	70.6	17.6	11.8
Members from CGIAR centers	64.2	23.9	11.9
NGOs	59.6	23.4	17.0
Extension service offices, including from private and third sector	59.3	25.9	14.8
Actors of the value chain (e.g., input dealers, processors, retailers, consumers)	58.7	37.0	4.3
Other international research organizations	58.1	25.6	16.3
Education institutions (e.g., vocational schools)	55.6	29.6	14.8
Farmer organizations/ cooperatives	41.7	27.1	31.3

3.1.3 Perceptions of Challenges in the Agricultural Sector, Mission of Organization, and Sustainability Aspects

The main farming challenges enumerated by the respondents in the last 10-20 years seemed not to have changed significantly (Table 13 and 14). But two main challenges mentioned by majority of the respondents in the last 10-20 years and currently were changing climatic patterns and pests and diseases. While in the last 10-20 years pest and diseases and climate change were mentioned as the major challenges in that order, currently, the two remained the main challenges, but in reverse order. The two challenges however were positively correlated because one major indicator of climate change is new emerging insect pests and diseases.

Poverty/inequality and education issues were mentioned among the top 5 challenges in the last 10–20 years, however, they did not feature in the top 5 main challenges currently. Low productivity, and, low and unpredictable rainfall features among the top 5 main farming challenges currently. Overall, the challenges remain similar but what has changed is the magnitude as perceived by the respondents.

Table 13. Main Challenges of Farming 10-20 years ago

Main farming challenges	Percent (%) respondents mentioning the challenge			
	NARS (n=56)	ATVET (n=56)	Extension (n=42)	Average
Pests and diseases	10.2	10.6		11.8
Changing climatic patterns	6.9	4.8		9.2
Poverty and inequality	10.7	11.3		8.7

Main farming challenges	Percent (%) respondents mentioning the challenge			
	NARS (n=56)	ATVET (n=56)	Extension (n=42)	Average
Education issues	9.7	10.9		8.3
Lack of inputs	8.9	6.1		8.0
Lack of finances	6.9	6.8		7.5
Low productivity	5.1	6.5		7.2
Poor roads and rural infrastructure	8.9	10.0		6.8
Low and unpredictable rainfall	5.1	3.4		6.2
Lack of markets	6.9	5.8		5.8
Few extension service issues	5.1	8.2		5.7
Livestock health and welfare	3.8	4.4		3.8
Low soil fertility	2.3	2.4		2.9
Digital tool issues	4.8	2.7		2.7
Water issues	1.0	1.7		1.6
Network coverage	2.6	1.0		1.2
Inadequate power (Electricity issues	0.8	1.0		0.6
Flooding	0.3	0.7		0.3

Table 14. Current Main Challenges of Farming

Current main farming challenges	Percent (%) respondents mentioning the challenge			
	NARS (n=56)	ATVET (n=56)	Extension (n=42)	Average
Changing climatic patterns	14.6	18.4	15.8	16.3
Pests and diseases	13.0	11.8	14.7	13.2
Low and unpredictable rainfall	12.2	12.2	10.0	11.7
Lack of inputs	13.0	8.9	8.9	10.3
Low productivity	9.0	8.1	10.0	9.0
Marketing issues	7.9	7.7	4.7	6.8
Finance issues	6.4	4.8	8.9	6.7
Low soil fertility	5.6	7.7	4.2	5.8
Extension service issues	2.7	7.0	3.7	4.5
Livestock health and welfare	3.7	3.3	3.2	3.4
Poverty and inequality	3.2	2.6	4.2	3.3
Education issues	3.2	2.6	4.2	3.3
Water issues	2.4	1.8	2.1	2.1
Roads and rural infrastructure	0.3	0.7	1.6	0.9
Digital tool issues	2.1	-	0.5	0.9
Network coverage	0.3	0.7	-	0.3
Electricity issues	0.3	-	-	0.1

3.1.3.1 Changes in the Institutional Mission

The mission for the three institutions seemed to have changed in the last ten years as shown in Figure 2. Overall, close to 40% of the respondents reported that the mission of the institution had changed significantly. Disaggregated by institution, more extension respondents (45%) reported more significant changes than ATVET and NARS. This could be attributed to changes in the extension models which usually varied subject to the agency/body funding the extension programme particularly the change in policy that placed agriculture function under the county governments.

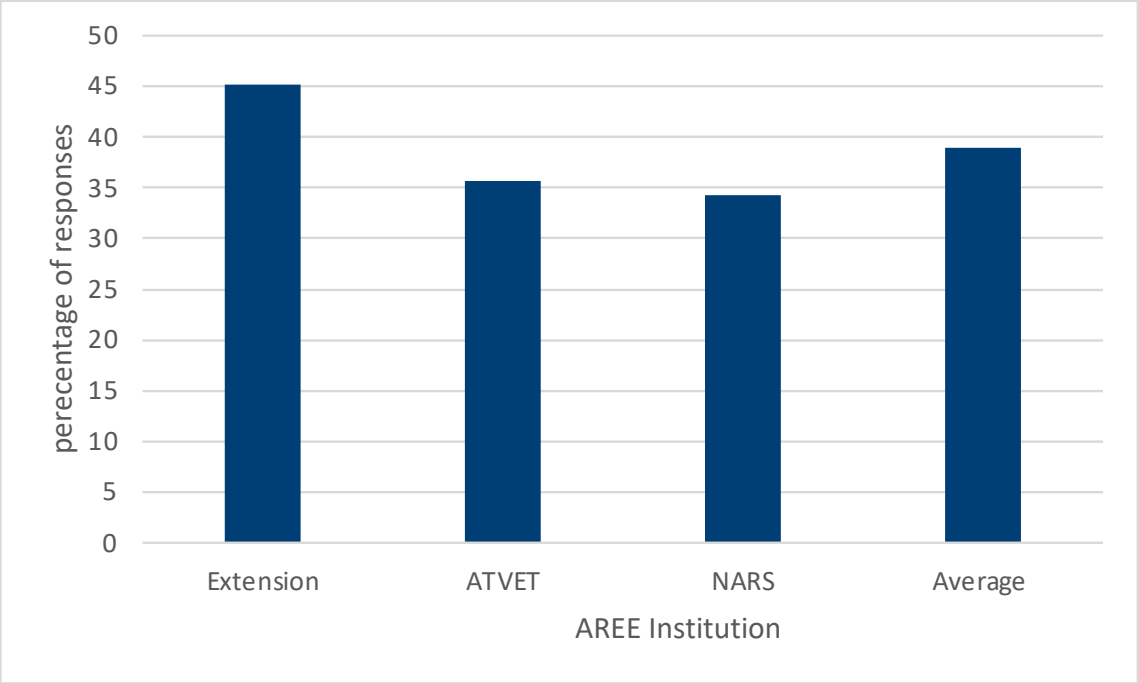

Figure 2. Level of Affirmation for Significant Changes in the Institutional Mission in the Last 10 Years

3.1.3.2 Importance of various topics to the institutions

Various topics relevant to three institutions were presented to the respondents and were asked to rate them using a Leichardt scale (1=Not important, 2=slightly important, 3=important, and 4=very important) (Table 15, 16 and 17). The topics cut across crop and livestock value chains, including but not limited to productivity, health, finance, marketing, climate change and biodiversity. Results shows that all the topics presented to the respondents were relevant with the majority across the institutions rating them from important to very important.

Table 15. Importance of Various Topics to the NARS

Topic/ Magnitude of importance	Not important	Slightly important	Important	very important
Crop yields and productivity (%)	0.0	0.0	10.1	89.9
Efficient input use (%)	0.0	3.8	12.7	83.5
Safe handling of agro-chemicals (%)	0.0	1.3	6.3	92.4
Marketing/commercialization (%)	0.0	1.8	11.4	87.3
Microfinance (%)	1.3	5.1	20.3	73.4
Land degradation (%)	0.0	1.3	7.6	91.0
Climate change (%)	0.0	0.0	5.1	94.9
Water management (%)	0.0	1.3	3.8	94.9
Biodiversity-friendly agriculture (%)	0.0	0.0	13.9	86.1
Livestock productivity (%)	0.0	2.2	4.4	93.3
Animal Health (%)	0.0	0.0	8.9	91.1
Nutrition (%)	0.0	1.3	6.3	92.4
Gender (%)	0.0	0.0	7.6	92.4
Marginalized groups and/or the poorest (%)	0.0	1.3	7.7	81.0

Table 16. Importance of Various Topics to the ATVET

Topic/ Magnitude of importance	Not important	Slightly important	Important	very important
Crop yields and productivity (%)	0.0	0.0	25.0	75.0
Efficient input use (%)	0.0	5.4	25.0	69.6
Safe handling of agro-chemicals (%)	0.0	0.0	25.0	75.0
Marketing/ commercialization (%)	0.0	1.8	25.0	73.2
Microfinance (%)	1.3	12.5	30.4	57.1
Land degradation (%)	0.0	3.6	7.1	89.3
Climate change (%)	0.0	0.0	1.7	98.2
Water management (%)	0.0	3.6	16.1	80.4
Biodiversity-friendly agriculture (%)	0.0	0.0	14.2	85.7
Livestock productivity (%)	0.0	0.0	8.9	91.1
Animal Health (%)	0.0	0.0	12.5	87.5
Nutrition (%)	0.0	0.0	7.1	92.9
Gender (%)	0.0	0.0	25.0	75.0
Marginalized groups and/or the poorest (%)	8	5.3	25	67.9

Table 17. Importance of Various Topics to the Extension

Topic/Magnitude of importance	Not important	Slightly important	Important	very important
Crop yields and productivity (%)	2.4	0.0	9.5	88.1
Efficient input use (%)	0.0	2.4	25.0	76.2
Safe handling of agro-chemicals (%)	0.0	7.1	23.8	69.0
Marketing/commercialization (%)	0.0	0.0	35.7	64.4
Microfinance (%)	2.4	4.8	71.4	21.4
Land degradation (%)	0.0	4.2	26.2	69.0
Climate change (%)	0.0	4.8	16.6	78.6
Water management (%)	0.0	0.0	21.4	78.6
Biodiversity-friendly agriculture (%)	0.0	0.0	35.7	61.9
Livestock productivity (%)	0.0	4.8	45.2	50.0
Animal Health (%)	0.0	0.0	45.2	47.6
Nutrition (%)	0.0	0.0	35.7	64.3
Gender (%)	0.0	4.8	47.6	47.6
Marginalized groups and/or the poorest (%)	0.0	4.8	57.1	38.1

3.1.3.3 Importance of different thematic areas

Overall, import thematic areas were microfinance, commercialization and efficient input use (Table 18). However, a comparative analysis of responses from institutions varied. While NARS placed more importance on gender, microfinance, commercialization and land degradation; ATVET seemed to be more concerned with efficient input use with over 82% ranking it as important. On their part, extension placed more importance on commercialization (93%), microfinance (74%) and animal health (52%) and livestock productivity (50%). The common denominator among the institutions, seemed to be commercialization and microfinance. Agricultural Commercialization has received significant focus in the last ten years which is positively correlated to microfinance.

Table 18. Importance of different thematic areas per institution

Thematic area/aspect	Percent (%) response			
	NARS (n=79)	ATVET (56)	Extension (n=42)	Overall
Microfinance	29.1	41.1	73.8	48.0
Marketing/ commercialization	15.2	26.8	93.4	45.1
Efficient input use	17.7	82.4	23.8	41.3
Biodiversity-friendly agriculture	16.5	14.3	38.1	23.0
Animal Health	3.8	12.5	52.4	22.9
Safe handling of agro-chemicals	11.4	25.0	31.0	22.5
Livestock productivity	3.8	7.1	50.0	20.3

Gender	34.2	23.2	0.0	19.1
Land degradation	15.2	10.7	31.0	19.0
Nutrition	12.7	7.1	35.7	18.5
Water management	11.4	19.6	21.4	17.5
Crop yields and productivity	13.9	20.0	11.9	15.3
Climate change	10.1	10.7	21.4	14.1
Marginalized groups and/or the poorest	12.7	23.4	0.0	12.0

3.1.4 Digitalization

3.1.4.1 Digitization Characteristics of the Respondents

Exponential growth in access to digital devices over the last decades has spurred growth in the provision of digital services. The use of digital tools to support advisory services in Kenya was 100%, which aligns with a report by FAO (2022). The devices used include phones and smartphones (39.8%), computers (34.2%), tablets (19.2%) and others (6.8%) as summarized in Figure 3.

There were however low number of respondents (less than 40%) from each of the category of organizations who positively indicated that they used devices (Table 19). Whereas the use of various devices by the different organizations did not vary significantly, it would be interesting to assess the heterogeneity of use of specific advisory services, between and within organizations.

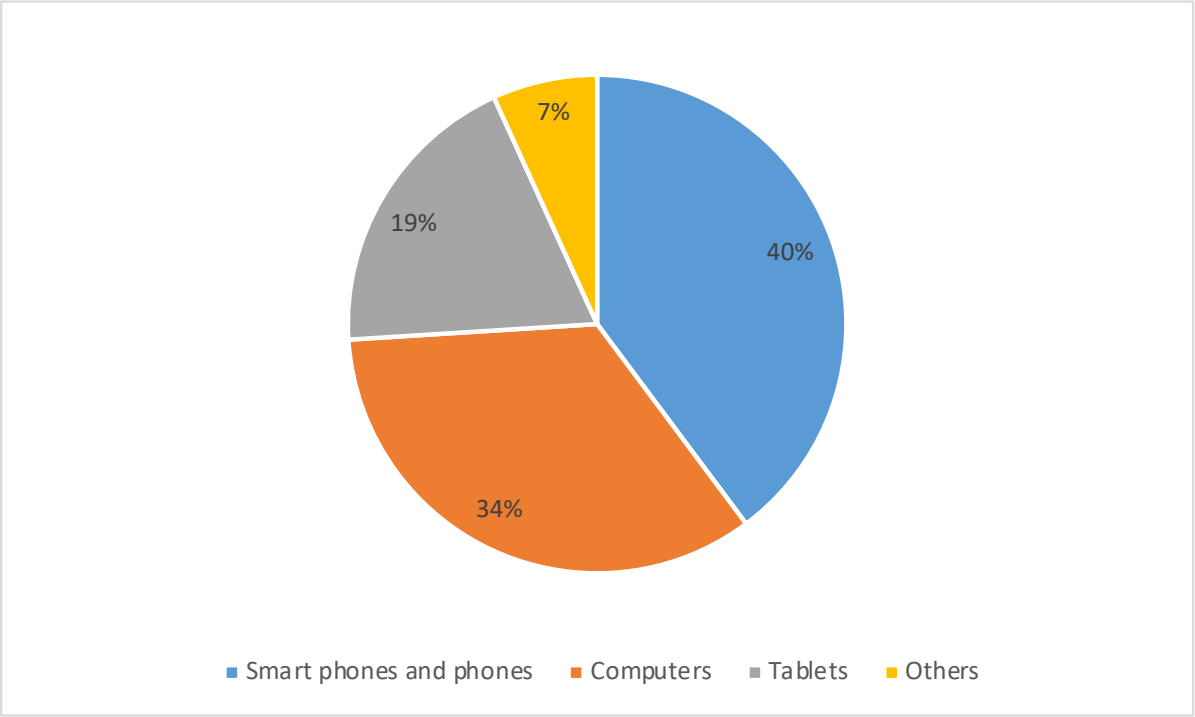

FIGURE 3: TYPES OF DEVICES USED BY THE DIFFERENT ORGANIZATIONS

The respondents indicated that the devices were used for different reasons e.g. teaching. ATVET had the highest use of devices for teaching (24.7%), while 16.4% of extension service providers and

7.7% of NARS indicated use of devices for teaching (Table 19). Similarly, ATVET personnel were the highest users of digital devices to get pricing information (9.3%), then extension (6.6%), followed by NARS (3.4%). Devices were mostly used by ATVET for weather forecast information (8.6%) followed by extension (7%) and NARS (5.1%) (Table 19). A comparison on the use of digital devices for leisure (videogames, video clips and music) showed ATVET at 11.7%, followed by extension (10.8%) and 5.3% for NARS. While, for other parameters, ATVET was highest at 24.7%, followed by extension (13.1%) and NARS at 10.25%.

As expected, more teaching is undertaken in ATVET and less in NARS, however, the data showed that even in ATVETs, the use of these devices was still low. This is disadvantageous, considering that agriculture as a profession, and ATVET as an education provider are less attractive to young people in Kenya. There is need for increased use of digital devices in Agricultural TVET, to act as a stepping stone to more attractive academic progression of many ATVET students.

Likewise, the use of the devices for teaching by extension personnel was relatively low, contrary to the acknowledged versatility of mobile devices, which offer an informal environment for farmers learning anywhere, anytime and at any location. Increased device use by extension officers would address the weaknesses of traditional dissemination methods like in-person meetings or radio programming. The use of these devices for communication (e.g., WhatsApp) was highest by NARS (15%) followed by ATVET (14.8%), and then extension (11%). The low use could be attributed to level of awareness of the versatility of the devices and the inhibitive cost of mobile use in the country coupled by the network coverage. Other contributory factors include the significant taxation measures implemented by the government within the mobile phone sector. This has resulted in Kenya's mobile sector tax rates being among the highest in Sub-Saharan Africa. Excise duty on mobile services increased from 10-15 percent in 2018 to 15-20 percent in 2021, reaching 15% in 2023 (Annon, 2023). Taxation has therefore impacted consumer affordability and usage of digital devices. Likewise, the use for social media was highest in NARS (10.9%), followed by extension (6.9%) and ATVET (4.3%).

Table 19 shows that the use of digital devices for agricultural information/advice/training (crops and livestock etc.) was highest among NARS (6.1%) followed by extension (4.9%) and the lowest was by ATVET (3.7%). Likewise, for acquiring news (e.g., BBC, local TV or radio) the average use of digital devices was on average at 8.9% for three categories of respondents. Similarly, for banking transactions, NARS used digital devices at 8.9%, followed by extension (6%) and then ATVET (4.9%). Information on transport options was obtained using digital devices at 3.8% by NARS and extension and 1.9% for ATVET. The latter was higher for NARS and extension because of the need to work in fields further away from their station of work. Although, the use of these devices by extension personnel was relatively low, there is need for increasing the same, because dissemination of information in the country is evolving very rapidly, i.e. within an environment of decreased funding for public sector extension, increasing demand for novel and appropriate agricultural technologies, rapidly developing ICT; coupled with the decentralized system of government, where agriculture is entirely a developed function. Extension services through mobile phones are mostly on weather advisory, crop and livestock production, record keeping, financial services, market information, and data analytics (Haruna et al., 2018).

Table 19: Use of digital tools by the different organizations in Kenya

Use for Devices	NARS (%)	ATVET (%)	Extension (%)	Average (%)
Teaching	7.7	24.7	16.4	16.3
Communication (e.g. WhatsApp)	15	14.8	11	13.6
Social media (e.g., Facebook, Twitter, Instagram)	10.9	4.3	6.9	7.4
News (e.g. BBC, local TV or radio)	8.3	9.3	9.0	8.9
Banking	8.9	4.9	6.0	6.6
Weather forecast	5.1	8.6	7	7
Agricultural information/ advice/training (crop, livestock, etc.)	6.1	3.7	4.9	5.2
Information/advice/training on other aspects (e.g., marketing, finance)	4.9	?	7.6	7.7
Price information	3.4	9.3	6.6	6.4
Transport options	3.8	1.9	3.8	3.2
Leisure (e.g. videogames, video clips, music)	5.3	11.7	10.8	9.3
Others	10.25	24.7	13.1	16

3.1.4 Work Environment

3.1.4.1 Job satisfaction

The level of job satisfaction in NARS, ATVET and extension was affected by factors like whether staff were satisfied with their jobs, salary, hiring and promotion; staff support and supervision. Considerations about the feelings of staff on these aspects undoubtedly negatively affect their effectiveness in performance. The respondents' answers to job satisfaction questions to assess the broad attitudes of persons in different organizations, as a reflection of the degree to which their important needs were satisfied. Figure 4 shows that respondents in NARS strongly agreed (4) that they received feedback about the quality of their work, they set for themselves high standards of performance, had freedom to make decisions to solve problems at the work place, were recognized by their peers as hard workers, their bosses had confidence in their judgement and that their jobs made them gain experience which will help them in life. The assessed factors contributed to job satisfaction, indicating that in Kenya, the NARS had created career growth and investment opportunities for mutual employee – organizations. Although, they also simply agreed they were satisfied with their work. There is need to further interrogate how important the last question contributed to overall satisfaction.

Respondents from ATVET strongly agreed (4) with the questions on feedback about the quality of their work, whether they set for themselves high standards of performance, on recognition by their peers as hard workers, confidence of their bosses in their judgement and how their jobs helped them to gain experience which will help them in life. However, they fairly agreed that they had freedom to make decisions, and were satisfied with their jobs. These responses indicated a lower job satisfaction by the ATVET.

On the other hand, respondents from extension reported strong agreement that they set high standards of performance for themselves, and also were recognized by their peers as hard workers. But they indicated that they fairly agreed (3) with receiving feedback about the quality of their work, had freedom to make decisions to solve problems at the work place, and that their bosses had confidence in their judgement.

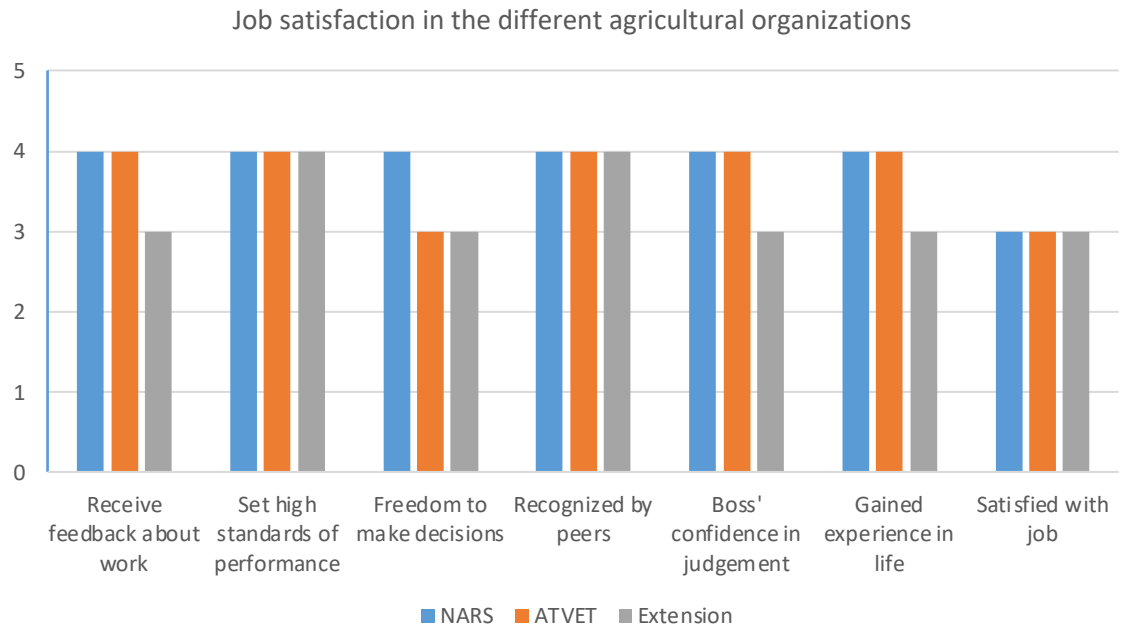

FIGURE 4: PARAMETERS OF JOB SATISFACTION BY STAFF OF DIFFERENT AGRICULTURAL ORGANIZATIONS

3.1.4.2 Salary payments

Respondents from NARS agreed (3) with the questions on salary payments, but the respondents from ATVET, the trainers of staff disagreed with all the issues of salaries, except the reflection of scales based on difference in workload. While extension staff members agreed on other questions except being happy with salaries they received (Table 21). This implies that ATVET staff's inability to lead a decent life with their salaries could decrease the probability of their being satisfied with their job, and hence reduced work performance i.e. training of agricultural workers.

Table 20: Payment of salaries in the NARS, ATVET and Extension

Rating of Salary Related attributes (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	NARS	ATVET	Extension	Average
Salary encourages staff to work better	3	2	3	2.7
Happy with the salary received	3	2	2	2.3
Equal pay as staff in other departments/institutions for comparable tasks	3	2	3	2.7
Staff receiving salaries on time	3	2	3	2.7
Salary increments received as expected	3	2	2	2.3
Pay scales reflect differences in workload and responsibility	3	3	3	3

3.1.4.3 Hiring and Promotion

All respondents agreed (3) that staff were hired and promoted based purely on merit (Table 22); that there were good opportunities for promotion; that performance appraisals were carried out fairly; that majority of people in the offices were qualified to perform their duties; that both male and female staff had equal opportunities for promotion. But on the contrary, respondents disagreed on whether promotion depended on how long one had served.

Promotion mechanisms based on performance in organizations affects the level of job satisfaction. Respondents from extension seemed to indicate that a fairer promotion policy based on how long an officer had served could be a driving force for positive job satisfaction. Therefore, there is need for government and other stakeholders to emphasize the need to improve job satisfaction through different packages/schemes.

Table 21: Hiring and Promotion in NARS, ATVET and Extension

Rating of view on statements related to hiring and promotion? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	NARS	ATVET	Extension	Average
Staff is hired purely based on merit	3	3	3	3
Staff is promoted purely based on merit	3	3	3	3
Promotion depends on how long you have served	3	3	2	2.7
There are good opportunities for promotion	3	3	3	3
Performance appraisals are carried out fairly	3	3	3	3

The majority of people in this office are well-qualified to do their job	3	3	3	3
Male and female staff have equal opportunities in getting promoted	3	3	3	3
Promotion depends on duration of service	2	2	2	2

3.1.4.4 Overall Staff Support

On average, respondents from the three organizations agreed that their programmes had specified targets, but disagreed that staff had adequate resources and inputs, and that they were disbursed in a timely manner, and also that mobility to their operational area was easy (Table 23).

Table 22: Support Given to Staff in NARS, ATVET and Extension

Staff view on statements related to overall support? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	NARS	ATVET	Extension	Average
The programs you have to implement in the office have specified targets	4	4	3	3.7
Staff has enough resources available to carry out their work as required by professional norms	3	2	2	2.3
Inputs and resources for your work come regularly and on time	3	2	2	2.3
Mobility to your operational area is easy	3	3	2	2.3

3.1.4.5 Staff Supervision

All respondents agreed (3) on whether supervisors had increased job satisfaction; disagreed (2) that it was hard to please their supervisors; agreed (3) that supervisors praised their good work; agreed (3) that supervisors knew their job well; and also agreed (3) on availability of supervisors when needed. Respondents agreed (3) that supervisors did not show favoritism. Respondents from NARS and extension agreed (3) on adequacy of workload, but those from ATVET strongly disagreed (1). All respondents agreed (3) that they had clear and structured work/programme (Table 24).

Table 23: Staff supervision in the NARS, ATVET and Extension

What is your view on the following statements related to supervision? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	NARS	ATVET	Extension	Average
Your supervisor has increased your job satisfaction	3	3	3	3
It is hard to please your supervisor	2	2	2	2
Your supervisor praises good work	3	3	3	3
Your supervisor knows the job well	3	3	3	3
Your supervisor is always around when needed	3	3	3	3
Your supervisor does not show favoritism	3	3	3	3

What is your view on the following statements related to supervision? (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	NARS	ATVET	Extension	Average
Your workload is adequate	3	1	3	2.3
You have a clear, structured work program	3	3	3	3

Findings suggest that the issues of pleasing the supervisor and work load should be considered as a contributory factor to job environment and staff's satisfaction. Thus, there is need to organize professional leadership development trainings for the middle-level managers who serve in supervisory roles.

3.2 Students Survey

3.2.1 Student Characteristics and Motivation

Table 25 shows that about 62% of the students interviewed were females, thus giving a national representation that more than 50% of the population were females. In addition, the agricultural sector in Kenya is dominated by women. The average age of the students interviewed was 25 years, giving a good representation of the youth in the country. About 51% (responses of secure job, job with regular income, prestigious job) of the students said their main motivation for starting their courses was to be employed, while 38% of the students said they wanted to bring change in farming. The latter response was quite encouraging because a change in the conventional way of farming can reduce drudgery, entice the youth in agriculture and increase productivity. After graduation, 51% of the students aspired to render extension services, 13% aspired to work in the Ministry of Agriculture and Livestock Development (MoALD), 4% in a research institute, while 3% would like to work in the academia. About 16% of the students said they aspired to be agro-entrepreneurs after graduation, while 6% aspired to be independent consultants. Agro-entrepreneurship attracts the youth, therefore creates employment, which is in line with the goal of the Bottom-Up Economic Transformation Agenda (BETA) of increased farmers' income and job creation in agriculture (GoK, 2023).

Table 24: Gender, Characteristics and Motivation

Attribute/Motivation		Average (%)
Gender (share of females)		61.5
Age		25
Origin (share rural)		95.8
Origin (share farming)		96.9
Own cultivation (share yes)		70.8
Year of training		2
Motivation to start the course	Secure job	21.5
	A job with a regular income	19.4
	Representative (prestigious) job	9.9
	Knowledge to bring about change in farming	38.2

What do you see yourself doing after graduation?	Private, public, or third-sector extension service	51.0
	Jobs in the Ministry of agriculture	12.5
	Agricultural Research Institute	4.2
	Academia	3.2
	Independent Consultant	6.3
	Agro-entrepreneur	15.6
	Other	7.2

3.2.1.1 Students Opinion on Budgetary Allocation on the Three Different Aspects of Sustainability

The students indicated that about 22% of the national budget should go towards economic sustainability while 19% should be allocated to social sustainability as indicated in Table 26. This resonates well with Kenya´s policies, development plans, programmes and strategies which put emphasis on economic sustainability anchored on Vision 2030, which is the blueprint to transform the country to an industrial middle-income country, capable of providing high quality life to all citizens by 2030. For instance, according to the National Food and Nutrition Security Policy (GoK, 2011) the government's objective is to achieve good nutrition for optimum health for all Kenyans, increase the quantity and quality of food available, accessible and affordable to all Kenyans and to protect vulnerable populations using innovative and cost-effective safety nets linked to long-term development. In addition, the Agriculture Sector Growth and Transformation Strategy (ASTGS) anchored in the MoALD has laid down strategies to achieve 100% food security by the year 2030, where Flagship No. 3 of the ASTGS seeks to boost food resilience of 1.3 million farming households through interventions at the community level (GoK, 2019).

The students allocated 10% of the national budget to environmental sustainability. This allocation is justified because environmental sustainability needs less cash investments since it mainly involves change in practices, such as agroforestry, use of renewable energy sources such as biogas made from livestock manure, use of improved cooking stoves that use less firewood and land practices that reduce land degradation.

Table 25: Opinion of Students on National Agricultural Budgetary Allocation to Economic, Social and Environmental Sustainability

View on allocation of 100% of the national agricultural budget, on the three different aspects of sustainability	Average
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.)	21.5
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.)	19.4
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.)	9.9

3.2.1.1 Students' Views on Their Aspirations and Future Contribution to the Society

Table 27 shows that about 21% and 16% of the students wished to make the greatest contribution for increased productivity and food security, respectively. About 14% of the students said they wished to make the greatest contribution to improve adaptation to climate change, while 13% mentioned biodiversity conservation. Only 4.5% of the students interviewed said they would foster the use and development of digital tools. The use of digital tools can overcome information asymmetry challenges, increase productivity and create employment significantly. In Africa, Kenya leads in the use of ICT, therefore provides opportunities for digital solutions for agricultural value chains in Africa (Bolwig et al., 2021). Therefore, more students should embrace this area of study in order to make significant change in agriculture. The gender issues, integration of marginalized groups and women empowerment were mentioned by 7.4% and 0.3% of the students, respectively. Generally, this result shows that the students gave highest priority to food production and food security, followed by environmental issues while gender issues, access to information and financial services came last.

Table 26: Aspects where Respondents Wish to Have greatest contribution in the future

Where do you wish to make the greatest contribution in the future?	Average (%)
Increase productivity	20.8
Reduce poverty	12.5
Improve the adaptation to climate change	14.3
Foster women's empowerment	0.3
Improve food security	16.1
Contribute to biodiversity conservation	13.4
Integrate marginalized groups and the poorest	7.4
Improve access to financial services	0.3
Foster the use and development of digital tools	4.5

3.2.1.1 Student Views on the Challenges Facing Agriculture

About 15% of the students mentioned pests and diseases and changing climatic patterns as the main challenges in farming (Table 28). In general, the perceptions were skewed towards production challenges, thus reflecting the perception in the general population that challenges in production are the greatest challenges in Kenya. Infrastructure, institutional and access to information were the least mentioned. Any given value chain can only develop if all aspects of the value chain are addressed. Mega projects in the MoALD such as the National Agricultural Value Chain Development Programme (NAVCDP) and the Agricultural Sector Development Support Programme (ASDSP) have addressed issues along the value chain.

Table 27: Perceptions of Challenges in the Agricultural Sector

Perceived main challenges of farming	Average (%)
Low productivity	12.2
Pests and diseases	15.1
Livestock health and welfare	5.6
Low soil fertility	2.4
Water issues	2.9
Changing climatic patterns	14.8
Inputs issues	10.0
Poverty and inequality	5.6
Roads and rural infrastructure	5.0
Marketing issues	4.0
Finance issues	9.2
Extension service issues	8.2
Education issues	5.6
Digital tool issues	3.7

3.3.2 Perceptions of Training

3.3.2.1 Students View on Courses Taken

All aspects of the courses that the students were undertaking were rated highly as indicated in Table 29. This rating provided an indication that the students were getting good quality and relevant training from their institutions. In addition, almost all the students (98%) said they would recommend the course to others.

Table 28: Rating of Courses Undertaken

Students views on the statements related to course work (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	Average
The course you have chosen accommodates well to your background needs	4
The objectives of the course were clearly defined	3
Participation and interaction were encouraged	3
The topics covered were relevant to me.	3
The content was organized and easy to follow.	3
The content meets my expectations.	3
The materials distributed were helpful and relevant.	3
This course experience will be useful in my work.	4
The trainers were knowledgeable about the course topics.	3
The quality of the answers to the questions was good	3
The trainers were well prepared.	3
The course objectives were met.	3
The time allotted for the course work was sufficient.	3
The time allotted for the practical works was sufficient.	3
The course rooms and facilities were adequate and comfortable.	3
The course offers capacity in digital tools	3
The course allows visiting farms and or/interacting with farmers	3
Can the student recommend the course to a friend or family (Share yes) (%)	97.9

3.3.2.2 Student Perception on How Time and Teaching of the Courses were Devoted to Aspects of Sustainability

Table 30 indicates that about 43% of the students said that their courses gave most emphasis on economic sustainability, as indicated in Table 30. About 36% of students indicated that emphasis was on environmental sustainability, while 21% mentioned social sustainability, meaning that the teaching/training was skewed towards economic and environmental sustainability.

Table 29: Perceptions on How Time and Teaching of the Courses were Devoted to Economic, Social, and Environmental Sustainability Aspects

Student perception, how much of the time and teaching of the courses were devoted to economic, social, and environmental sustainability aspects.	Average (%)
Economic Sustainability (e.g., reduction of hunger and poverty, improvement of living standards, etc.)	43.2
Social Sustainability (e.g., gender aspects, integration of marginalized groups, youth, etc.)	20.5
Environmental Sustainability (e.g., integration of biodiversity goals, climate change mitigation, etc.)	36.3
Total	**100**

Table 31 shows that all the aspects of sustainability received a balanced attention, which does not resonate well with the results shown in the previous table, where social sustainability was said to have least emphasis.

Table 30: Coverage of other Aspects in Training

Student on sufficiency in covering the following aspects (On a scale from 1 = Strongly disagree to 4 = Strongly agree)	Average
Crop yields and productivity	3
Efficient input use	3
Safe handling of agro-chemicals	3
Marketing/ commercialization	3
Prices, quality standards, value creation, and cost-saving techniques	3
Microfinance	3
Land degradation	3
Climate change	3
Water management	3
Biodiversity-friendly agriculture	4
Livestock productivity	3
Animal health	3
Livestock welfare	3
Nutrition	3
Gender	3
Marginalized groups and/or the poorest	3
Youth	3
Digital tools	4

3.3.2.2 Areas of Concern Students Viewed as Challenges in Agriculture

Table 32 results does not give any issue different from the ones mentioned before, but highlights areas of concern for students as challenges in agriculture. Some responses (low and unpredictable rainfall, flooding, changing climatic patterns, and water issues) depicted climate change as a concern among the youth which is also a major concern in Kenya. As youth, one would expect a mention of detailed issues around ICT such as Internet of Things (IoT), Artificial Intelligence (AI) and robotics in production and service provision, because this is the direction agriculture should take to revolutionize the sector. Other aspects not mentioned in this table are value chain analysis and development, hydroponics, urban agriculture and agribusiness.

Table 31: Coverage of Other Aspects that May Need Focusing on in Training

Opinion, the other aspects the course should focus more on to even better address the country's challenges (Share yes)	Average (%)
Low productivity	11.1
Pests and diseases	8.8
Livestock health and welfare	7.6
Low soil fertility	6.2
Water issues	1.8
Low and unpredictable rainfall	6.9
Flooding	0.5
Changing climatic patterns	9.7
Inputs issues	0.9
Poverty and inequality	4.8
Roads and rural infrastructure	0.2
Marketing issues	0.7
Finance issues	1.6
Extension service issues	8.5
Education issues	1.2
Digital tool issues	1.2
Electricity issues	0.2
Network coverage	0.2

3.3.2.2 Areas where Students are Facing Challenges in their Courses of Study

Table 33 shows that the most frequently mentioned challenge that students faced in their course was having a few practical lessons, where about 28% of the students mentioned it as a challenge. In any agricultural course, practical lessons are essential to enable graduates to respond to the needs in the agricultural sector and even become self-employed. The essence of having TVETs is to have skilled personnel that offer practical solutions to the agricultural sector.

Table 33: Challenges in the Chosen Courses

Challeges	Percentage
Are students facing challenges in their course of study? (Share yes)	62.5
Insufficient access to computers	1.9
Insufficient access to internet	1.9
Insufficient access to relevant literature	0.9
Not easy access to consult with teachers/lecturers	0.9
Few practical lessons	28.3

3.4 Qualitative Insights from Interviews with Managers

Interviews with managers of various institutions were scheduled to solicit their views on various aspects including overall mission of the institution and how it has changed or evolved over time, the innovation system, sustainability aspects and finally the staff and sustainability aspects. A checklist was used to guide the interviews. The institutions covered were: 1) National Agricultural Research Stations (NARS): the institutions covered were KALRO (KALRO Kiboko, KALRO Katumani), Egerton University, Tegemeo Institute, Eldoret University, University of Nairobi (UoN) and International Maize and Wheat Improvement Centre (CIMMYT, 2) Agricultural Technical and Vocational Education and Training Institutions (Bukura and Baraka Agricultural College), and, 3) Agricultural Extension (Machakos County, Nakuru County and Kenya National Farmers Federation (KENAFF).

3.4.1 Overall Mission and Changes in Mission

Faculty of Agriculture at the University of Nairobi (UoN) was established early 1970s to train agricultural experts to work in agricultural sector disseminating improved technologies to farmers. An interview schedule was arranged with the Dean of the faculty and the Head, Department, of Agricultural Economics to provide insights on building skills and research extension linkages for sustainable agricultural transformation. The Vision of the University of Nairobi is to be a world class University committed to scholarly excellence. While the mission is to provide quality university education and training and to embody the aspirations of the Kenyan people and the global community through creation, preservation, integration, transmission and utilization of knowledge.

On the question of whether the mission has changed in the last 5-10 years the two respondents indicated there has been no major changes of the mission. It was indicated that the objectives and the mode of achieving/delivery of the mission had changed due to the changing global trends in education. Some of the challenges of achieving the mission include: low funding for the University, reducing numbers of the students which have resulted in closing some faculties emerging challenges such Covid 19. The opportunities on the hand include; ICT technologies, partners (other universities, funding agencies, research institutions, employers), teaching infrastructure including land, UoN's established name and supportive government.

The mission and objectives of the university may shift, change or expand in future due to globalization and digitization. The drivers of these changes may include, the preparedness of the University, existing infrastructure and strategy, staff and existing skills, emerging problems due to climate change. Whenever the UoN has changes its objectives for some reason or another there exist a restructuring strategy on the basis of self-evaluation. The restructuring strategy is informed by a monitoring and evaluation system put in place by the University that involves all staff and students and the University stakeholders.

3.4.2 Innovation System

3.4.2.1 General Thinking about Research in Agriculture

Research in Agriculture in Kenya is mainly undertaken by KALRO, Universities and CGIAR organizations. Many good technologies have been released but more work needs to done on

uptake of the technologies and funding which is inadequate. While funding mainly comes from donors, there is need for the government to allocate more funding for agricultural research which is currently very low and done through National Research Fund (NRF).

3.4.2.2 Areas Requiring Improvement in the Research Arena: How Such Could be Achieved

While many improved agricultural technologies have been released, adoption at the farm level is still low. Many of the technologies remain in the shelves. This is an area that requires more work to deploy the technologies to the farmers. Further, more funding should be allocated to address emerging issues as a result of climate change.

To achieve enhanced adoption of agricultural technologies, there is need to allocate more funding to disseminate, adopt robust and whole inclusive extension models.

3.4.2.3 General Thinking about Agriculture Educational System: How Well It Prepares Young Students/Researchers to Understand Agricultural Systems

The education system in Kenya is appropriate, especially the curriculum because it covers major aspects and it is comparable to other educational systems globally. However, the student teacher ratio is quite high. The recommended student ratio in Kenya is 40 students per teacher but it is quite high in some places, far much higher than the United Nations Educational, Scientific and Cultural Organization (UNESCO) recommended ratio of 25 students per teacher. More than 72% of the public schools in Kenya have a high teacher to student of more than 40 students per teacher (Kyambi, 2019).

The Kenya education system prepares the students well to understand the agricultural systems. The curriculum for agriculture is comprehensive and covers all major agricultural topics and specializations. Theoretical concept of the educational system is appropriate and adequate but what is lacking are the practical aspects both in terms of practical experience at the agricultural educational institution and industrial attachment/internship. This is compromised because of the high number of students.

3.4.2.4 Important Aspects That Should Be Integrated Into the Educational System in The Country

Overall, most of the aspects have been incorporated in the education systems in Kenya, however, what is lacking are the practical aspects. Although the practical aspects have been incorporated, implementation has been a challenge because of the high numbers of students compared to the facilities for practical exposure, so students may not have hands-on skills.

3.4.2.5 The Role and the Perception Extension Services Play In the Agricultural System

According to the key informants, extension services play a central role in the agricultural system. The role of extension is to act as link between technology developers and farmers, thus they are regarded as the gatekeepers of agricultural knowledge to farmers. Extension programs in rural communities play a critical role in linking farmers and other actors in agricultural and rural developmental agenda, thus they are an integral pillar in Kenya's agricultural system.

3.4.2.6 Main Types of Institutions AREE Staff Collaborate With

The key informants indicated they collaborate with several institutions cutting across various sectors. Collaborators included, NARS institutions, CGIAR institutions, Universities: both local and international, Non-governmental Organizations (NGOs), farmers, financial institutions, input and output dealers, regional organizations such as ASARECA and funding agencies. These collaborations, however, depend on the specific organization that the key informant represents and the mandate.

NARS organizations and universities have very close collaborations with CGIAR working on agriculture. KALRO and UoN have close collaboration which has been institutionalized through signing of memorandum of understanding (MoU) to work together addressing agricultural constraints. There also exists collaboration between extension and CGIAR either directly or indirectly through KALRO or universities. Collaboration between ATVET and CGIAR is limited probably because ATVET do not conduct research.

Key informants indicated that there have been changes in their organizations. Major changes have occurred in the extension system with the amalgamation of the new constitution in 2010 where agriculture was devolved and made a function of the county governments. This has had major impacts on extension of agricultural technologies depending on how devolved units rank agriculture in the county. The CGIAR's recent change to One CGIAR is beginning to take root and the impact is yet to be assessed.

Key informants from NARS and universities reported some changes. KALRO had undergone reforms where agricultural research was placed under one umbrella. Universities had also undergone changes as a result of reforms which were undertaken in the universities and, similarly, ATVETs had undergone changes with some being upgraded either to offer higher diplomas or university degrees.

3.4.3 Sustainability Aspects

Based on questions and answers in section A, there were major positive shifts in trade-offs especially under pest and diseases, climate change and unpredictable rainfall. However, it was indicated that under poverty/inequality and education issues, the gap was narrowed as indicated in Figure 5. Productivity, although an important issue was relegated to the fifth place in terms of importance although with a net increase in importance.

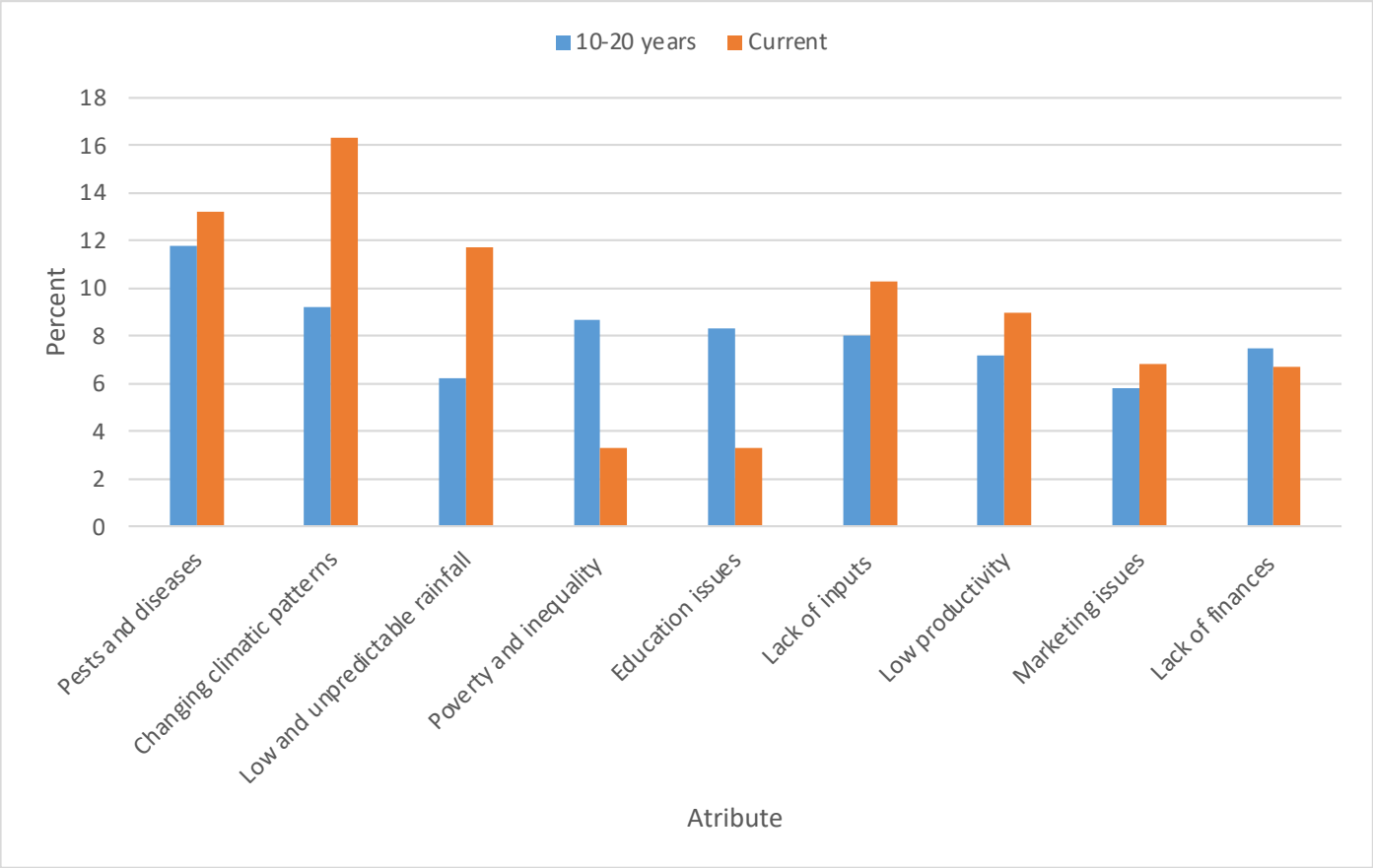

FIGURE 5: CHANGES CONTESTED TRADE-OFFS BETWEEN PRODUCTIVITY AND OTHER SUSTAINABILITY ASPECTS BETWEEN CURRENT AND 5-10 YEARS AGO

3.4.4 Changes in the Institutional Mission

There has been significant change in the missions of the institutions under AREE due to reforms designed to address the challenges in agriculture. However, much of the significant change were perceived to have occurred under extension services more than ATVET and NARS. Agricultural extension programs have changed significantly over the past four decades. Structural changes in agriculture, new types of agricultural technologies, tight public budgets, efforts to decentralize government, and emerging information and communication technologies (ICT) have led to pluralistic and, in some cases, lower-cost extension and advisory services that combine public and private mechanisms for financing and implementing extension activities. Farmer groups and virtual networks play a growing role in technology diffusion, and extension services can exploit these networks using the latest ICT approaches (Norton and Alwang, 2020).

5. Discussion and Policy Recommendations

5.1 Discussion

The use of digital tools while moderate at 60% among the AREE was encouraging. However, there is need to venture from the basic ICT into advanced applications in agriculture. It was noted that the satisfaction levels with remuneration was mixed with low satisfaction at TVET institutions while satisfaction was fair for extension and NARS and Extension. However, hiring and promotion was satisfactory among all levels of AREE institutions.

AREE Staff acknowledged that the resources and inputs were inadequate and that there was poor disbursement, although the disbursement was timely. Mobility to their operational area was rated poorly, while other parameters such as supervision was above average while adequacy of workload was considered poor under ATVETS. Gender equality in students' admission was rated highly favorable and most of the students had high aspirations to secure employment as extension agents, agro-entrepreneurship and less at NARS. Generation and transfer of technology was rated poorly, which means that the technology and innovation system is inadequate. Productivity and environment have been given more emphasis over social sustainability aspects, suggesting that there should be a deliberate enrolment in social behavioral sciences which are important in diffusion of agricultural technologies.

Regarding the students' responses, most of them said they were studying to get employment as opposed to those who wanted to bring change to agriculture, and a paltry 16% aspired to be agro-entrepreneurs. For agriculture to move away from low productivity, drudgery and entice the youth, the education system should be tailored towards supporting students to innovate. Opportunities for innovation are many, especially with ICT, yet only 5% of the students interviewed indicated desire to pursue use and development of digital tools. The students' response on budget allocation resonates well with the government's emphasis on not only economic sustainability but also social and environmental sustainability. The effects of climate change have brought the fact that matters of the environment cannot be ignored in pursuit of economic sustainability to the fore. In addition, economic sustainability cannot be achieved without social sustainability.

That students 'comprehensive understanding of production challenges cannot be over-emphasized. This could be because most of the students interviewed were pursuing bio-physical science and not social science courses. Social science enables a look at agriculture in terms of the whole value chain and not just segments of the value chain, addressing production, marketing, consumption and policy issues. From the responses on ICT, the institutions seemed to give little emphasis on ICT as a tool that can revolutionize agriculture. Training in institutions should allocate more resources to ICT.

a) Challenges

The challenges of achieving the mission in AREE institutions include: low funding, declining students' enrolment which has resulted in shutting down some faculties, emerging challenges such COVID-19 as well as poor teaching and research infrastructure. The education system in Kenya, especially the curriculum is adequate as it covers major aspects and is comparable to other educational systems globally. However, the student-teacher ratio in Kenya is higher than the recommended ratio of 40, which is far higher than the United Nations Educational, Scientific

and Cultural Organization (UNESCO) recommended ratio of 25.

b) Opportunities

The opportunities on the hand include:

- Use of ICT technologies
- Leveraging on collaborations with partners (other universities, funding agencies, research institutions, employers). NARS organizations and universities have very close collaborations with CGIAR while collaboration between ATVET and CGIAR is limited probably because ATVET do not conduct research.
- Supportive policy environment (2% of GDP government investment in research)

c) Drivers

Drivers of institutional changes may include:

The preparedness of the AREE institutions,

Existing infrastructure and strategy,

Staff and existing skills,

Emerging problems due to climate change.

Change in objectives and adoption of a restructuring strategy on the basis of self-evaluation.

5.2 Policy Recommendations

Based on the challenges identified, the following are the suggested recommendations:

1. Allocate more funding for AREE which is currently very low and done through National Research Fund (NRF).
2. Improve student teacher ratio towards the recommended 25:1 as per UNESCO recommendations
3. Support use of ICT in AREE institutions
4. Full support for implementation of ongoing AREE institutions restructuring

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