AFRICAN UNION
INTERAFRICAN BUREAU
FOR ANIMAL RESOURCES

LiVe2Africa
Sustainable Development of Livestock for Livelihoods in Africa

EUROPEAN UNION

HANDBOOK ON LESSONS LEARNT AND BEST PRACTICES FOR TECHNOLOGY UPTAKE AND TRANSFER IN THE ANIMAL RESOURCES SECTOR FOR NATIONAL AGRICULTURAL EXTENSION SERVICES IN AFRICA

DISCLAIMER

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FOREWORD

The Sustainable Development of Livestock for Livelihoods (Live2Africa) Project is the European Union's support for the implementation of the Continentals component of the Livestock Development Strategy for Africa (LiDeSA). It responds to identified constraints for the development of the Africa's Livestock sector, which include inadequate policy, legislative and institutional frameworks; low productivity and production, unsustainable utilization of natural resources; insufficient animal health services and disease control; inadequate application of technologies; inadequate input supply and service delivery; low value addition; and insufficient market information and infrastructure. The Live2Africa project thus promotes among others technology adoption in the livestock value chain in Africa. To achieve this objective, a handbook on lessons learnt and best practices for technology uptake and transfer in the animal resources sector is needed to ensure that of national agricultural extension services are fully equipped and guided to improve technology adoption in the animal resources sector in Africa.

Globally, a large number of technologies and innovations have been developed to support the animal resources sector. While some of these technologies and innovations have been put to very good and productive use by the end-users, a large number of these technologies and innovations has not been utilized as intended in Africa, mainly due mainly to challenges and limitations of national agricultural extension services in uptake and transfer of these technologies to stakeholders. This calls for a resourcing and a paradigm shift in the strategy of national agriculture services to enable them improve on technology adoption and transfer for enhanced animal production.

A handbook on best practices and lessons learnt, in the use and adoption of innovative technologies by various stakeholders along the livestock value chain will be a valuable resource in this regard. This handbook is a catalyst for improved technology transfer and utilization by stakeholders ultimately resulting in increased productivity of animal resources in Africa.

H.E. Mrs. Josefa Sacko
Commissioner for Rural Economy and Agriculture, AUC.

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LIST OF ACRONYMS

Acronym	Meaning
AE	Agricultural Extension
AI	Artificial Insemination
AnGR	Animal Genetic Resources
AU	African Union
AU-IBAR	African Union Interafrican Bureau of Animal Resources
E-Discussion	Electronic discussion
E-Survey	Electronic survey
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
IT	Innovative Technologies
NAES	National Agricultural Extension Service
OIE	World Organization of Animal Health
ONBS	Open Nucleus Breeding Scheme
PLA	Precision Livestock Agriculture
PLF	Precision Livestock Farming
RECs	Regional Economic Communities
REFILS	Research-Extension-Farmer Input Linkage Systems
RELCs	Research Extension Linkage Committees

ACKNOWLEDGEMENTS

This Handbook on Lessons Learnt and Best Practices on Technology Uptake and Transfer in the Animal Resources sector for National Agricultural Extension Services in Africa is a compilation of expert views on identified gaps and the recommendations needed to fill them in to ensure sustainable adoption and transfer of innovative technologies in the animal resources sector.

We are very grateful to all the experts who provided valuable information at various stages in the preparation of this document. First, we would like to thank all participants of the Electronic Forum and the Electronic Survey for taking time off their busy schedules and contributing to the discussion and also answering questions posed around specific thematic areas during the survey. After the analysis and discussion of the data collected, a preliminary report and an interim handbook was prepared which was validated in a stakeholders meeting. We are highly indented to all the experts who took part in the validation meeting.

Finally, our sincere appreciation to the European Union and the African Union Commission for their financial support. A special note of gratitude to all our stakeholders and partners for their support without which the compilation of this Handbook would have been but a mirage. Lastly, we make special mention of the invaluable technical support offered by AU-IBAR's Technology, Innovations and Skill Development Expert, Dr. Mary Mbole-Kariuki, in the compilation, drafting and finalization of the publication.

EXECUTIVE SUMMARY

The Oxford Dictionary defines technology as the application of scientific knowledge for practical purposes or machinery/equipment developed from this knowledge. An innovation refers to the introduction of new ideas or products including technology. A number of such innovations and technologies have been produced globally especially since the 1980s to improve the efficiency and productivity of the animal resources sector. A critical analysis of shared experiences indicate that Africa is yet to tap in fully to technology use and digitalization of activities in its animal agriculture, a situation which has to be reversed if the continent is to become protein self-sufficient.

This handbook throws more light on these technologies with particular emphasis on the lessons learnt and the best practices in the Africa Region. The main machinery for adopting and transferring these technologies to stakeholders and other end users, the National Agricultural Extension Services (NAES) have been discussed regarding the plethora of services they provide, the institutional and operational bottlenecks they face and the many opportunities available in transforming the NAES into a more useful entity. Public-private partnerships will play a very crucial role if Africa is to succeed in using technologies to upscale its fortunes in the animal resources sector. Based on reviewed case studies and shared experiences from sampled regions in Africa, we finally provide what we call the "best bet strategies" for achieving digitalization of the animal resources sector in Africa. Whilst some successes have been chalked in use of technology in general husbandry (nutrition, reproduction and record keeping), a lot remains to be done in terms of precision animal agriculture, with an estimated less than 10% of such technologies currently in use in Africa. Service providers will therefore need more incentives and be motivated through more stable environments (supportive government policies, regulatory and legislative framework, thriving markets, tax holidays among others) to encourage them to invest in innovations and technologies in the animal resources sector. At the same time, a platform for researchers, tech innovators, farmer associations, the NAES and other key sectors on the animal value chain to engage various challenges and find solutions to them will be an important ally on this journey.

This handbook should thus motivate effective adoption, transmission and sustainable utilization of proven products of innovation and technologies for the development of the animal resources sector whilst offering evidence-based data to guide policy formulation. Hopefully it will help national governments and other stakeholders collaborate and guarantee seamless transmission and greater chances of adoption and utilization of the technologies and innovations in our pursuit of animal protein sufficiency.

CHAPTER 1: INTRODUCTION

1.1 Background

The animal resource sector plays a crucial role in the socio-economic development of Africa impacting millions of livelihoods and contributing to food and nutritional security (FAO, 2007; 2015; AU-IBAR, 2019). Animal genetic resources (AnGR) support and sustain livelihoods of actors along the value chain including traders, transporters, slaughter facilities/processors, feed manufacturers, governments, local authorities, veterinary medicine suppliers. Projected rising demand for animal product-sourced foods (Delgado, 2005; Thornton, 2010, AU-IBAR, 2015) requires growth in livestock populations and sustainable intensification for efficient production and prevention of animal diseases. In this regard, innovation of traditional livestock production practices through incorporation of appropriate, simple, cost-effective and gender sensitive technologies becomes increasingly attractive. Innovative technologies provide a myriad of options for improving efficiency of livestock production from animal housing, temperature regulation, feed formulation, biosecurity, disease prevention, animal identification and recording, processing, packaging, product advertising, marketing and financial management. Whilst these technologies have been used in many countries to improve the lot of stakeholders including farmers, a lot still remains to be done in Africa.

In recent times, a number of improved agricultural technologies has been developed and promoted globally including breed improvements, nutritional advancements, irrigation management techniques, improved/integrated pest management strategies, and climate-resilient technologies (Kumara et al., 2020). Unfortunately, Africa still remains a low beneficiary of these innovations and technologies required for transformation of the animal resources sector and climate change mitigation and adaptation (Olawuyi, 2018; Osei-Amponsah et al., 2019). In order to meet the growing demand for animal protein, farmers need to accept and be capacitated to use technological inputs such as improved livestock genotypes, nutrition and health care (Kebebe, 2019). While attempts were made in the past to introduce new technologies into the production system, smallholder farmers are yet to fully adopt and use these technologies that could potentially benefit their livelihoods (Kebebe, 2019) and enhance the efficiency of their operations. The reasons for failure of stakeholders to accept and use introduced technologies need to be well synthesised and documented to inform policy, development of future technologies and training of animal farmers.

1.2 Problem statement

The reasons for failure of stakeholders to accept and use introduced technologies need to be well synthesised and documented to inform the development of future technologies and training of animal farmers. While some of these technologies and innovations have been put to very good and productive use by the end-users, many of them have not been utilized as intended, due mainly to challenges and limitations of the NAES in uptake of these technologies and transfer to stakeholders. This calls for a paradigm shift in the strategy of the NAES to enable them improve on technology adoption and transfer for enhanced animal production. To help nations address some of these challenges and usher

in a new era of technological animal agriculture in Africa, AU-IBAR is implementing a 5-year project on "Sustainable Development of Livestock for Livelihoods in Africa - Live2Africa" aimed at promoting among others technology adoption in the livestock value chain.

1.3 Justification

A handbook on lessons learnt and best practices for technology uptake and transfer in the animal resources sector is needed to ensure that the NAES are fully equipped and guided to improve technology adoption in the animal resources sector in Africa. Given, their importance in the transfer and uptake of technologies and innovations, it is imperative to tap in on the experiences of the NAES and other stakeholders in the preparation of this handbook. This handbook on lessons learnt and best practices was developed based on stakeholder interaction and inputs as well as experiences shared and success stories of various country NAES and should catalyse adoption and application of innovations and technologies germane to the animal resource value chain in line with the Live2Africa project's objective of transforming the African livestock sector for enhanced contribution to environmentally sustainable, climate resilient, socio-economic development and equitable growth. The handbook will also be a valuable resource highlighting the availability, importance, application and success stories of such technologies in improving livestock production thus catalysing their adoption and implementation.

1.4 Objective

The objective of this handbook is to document the lessons learnt and best practices in the use of innovative technologies along the animal resources value chain in Africa and thus provide a catalyst for improved technology adoption, transfer and utilization by stakeholders. It presents a one-stop-shop on best practices and lessons learnt in technology uptake and transfer along the livestock value chain with best bet strategies to bridge existing gaps. Institutional arrangements and capacity building practices in technology transfer and utilization, existing policies and legislative frameworks on technologies and innovations have been reviewed and appropriate recommendations made for improved use of available technologies.

1.5 Methodology

Information for the handbook were obtained from three (3) principal sources: desktop literature review on topics relevant to the handbook, an E-discussion (Annex 1) and an E-Survey (Annex 2) involving a cross-section of stakeholders drawn from 38 African countries and belonging to various institutions and organisations. A total of 101 respondents made up of 76 males and 25 females (Annex 3) took part in the E-Survey held from December 1st 2020 to December 31st 2020. The E-discussion was held from 1st October 2020 to 31st December 2020. The information gathered from these sources were synthesised and discussed under key thematic topics and the results presented as bar graphs and pie charts. Based on the findings, various suggestions made to help improve use of innovations and technologies in the animal resources sector in Africa. Finally, the draft Handbook on Lessons Learnt and Best Practices on Technology Uptake and Transfer in the Animal Resources sector for National Agricultural Extension Services in Africa was validated by stakeholders from all regions of Africa on 8th October 2021.

1.6 Structure of Handbook

This first chapter highlights the importance of AnGR particularly in supporting livelihoods and protein food security and the potential positive impact of technology adoption on animal agriculture. Chapter 2 of the handbook focuses on the organisational structure and key functions of the NAES in Africa as the main vehicles for carrying appropriate innovative technologies from research to farmers and other end-users. In Chapter 3 we delve deeper into stakeholder challenges of technology adoption and transfer in Africa including low institutional and human resource capacities, weak collaboration with stakeholders, poor diagnosis of farmers challenges and weak research extension linkages, poor service conditions and non-existent funding mechanisms. Having fully reviewed the strengths and weaknesses of the NAES as regards adoption and transfer of innovative technologies in Africa in the previous two chapters, Chapter 4 lists the lessons learnt and best practices from stakeholder perspective and published literature sources. Finally, Chapter 5 of the handbook prescribes the way forward by discussing the best bet strategies, the resources and enabling environment needed to achieve. In summary the handbook is structured purely from a stakeholder perspective and reinforces the need for governments to put in place the much-needed policies and regulatory frameworks, resource NAES to enable it catalyse the adoption of innovative technologies in the animal resources sector. Successful attainment of these objectives, hinges on good stakeholder collaboration as technology development, adoption and transfer requires strategic team work.

CHAPTER 2: NATIONAL AGRICULTURAL EXTENSION SERVICES (NAES) IN AFRICA

2.1 Characteristics, structure and roles

Agricultural Extension (AE) is the process of carrying the technology of scientific agriculture to the farmers to enable them utilize the knowledge (Altalb et al., 2015) for improved production. According to Richardson (2006), extension is a service, public or private, that responds to the needs of farmers and rural people for knowledge they can use to improve their productivity, income and welfare, and to manage the natural resources on which they depend in a sustainable way. Agricultural extension conveys information and new technologies to farming communities, allowing them to improve their production, income and standard of living. Increasing agricultural productivity through the adoption and diffusion of improved technologies and practices is a viable means for achieving economic growth and agricultural transformation in the face of natural resource scarcity and climate uncertainty particularly in low-income countries. Innovation as defined in the Forum for Agricultural Research in Africa (FARA) refers to "the activities and processes associated with the generation, product distribution, adaptation and use of new technical and institutional/organization knowledge" (Garzia Matinez et al., 2016). The innovation process allows identifying appropriate technologies and best organizational practices, which will be transferred for satisfying specific needs of the productive activity (Garzia Matinez et al., 2016).

National Agricultural Extension Services (NAES) have an important mandate in motivating animal farmers to use various technological innovations in order to enhance their production efficiencies. The NAES apply scientific research results to agricultural practices through farmer education encompassing a wider range of communication and learning activities organized for rural people by educators from different disciplines. In the process, they do not only expose the farmers to the technology but also provide guidance in the use of the technologies, collect feedback data to the producers of the technology to facilitate successful adoption and sustainability. The role of the NAES in technology generation, development, dissemination and adoption by farmers can thus not be overemphasized. In spite of this relevant role, NAES in Africa unfortunately in most cases lack the human and the institutional resources to function effectively especially where national governments are their sole financiers. At the same time, private agricultural extension services are costly and in most cases are often beyond the reach of the predominantly resource-poor farmers in Africa. The level of skilled human resource availability of the NAES also influences the success of adoption and transfer of particular technologies to stakeholders. For instance, Ssemakula and Mutimba (2011) reports that public extension services providers are highly trained in theoretical aspects but generally lack practical experiences and commitment to the service compared to farmer-to-farmer extension providers who though not highly technically trained have practical experiences as practising farmers and are committed to serving their peers.

2.2 *Governance structure and functions*

In Africa most of the NAES are public agencies, government-controlled and operate mostly under the Ministry of Agriculture, with private extension service providers being in the minority. In terms of organisational structure, NAES have a national office at the Ministry of Agriculture, supported by several regional/district offices. Governance structure and policy environment for extension exists at all levels in most countries with NAES personnel at sub-district, district, provisional/regional and national offices. Generally, it expected that all countries have an established system connecting researchers to farmers through the Research-Extension-Farmer Input Linkage Systems (REFILS). Additionally, the NAES have over the years established useful links/networks with the private sector and as well as service providers who support extension delivery. In some countries, farmer and staff training facilities and institutional frameworks already exist to support technology uptake and transfer. As part of their mandate, the NAES disseminate improved inputs and genetic material; organise breeders to facilitate the supply of inputs; awareness and demonstration for the valuation of agro-products. Personnel of the NAES have enough experience and ability to help identify critical constraints in the animal resources sector and recommend appropriate technologies via the research-extension-linkage committees (RELCs).

In some countries such as Cameroun, Ethiopia, Gabon, Ghana, Guinea, Nigeria, Gambia, Togo and Tunisia agricultural extension services are provided by a range of stakeholders all geared at helping to improve production efficiency. Most NAES are:

i. Information-focussed (provide information at no cost to farmer);
ii. Service-focussed (provide inputs, services, etc to the farmer);
iii. Integrated-market models – link farmers to market and input suppliers.

Additionally, livestock farms/centres and veterinary labs including agricultural research institutes exist in many countries and provide support to the NAES. As much as possible the NAES is structured to ensure close service provision as possible to farmers in the smallest administrative units (district/kebele) with NAES personnel available in each of these zones to provide both individual and group-based extension service as much as possible.

In summary the key functions of the NAES include;

i. development, collation, evaluation and dissemination of agricultural innovation on extension method and policy;
ii. facilitation of technological transfer and adoption process;
iii. training of farmers, human resource development and capacity building of actors in the agricultural value chain on sustainable good agricultural practices, identification and maturation of idea for agribusiness; information on critical farm inputs, baseline data for decision making;
iv. providing access to improved inputs, credit and intra-structural facilities;
v. provision of consulting, advisory, appropriate management, research and diagnostic services, efficient training and technical support system to producers;
vi. facilitating the development and practice of agricultural extension;

vii. promoting market-oriented knowledge;
viii. designing and implementing appropriate methods of structuring, training and extension in the field of livestock;
ix. keeping a database on professional livestock organisations and monitoring their socio-economic impact in relation to agricultural development;
x. undertake research, knowledge and technology transfer in animal health and production, in partnership with appropriate stakeholder institutions;
xi. advise on rational application of agricultural inputs including support production services in the supply of inputs (fertilizers, feed, pesticides, etc.);
xii. facilitate access to sales and marketing, economic and financial service and skills and knowledge on new technologies;
xiii. help popularize innovation and technologies to stakeholders.

2.3 Policy and Legislative Frameworks

The African Union AU Agenda 2063 recognizes Science, Technology and Innovation (STI) as multi-functional tools and as enablers for achieving continental development goals. The Agenda, further, emphasizes that Africa's sustained growth, competitiveness and economic transformation requires sustained investment in new technologies and continuous innovation in areas such as agriculture, clean energy, education and health. Whilst many NAES operate under the agricultural and/or livestock development policies, specific policies regulating use on innovation and technology are not always available but thankfully most countries are reviewing their policies to include to support technology development and adoption. A few of these country-specific policies are reviewed in the following paragraphs.

Egypt's National Strategy for Science, Technology and Innovation (NSSTI) 2030 constitutes a main pillar of the national vision, especially in relation to the production and localization of science and knowledge. Its vision is an Egyptian scientific society that, in construction and development, depends on a perpetually learning generations that generate and use the knowledge to provide scientific practical solutions to society problems, and export the knowledge within a system that supports innovation and stimulates knowledge-based economy for achieving sustainable development, increasing knowledge production, improving quality and raising its response to address societal challenges and increase the competitiveness of national industry (NSSTI, 2019).

Benin's national policy envisages modernization of its agriculture by the intensification and mechanization of the means of production in line with expectations of the government expressed through the objectives of the Rural Development Policy Declaration (DPDR, MAEP, May 2001, page 14) and in the document "Strategic Vision of Benin for the Horizon 2025". Since the basis of the economy is agriculture, priority is given to the gradual modernization of family farming, which allows the transition from a subsistence economy to a market dominated economy. The National Institute of Agricultural Research of Benin (INRAB) is responsible for research into agricultural technological innovation has, among other programs, the Agricultural and Food Technology Program (PTAA). The PTAA is one of the national research programs of the National Institute of Agricultural Research of Benin (INRAB), created in 1992,

with attributions in terms of storage and conservation of agricultural food products, processing of food products as well as pre- and post-harvest mechanization. Its mission is to adapt existing agricultural technologies and design new ones in order to increase yields, ensure soil conservation and improve the working conditions of peasants; adapt and if necessary, design technologies for the storage and preservation of food products in order to reduce post-harvest losses caused by damage from micro-organisms, insects and rodents; adapt existing technologies and develop new ones for processing food products.

Tanzania's national livestock plan aims at enhancing technologies and policy interventions with the greatest potential for contributing to achieving Tanzania's national agricultural objectives include feed, animal health, and animal genetics development. Priority investment interventions include various combinations of the three standard types of livestock technology interventions– improved genetics, health and feed–are needed to generate higher incomes and animal productivity, and contribute to achievement of national development objectives. In this regard it aims at designing and implementing policies and institutional interventions which enable private and private-public investment interventions in animal feed, genetics, animal feed and animal husbandry (Michael et al., 2018). Genetic improvement interventions include use artificial insemination with and without hormone synchronization and/or proven bulls for crossbreeding/breeding; increase the number of crossbred cattle in the improved family dairy system through crossbreeding/breeding of indigenous and crossbred cattle using exotic dairy cattle breeds like Friesian, Ayrshire, Jersey, Brown Swiss and Mpwapwa; strengthen existing national and zonal artificial insemination centres and establish a new semen production centre; acquire five new liquid nitrogen plants; Training and capacity building for 6,650 artificial insemination technicians; Encourage establishment of bull centres; Encourage establishment of crossbred heifer multiplication farms; Purchase and distribute crossbred heifers for under-resourced dairying beginners (2,000 every year); Sensitize farmers on the formation of breed societies (Michael et al., 2018).

Ghana has a national policy on science technology and innovation (MESTI, 2017) which cuts across all sectors. Ghana's National Science, Technology and Innovation Policy benefited from earlier documents, having been reviewed by a cross section of the science and technology community including scientists and policy makers. Unlike previous documents, the concept of innovation is strongly embedded in the new framework of actions, policies and programmes to apply science and technology towards social and economic objectives. Innovation implies the application of knowledge to bring about scientific and technological improvements to socio-economic activities where such applications are new in the context of usage even if they are not in other contexts. It is critical that scientific knowledge in whatever form be translated into direct application to benefit economies and societies in one way or other. In STI terms, Ghana's vision is to develop to become a high–income country which fully applies and integrates STI into national development strategies. This positions the country to harness the nation's total science and technology capacity to achieve national objectives for poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth (MESTI, 2017). In agriculture, the policy seeks to strengthen the STI capacity for livestock agriculture and the full development if its value chain especially for poultry and small ruminants; promote the development of food processing industries and

enhance value addition for the local market and for exports; strengthening the linkage between research and agricultural extension. In terms of funding, Ghana's STI policy recommends the establishment of a National Science, Technology and Technology Fund to incorporate support for innovation in its sphere of operations (MESTI, 2017).

Kenya drew up its detailed livestock policy in 1980. The major national objectives targeted by the policy were alleviation of poverty through the creation of income-generating employment at all stages of livestock production (primary production, marketing, processing, transportation and retailing); production of surplus over and above domestic demand for export, whenever possible, so as to earn foreign exchange; and conservation of the natural resources to ensure sustained resource productivity in the future. However, through science, technology and innovation (ST&I), Kenya is positioning itself as a major regional and international hub for emerging technologies to support quality of life and overall socio-economic development (STI 2013). The ST&I sector developed various policies, strategies, legislative and administrative measures that must be put into operation for successful revamping of the Higher Education Science and Technology Sector as a foundation of the Kenya Vision 2030 and in line with the Constitution of Kenya. Kenya's ST&I interventions for 2008-2012 were to be implemented through an enabling legal and policy framework. To this end the national strategy and bill for science and technology was developed in 2009 in alignment with the Kenya Vision 2030. When the Constitution of Kenya 2010 came into effect in 2010, the strategy and bill were realigned to conform to the provisions of the new constitution. This led to the development of the ST&I policy and ST&I bill 2012. The legal provision for delivery in ST&I is now guided by the ST&I Act of 2013 which provides for the promotion, coordination and regulation of the progress of Science, Technology and Innovation in the country, assignment of priority to the development of Science, Technology and Innovation and entrenchment of Science, Technology and Innovation into national production system (STI, 2013).

In an effort to streamline breeding activities, Uganda has put in place the National Animal Breeding Policy which is backed up by an institutional and legal framework in the form of the Animal Breeding Act (Sect. 5.3.2).

Rwanda's policy mission is to ensure food and nutrition security of Rwandans by using modern agribusiness technologies, professionalizing farmers in terms of production, commercialization of the outputs and then creating a competitive agriculture sector. To continue sustaining the productivity of milk, meat and eggs, the policy will prioritize the increase in productivity per animal, by addressing the feed deficit, animal health, genetics and markets through improve breed performance through crossing local with improved breeds; improve availability of feed (produced, agro-industrial by-products and processed feeds); strengthen disease control targeting the control and prevention of priority livestock diseases; strengthen extension services to improve the management skills of households raising livestock; incentives to promote more value addition through processing and product transformation, combined with a clearer role of the public and private sector (MAAR, 2017).

2.4 *Infrastructure and technical capacities*

Development and dissemination of improved technologies will help increase animal production and increase farmers' capacity to access food for their households and improve food security (Dumeh, 2011). The NAES are key vehicles for adoption and utilization of technologies and innovations and respondents in the E-survey ranked their contribution to successful technology and innovation uptake and transfer by the NAES mostly as good or average as shown in Figure 1 (Excellent – 1%; Very Good 11%; Good 40%; Average 37%; Poor 11%).

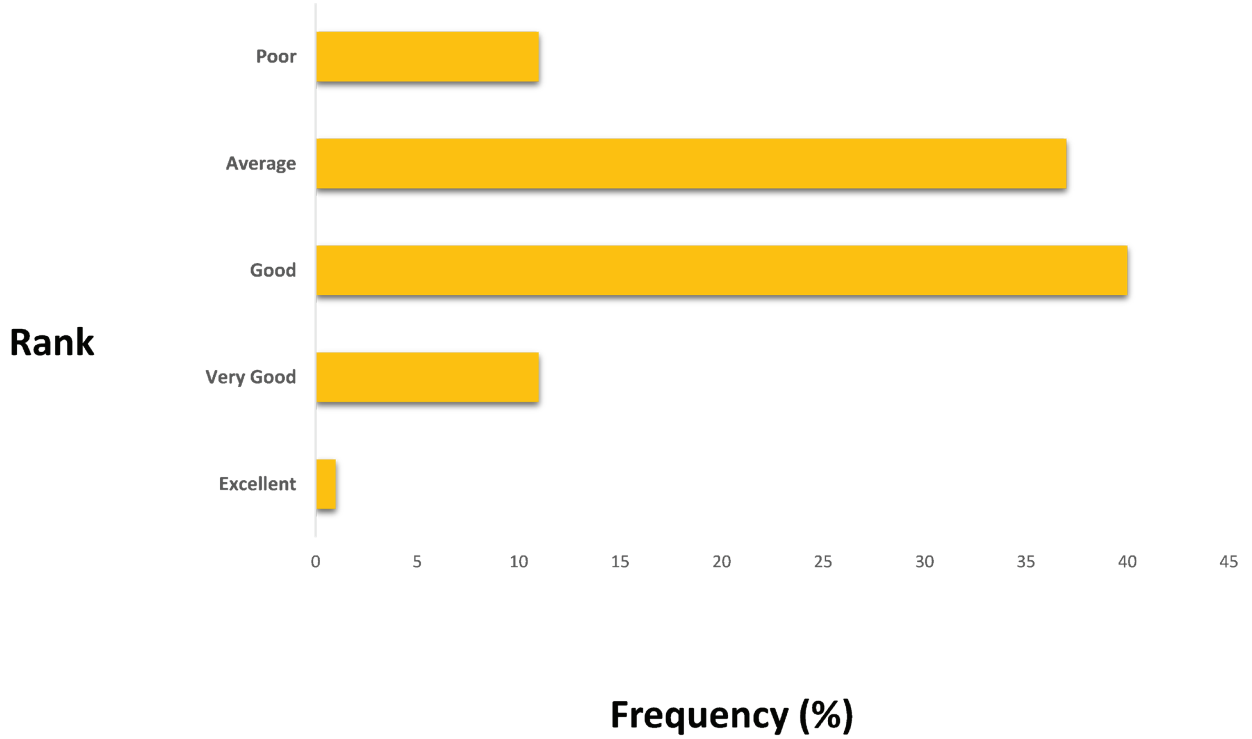


Figure 1: *Ranking of the performance of the NAES in technology adoption and transfer*

Major challenges encountered by respondents in their interactions with the NAES impinging negatively on their activities are as shown in Figure 2. These include low level of skilled personnel, lack of capacity building and training opportunities, high illiteracy rate of farmers/breeders, low coverage by the NAES (23%); low institutional capacity, unavailability of resources, poor motivation and strategies (21%); lack of financial resources and budgeting issues (14%); fragmented lines of command, cost-ineffectiveness, uncoordinated pluralistic extension service delivery, uncoordinated data collection and processing (11%); weak research-extension-farmer linkages resulting in poor coordination between research and extension/technology developers as well as little farmer involvement (9%); poor infrastructure and inputs (9%); low acceptance and adoption rate of technology by farmers as a result of cultural beliefs and unwillingness to innovate (5%); lack of awareness, poor communication and engagement of actors, language barriers and poor reporting of the benefits of innovative technologies (5%); absence of sustainable policies and enabling environments for the development and the use of innovative technologies in the animal resources sector (3%). Therefore, to ensure effective functioning of the NAES, and adequately use it to promote e-extension in the animal resources sector, governments and other stakeholders will need to find solution to these bottlenecks.

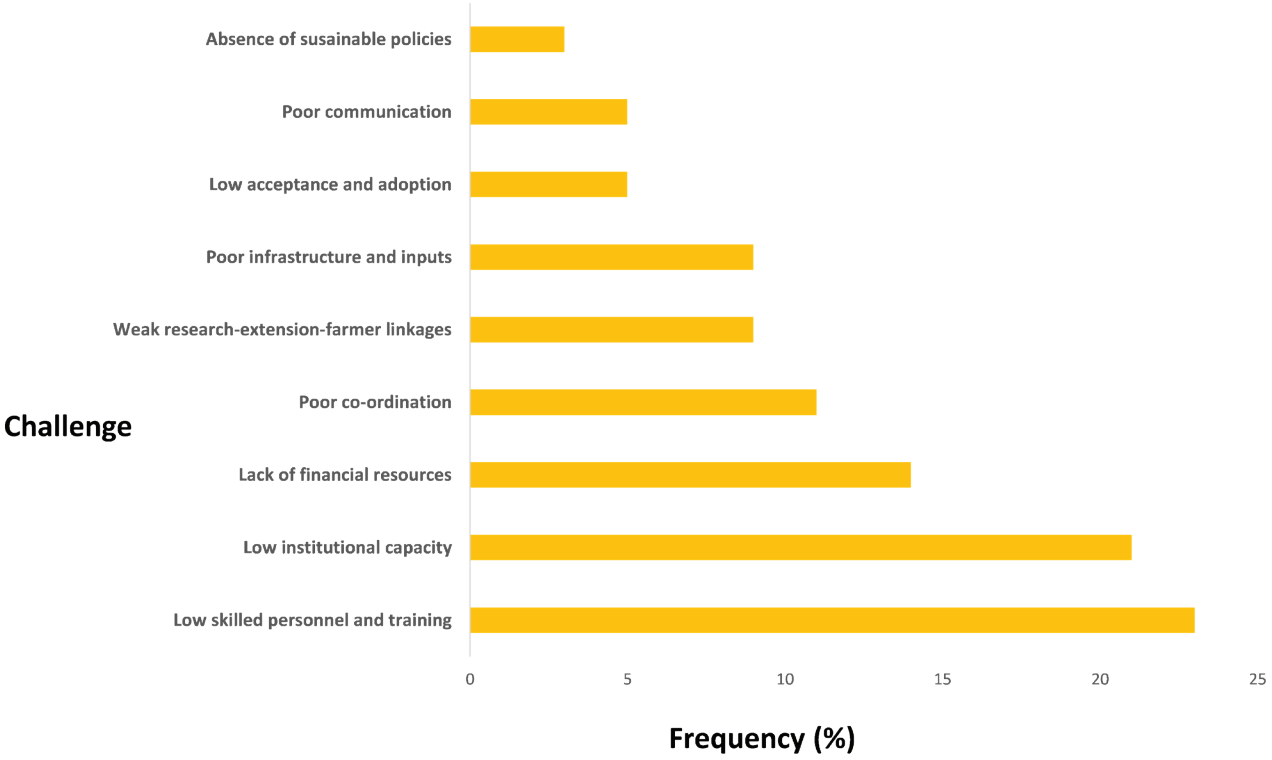


Figure 2: *Challenges encountered by respondents working with the NAES*

2.5 Current status in uptake and transfer of technologies

In Africa, the use of technology and innovations in the animal resources sector remains minimal, in spite of all these benefits which other parts of the world have taken advantage of over the years. For instance, precision farming has long been recognized as a major innovation of modern agriculture (Crookston 2006). Precision farming implies undertaking the right practice at the right location and time at the right intensity and utilizes information technology to obtain data from multiple sources. Since its inception in the early 1980s, precision farming has been adopted on millions of hectares of agricultural cropland around the world (Mulla and Khoslla, 2015). Precision Livestock Farming (PLF) creates a management system based on continuous automatic real time monitoring and control of production/reproduction, animal health and welfare and environmental impact of livestock production to enable farmers to detect and control the welfare status if their animals at any given time (Berckmans, 2014). Thus, PLF should help create a management system based on

control monitoring and control of production and reproduction, health and environmental impacts – house climate, weight and behaviour, water monitoring, sound monitoring, body temperature, feed monitoring among others. In Boxes 1, 2 and 3 we present examples of some of the innovative technologies in animal agriculture which are being exploited for improved efficiency in livestock production:

Box 1 Allflex Livestock Identification

Allflex provides an innovative technology for intelligent livestock management. This has evolved from more than 65 years of livestock development and experience which has made Allflex, a leader in technology innovation, product design, manufacturing process and customer service. Today animal owners around the world use Allflex visual tags, tissue sampling tags & collectors, and radio frequency tags (RFID) along with applicators and RFID readers, to participate in product branding programmes. These enable the farmers to comply with regulatory traceability and biosecurity programmes and to gather information which enables objective management and health decisions for improved productivity. This animal identification solution is backed by an excellent field staff providing customers with best-in-class technical services.

Website: *https://www.allflex.global/*

Box 2 SOOS Incubation technology

SOOS – Imagine a factory that throws away half of its production. This is how the egg-production industry works. Every year, commercial hatcheries around the world produce 15 billion chicks: 7.5 billion are females that can lay eggs, and 7.5 billion are males that have no commercial use and are therefore exterminated after they hatch. This practice involves major animal suffering and abuse, and a huge waste of energy, water, incubation space, and production capacity that could be used to ensure better nutritional security globally. SOOS has developed an incubation system that affect the sex development process in poultry embryo and turn genetic males into functional female chicks. The system operates an incubation protocol that control a combination of humidity, temperature, CO2 and air vibrations.

Website: *https://www.soos.org.il/*

Box 3 Beehome Technology

Beehome by Beewise is solar-powered beehouse and can house up to 40 bee colonies in an automatically controlled climate for optimal humidity conditions that can be conditioned by an app. Beehomes control the elements within the hive. Never worry about it being too hot or too cold for your bees. Humidity within the hive is an issue of the past; through efficient climate & humidity control, we optimize the climate so bees don't have to. Beehomes constantly monitor pests within the hive and apply pesticides where needed in real-time. The result is a significant reduction in infection, infestation and annual colony loss — as well as a reduction in the amount of pesticide being used.

Website: https://www.beewise.ag/

In spite of the availability of these scientific innovations and technologies, most smallholder animal farmers in Africa have little access even to science-based agricultural advice. On the other hand, widespread adoption and use of basic mobile phone technology presents opportunities to improve upon existing in-person agricultural extension efforts and provides a platform for inexpensive text and voice messages which can positively influence farmer behaviour. Smartphones with GPS systems create a potential for larger gains through the transmission of more sophisticated media, such as videos, and for locally customized information delivered at the appropriate time (Fabregas et al., 2019) to livestock

farmers. Mobile phones also facilitate two-way communication, whereby farmers can ask questions and request information and provide opportunities for networking and information exchange among farmers, watch videos demonstrating new agricultural techniques or take pictures of animal disease symptoms and request automatic identification and diagnosis (Fabregas et al., 2019).

2.6 Developers of available technologies and innovations

Respondents in our E-Survey identified technology/innovation developers in the animal resources sector in Africa (Figure 3) mainly as the private sector (29%), research institutions (26%), Government (25%), Farmer Groups/Associations (13%); vocational institutions (7%) and NGOs (1%). This was collaborated by the E-Discussion contributors who identified key technology and innovation developers in Africa as mostly computer scientists, animal scientists and other researchers in research institutes such as l'IRAF (l'Institut de Recherche Agricole et Forestière, the Technological Research Institute (IRT) and l'INSAB (Institut National Supérieur d'Agronomie et de Biotechnologie); universities, the national research system; Livestock development Projects; Private sector; International Trypano-tolerance Centre (ITC)/ West Africa Livestock Innovation Centre (WALIC).

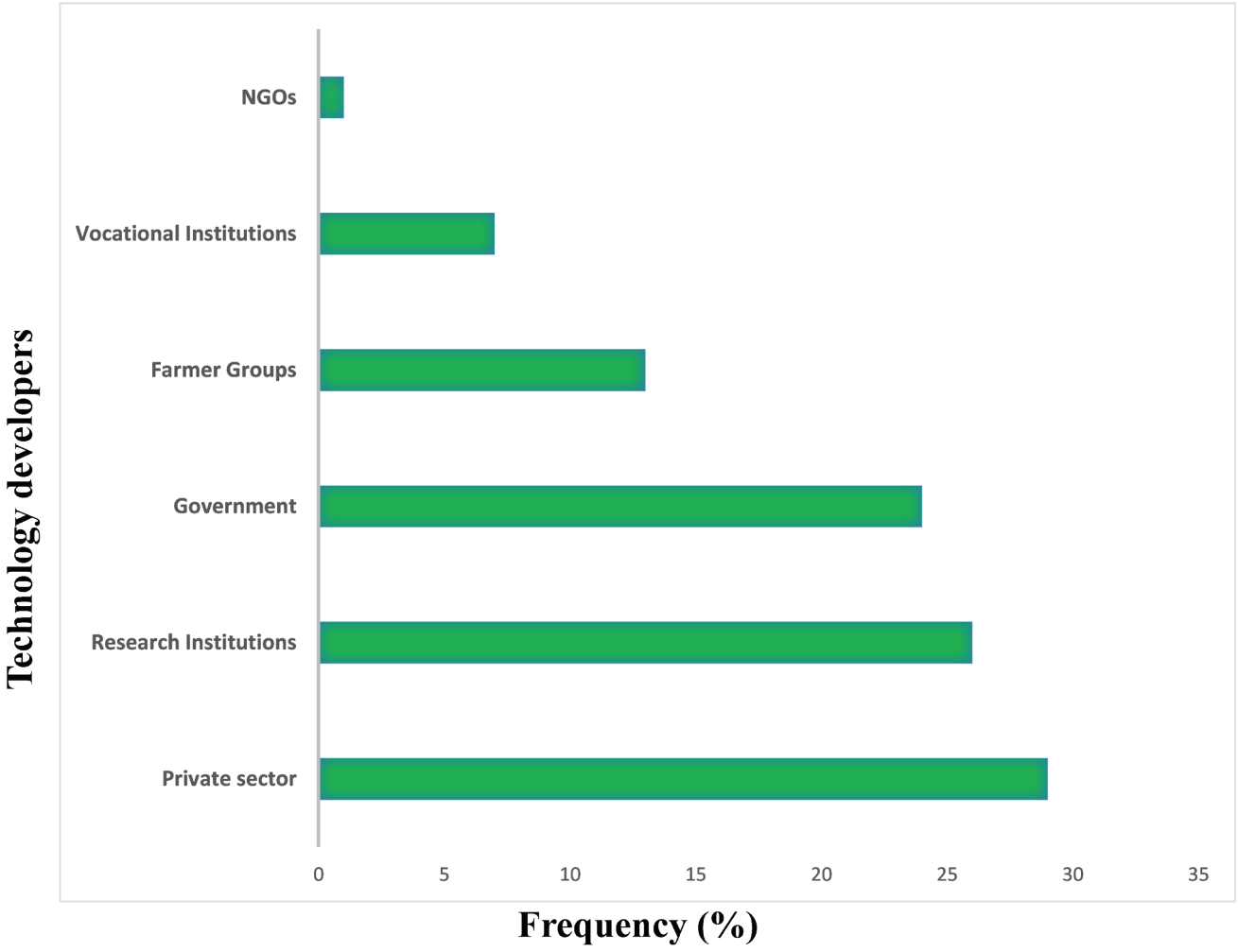


Figure 3: *Relative importance of technology developers in the animal resources sector*

2.7 Available Technologies in use in the Animal Resources sector in Africa

Some of the technological innovations in use in the animal resources sector in Africa include improved animal feed, genetic resources, improvement of species/breeds with a view to increasing performance; animal health packages; monitored breeding unit and use of WhatsApp platforms to exchange experiences between breeders. Mobile phones for money transfers and payment of products or bills, online data collection and transfer system (e.g., Open data kit-ODK) are in use in poultry and dairy research. The Ministry of Agriculture (MOA) in some countries such as Malawi, Guinea, Tunisia, Ghana, Gabon, Kenya and Nigeria have a call-in service where farmers can call and request advice on specific problems, they are faced with in animal agriculture. There are also initiatives providing market information to producers and primary livestock traders; artificial insemination to improve smallholder cow milk production. Additionally, feed storage infrastructure ensures feed availability during the period of scarcity. The open nucleus breeding system (ONBS) helps make genetically improved elite males to small scale farmers whilst innovations such as biogas production from animal manure provides alternate energy for agricultural purposes.

Poultry farmers use breeding, nutrition and disease control innovations/technologies to improve chicken production. Improved cockerels have been introduced into the local germplasm in a number of African countries including Tanzania, Nigeria, Ghana among others as exemplified by local hens are crossed with for example Black Australorpe cocks in Malawi to get improved offspring in terms of meat and egg production. Poultry farmers are also adopting incubation services where individuals in urban centres who have access to electricity, hatch and sell day old chicks to farmers or provide incubation services. There are also some select processors who make affordable chickens feed. However, with appropriate training, farmers are able to formulate feed for their flock and hence reduce production costs. In Ghana the NAES have developed a number of packages for poultry farmers including supplementary feeding, routine vaccination, housing of animals, mineral supplementation, cleaning of housing, detection and isolation of sick animals, de-ticking and hoof trimming. It is expected that the adoption of these technologies will result in an increase in stock numbers and will help ensure an all-year-round household food security (Dumeh, 2011).

2.8 Technology Uptake and Transfer in the Animal Resources Sector

In animal husbandry milking, feeding, environmental control, reproductive performance requires daily management decisions and provide opportunities for automation technologies and systems. Some of these include electronic recording, milking, heat detection auto-weighing, auto-drafting, genetic improvement, feeding, barn optimization, and health monitoring, livestock housing and equipment designs. These technologies among others provide to dairyman many opportunities to make easier and more convenient their decisions about dairy future plans (Göncü and Güngör, 2018). Results of the present survey indicates that the most popular technologies in the dairy, poultry and apiculture sectors in Africa and which the NAES have successfully adopted and transferred to actors in some sectors and which can potentially attract donor investments are as described in the following sections.

In the dairy cattle sector relevant technologies from the findings of E-Survey shown in Figure 4 include Artificial Insemination (28%), Feed supplements (17%), Milking Machine (12%), Oestrus Synchronization (11%), Milk pasteurizing equipment (11%), Breeding and selection programmes (7%), Tractor operated hay bailers (6%), GPS Ear Tags (4%), Hydroponics fodder machine (3%), Embryo Transfer (3%), Biogas production (3%), solar powered equipment (2%), Drones for grazing management and other uses (1%), Robotic Milking Machine (0.5%).

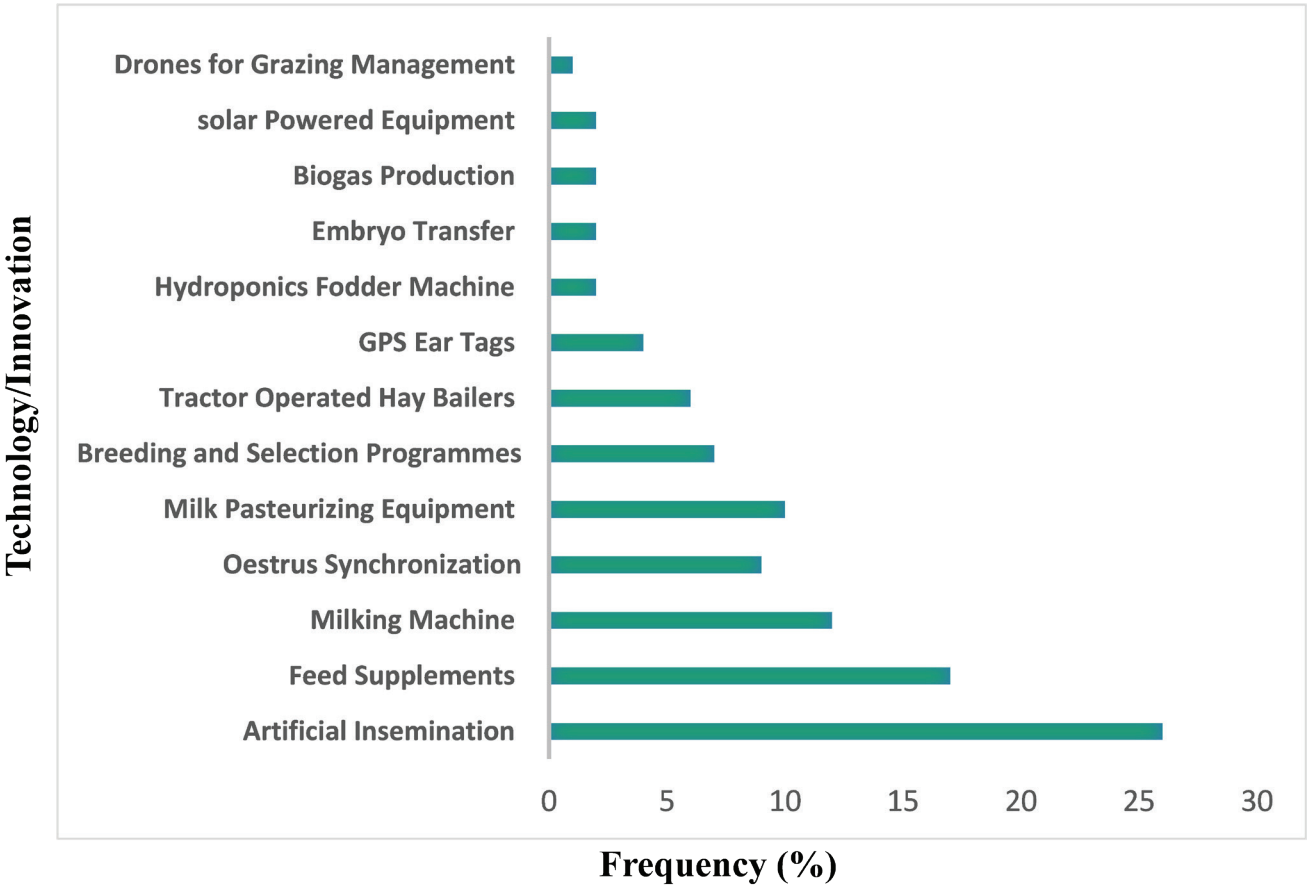


Figure 4: *Innovative Technologies in Dairy Sector*

Figure 5 shows popular technologies in the poultry sector: electric incubators (15%), automatic water drinkers (14%), ventilation fans to cool chicken houses (10%); automatic chick feeders (9%); smart lighting for chicken houses (7%); protein enriched feed (7%); automated layer management (6%); solar incubator (6%); smart poultry houses (5%); feed intake and body weight monitoring based on PLA (4%); co-operative incubation (4%); biogas production (4%); egg sexing (3%); integrating supply chain with digital technology (2%); artificial insemination in chickens (2%); ammonia production sensors (1%) and smart cameras in chicken houses (1%).

As indicated in Figure 6, in the bee Keeping/apiculture sector, respondents indicated modern bee hives (48%), new techniques for bee and honey production and honey distribution (31%) and honey processing equipment (21%) as the most relevant technologies.

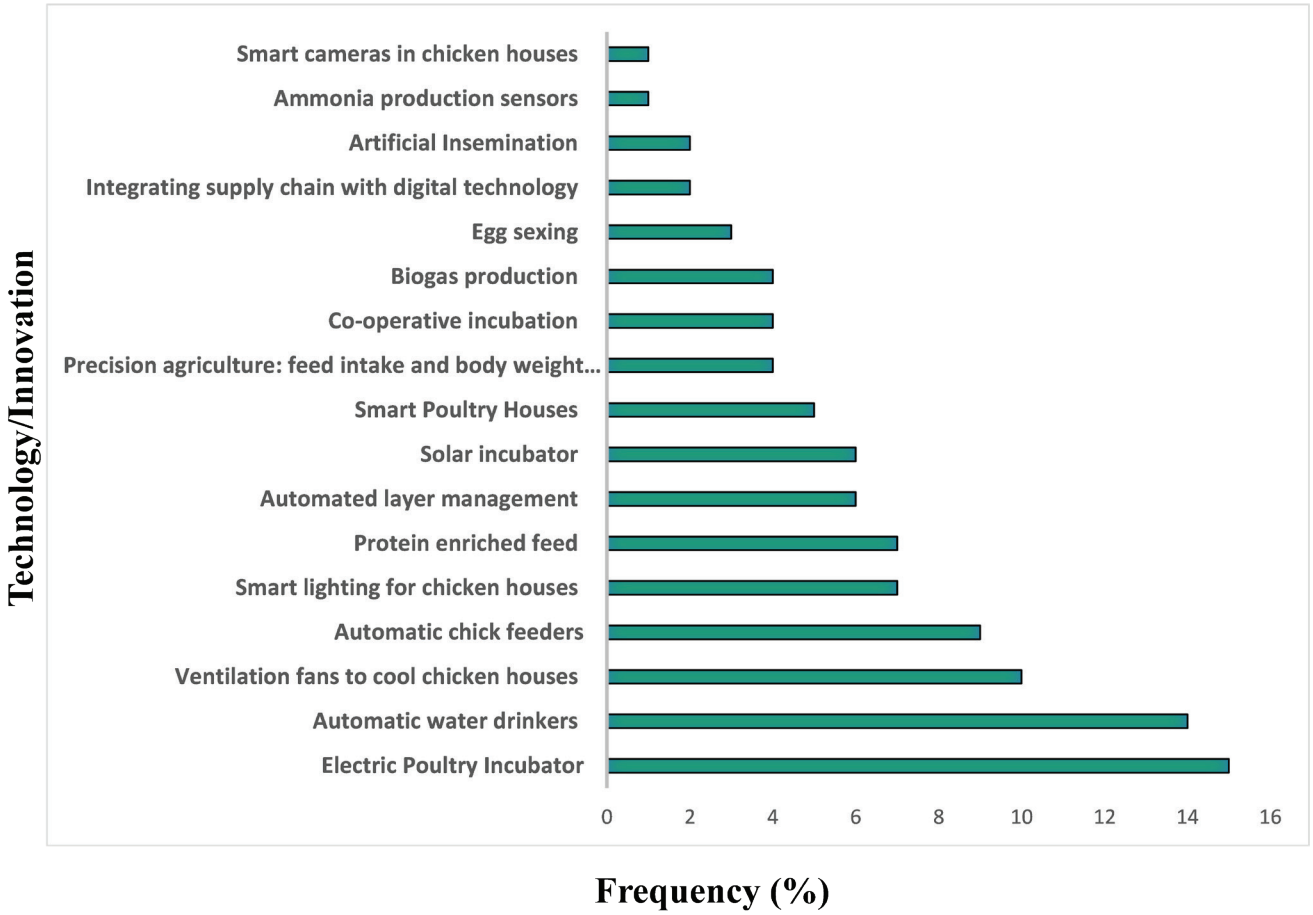


Figure 5: *Innovative Technologies in Poultry Production*

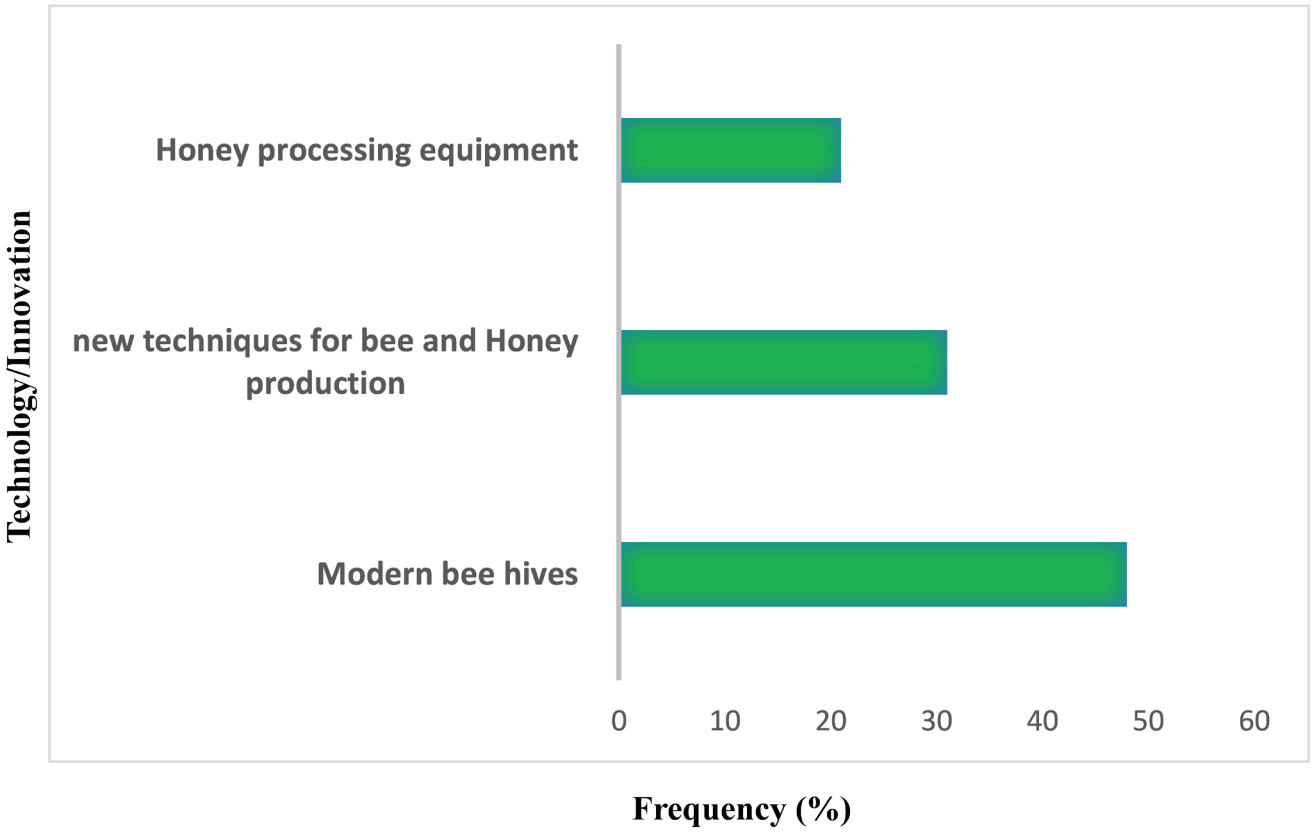


Figure 6: *Technologies in the apiculture sector*

CHAPTER 3: CHALLENGES IN TECHNOLOGY ADOPTION AND TRANSFER IN THE ANIMAL RESOURCES SECTOR IN AFRICA

3.1 Introduction

A plethora of challenges are faced by stakeholders in Africa as regards adoption and transfer of innovations and technologies in the animal resources sector. Over the years, inadequate support to the extension delivery system, marginalization of breeding associations, institutional bottlenecks including lack of suitable credit structures, lack of adequate capital to get inputs and late supply of inputs, failure to supply breeding inputs and insufficient technical field staff have hampered technology adoption. The challenges hindering smooth adoption and transfer of innovations and technologies in the animal resource sector include:

- lack of appropriate policies and legislative instruments on technology development;
- weak institutional and human resource capacities;
- lack/insufficiency of advisory support services;
- low private sector participation in technology development, uptake and transfer;
- low motivation and insufficient training of NAES agents;
- poor appreciation of the value of technology by key stakeholders;
- conservative farmers unwilling to try innovations;
- poor conditions of service/low motivation of NAES personnel;
- insufficient numbers skilled personnel/NAES staff;
- inadequate financial mechanisms/funding for the NAES;
- poor collaboration and coordination between NAES and key stakeholders.

Table 1 presents a summary of these challenges across stakeholders on the animal resource value chain.

Table 1: *Key challenges faced by stakeholders in technology uptake and transfer*

Livestock Keepers	Government	Private Sector	Regional Communities
Low literacy levels	Absence of pro technology policies	Poor infrastructure and network coverage	Unequal penetration of digital technology across countries
Poor internet connectivity	Institutional deficiencies of NAES	Poor internet connectivity	Heterogeneity in ICT infrastructure and expertise across countries
Poor /no electricity availability	Low internet coverage	Poor policies and investment climate including high taxes	Lack of regional policies on e-extension
Low appreciation of technology	Absence of electricity	Copyright violations, etc.	Lack of a funding mechanism for regional e-extension
Difficulty in assessing NAES services	Inadequate skilled personnel		Poor infrastructure for information sharing on digital agriculture
Low access to information of innovations/technologies	Lack of funds/low budgetary allocation		

Livestock Keepers	Government	Private Sector	Regional Communities
Inadequate human and financial resources	Remote locations of end users and the difficulties in reaching them		

3.2 Findings of E-Survey and E-Discussion

3.2.1 Challenges faced by the NAES

Some of the key challenges faced by the National Agricultural Extension Service (NAES) with regards to technology uptake and transfer in the animal resources sector in Africa include lack of appropriate technical infrastructure, non-suitability or poor understanding of technology and inappropriate technology transfer systems. E-Survey respondents confirmed that the NAES face these challenges regarding technology adoption with 28% indicating low capacity, limited technical skill and outreach and resources (Figure 7). Low awareness of the value of innovative technologies, poor communication and dissemination, inappropriate packaging, low support for adoption, unregulated service delivery, misplaced priorities, traditional public extension system were identified by a fifth of respondents (20%). Additionally, 15% of respondents indicated budgetary/funding constraints. Other challenges enumerated were weak farmer-extension linkage, poor co-ordination (10%); irregular training and capacity building, lack of policies, guidelines, SOPs (9%); non suitability or sustainability, inappropriate technology, livestock deficient technologies, low entrepreneurship in livestock (7%). Slow adoption rate by farmers due to cultural believes (5%), failure to link technology development to markets and market information (1%) and COVID-related illness (1%) completed the list of identified challenges.

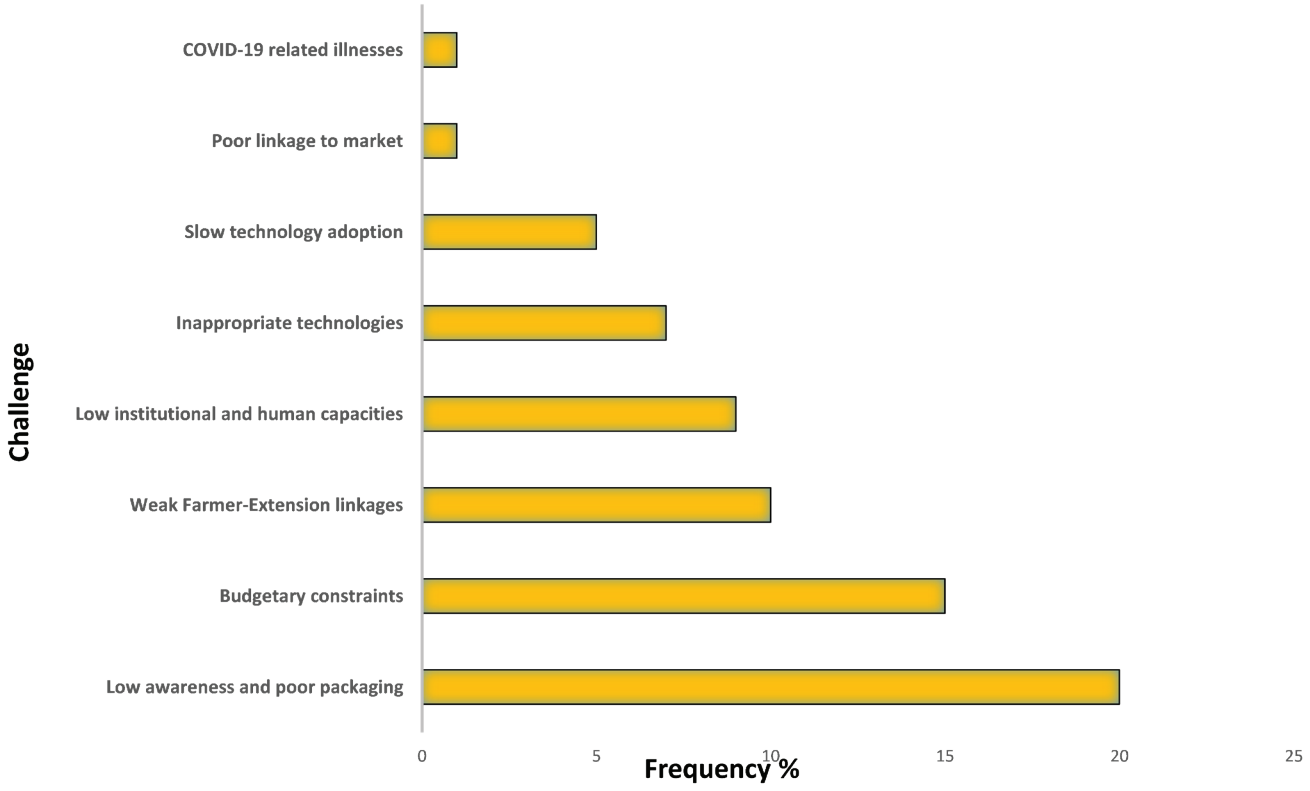


Figure 7: *Challenges affecting technology adoption and transfer*

3.2.2 *Challenges faced by Livestock Keepers*

Participants in our E-survey shared the following as challenges faced by livestock keepers regarding the uptake of digital technologies (Figure 8). Low educational level of farmers, lack of technology skill and user experience, illiteracy, aged farmers (18%); low awareness, lack of information about the value of digital technology, ignorance, low adoption rate (18%); poor network access, unavailability of internet connectivity (17%); cost of technology, lack of funds, no budgetary allocation by government, inflation, inability of farmers to afford the technology (15%); unavailability of gadgets such as smart phones, tablets, apps, platforms (14%); low resource base of NAES, infrastructural challenges (electricity, transport, roads, etc) (7%); non-availability of suitable/appropriate technology to meet needs of famers (6%); inadequate, ageing NAES staff, logistical challenges, livestock not given place of importance (5%).

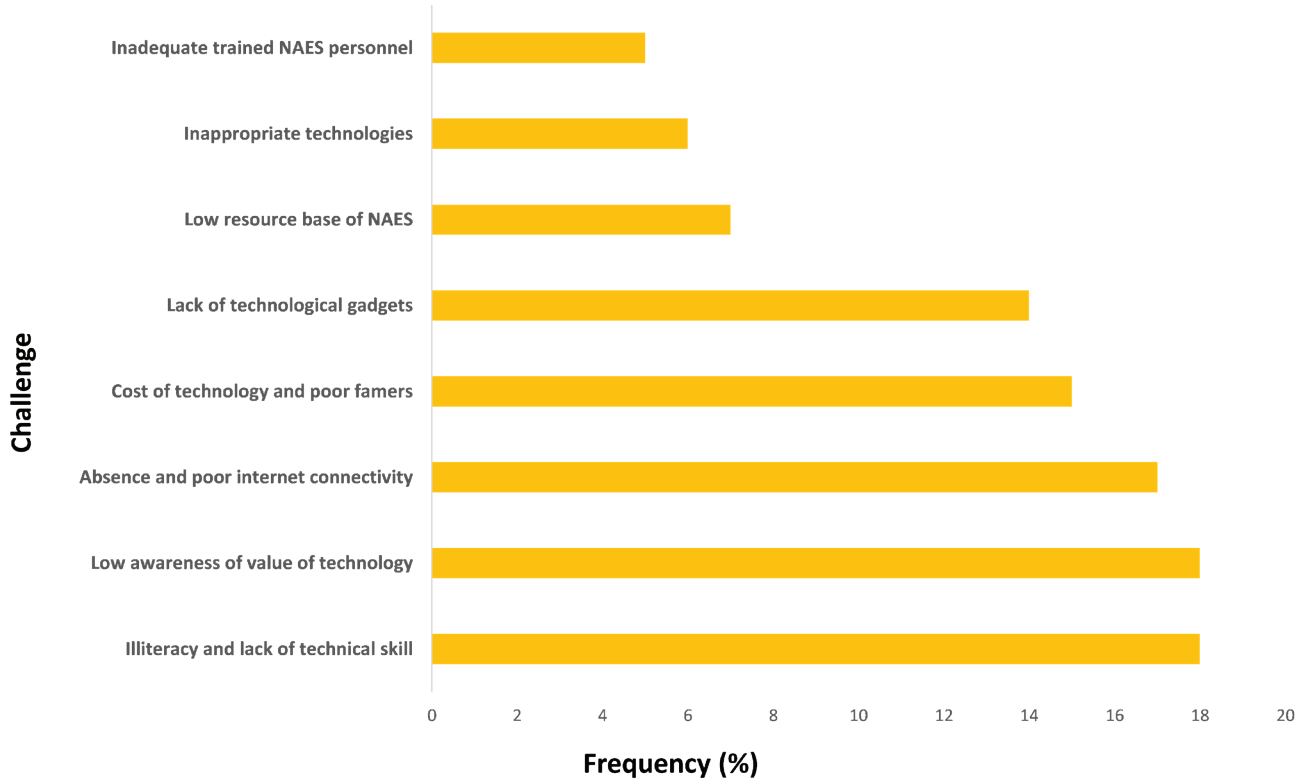


Figure 8: *Challenges faced by livestock keepers in technology adoption*

3.2.3 *Challenges faced by Governments*

Figure 9 presents the relative importance of various challenges faced by Governments in the use of innovations and technologies in Africa. These include lack of appropriate, enabling policy, investor non-friendly policies, bureaucracies, high tax on technological infrastructure and equipment (21%); budgetary issues/lack of funds to roll out the digital technology to every corner of the country (17%); failure of technology to address urgent challenges, poor consultation and co-ordination, non-involvement of stakeholders in technology development (15%); resource challenges, lack of appropriate and sustainable network infrastructure, software, technical development centre (16%); lack of expertise and skilled personnel to install and maintain digital technology (14%); cost of technology, internet service, poor farmers (7%); low level of capacity building, inability to train personnel (5%); ageing NAES staff, insufficient numbers of NAES personnel (3%); insecurity and political instability (2%).

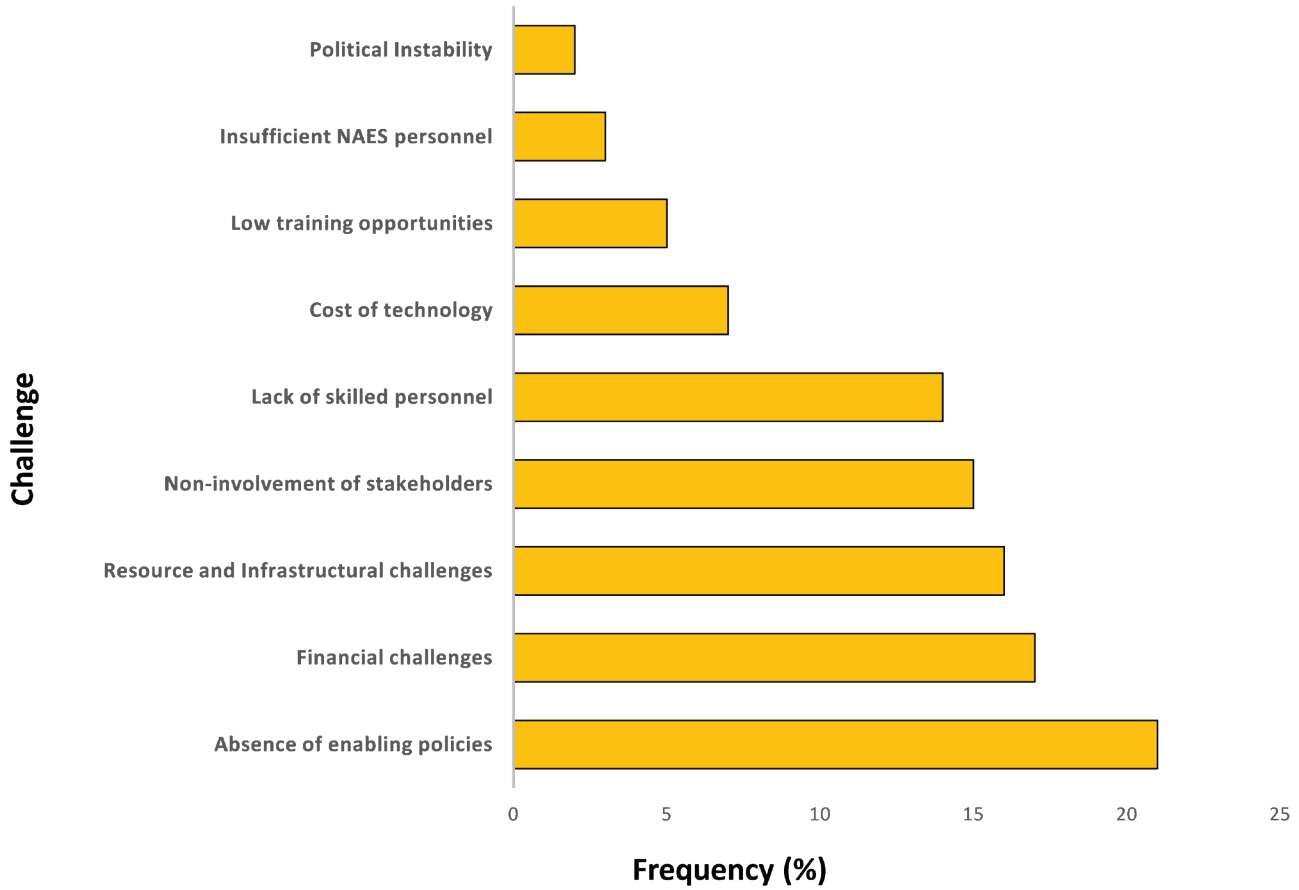


Figure 9: *Challenges faced by national Governments in technology adoption and transfer*

3.2.4 Challenges faced by the Private sector

The findings of the survey re-enforced the main challenges experienced with uptake of digital technologies by the private sector are as shown in Figure 10. Lack of budgetary allocation, funding to support technology development and uptake (25%); poor technology infrastructure and internet connectivity, lack of professional organisational structure and low institutional capacity (18%); failure of technology to address urgent need, non-suitability/appropriateness of technology, non-sustainability of technology (14%); poor skilled human resource base to develop, maintain and support technology development and uptake (12%); failure to involve the private sector, poor collaboration between stakeholders, competition between private and public sector actors (10%); country policy and politics do not support technology development and adoption, lack of appropriate legislative protection, poor livestock technology specific investment incentives (9%); low awareness, educational level of farmers, lack of knowledge and benefits of technology (7%); low adoption rate, low return on investments in such technologies (3%); lack of electricity and solar energy to power such technology development (2%).

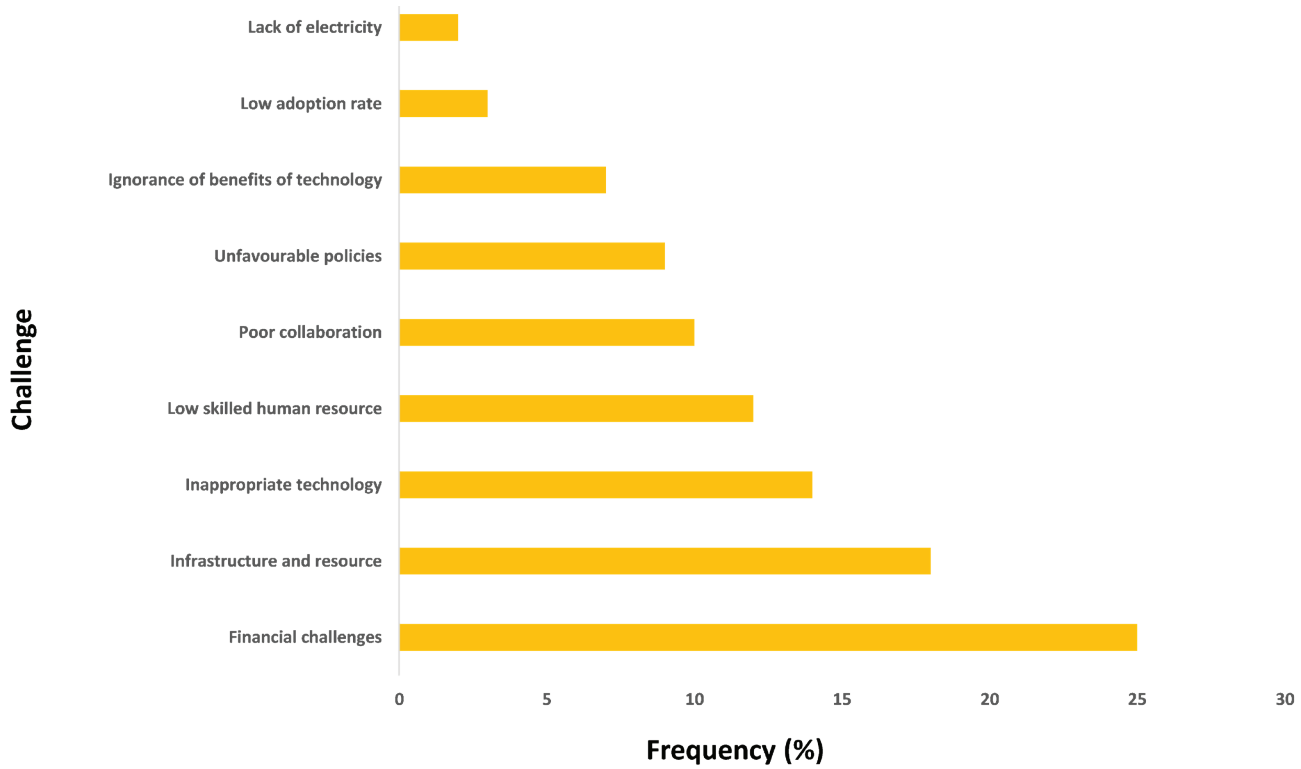


Figure 10: *Challenges faced by the private sector in technology adoption and transfer*

3.2.5 Challenges faced by Regional Communities

In terms of the relative importance of these factors, findings of the survey show that challenges that may be experienced with uptake of digital technologies by the Regional Communities (Figure 11) were as follows. Lack of political will, low commitment of regional governments to introduce digital technologies in animal farming, lack of regional market, low inter-regional trade (20%); cost of technology, lack of funding, low income of farmers (17%); lack of regional policies on livestock related technologies, poor corporation, heterogeneity in digital technology development and use (16%); poor human resource capacity, low level of skilled personnel (15%); poor infrastructure, resource limitation, poor internet coverage (10%); suitability and sustainability of technology, failure of technology to address specific needs of farmers (8%); low awareness of the value of such technologies and high illiteracy among farmers (7%); lack of electricity and solar energy (3%); language barriers (1%).

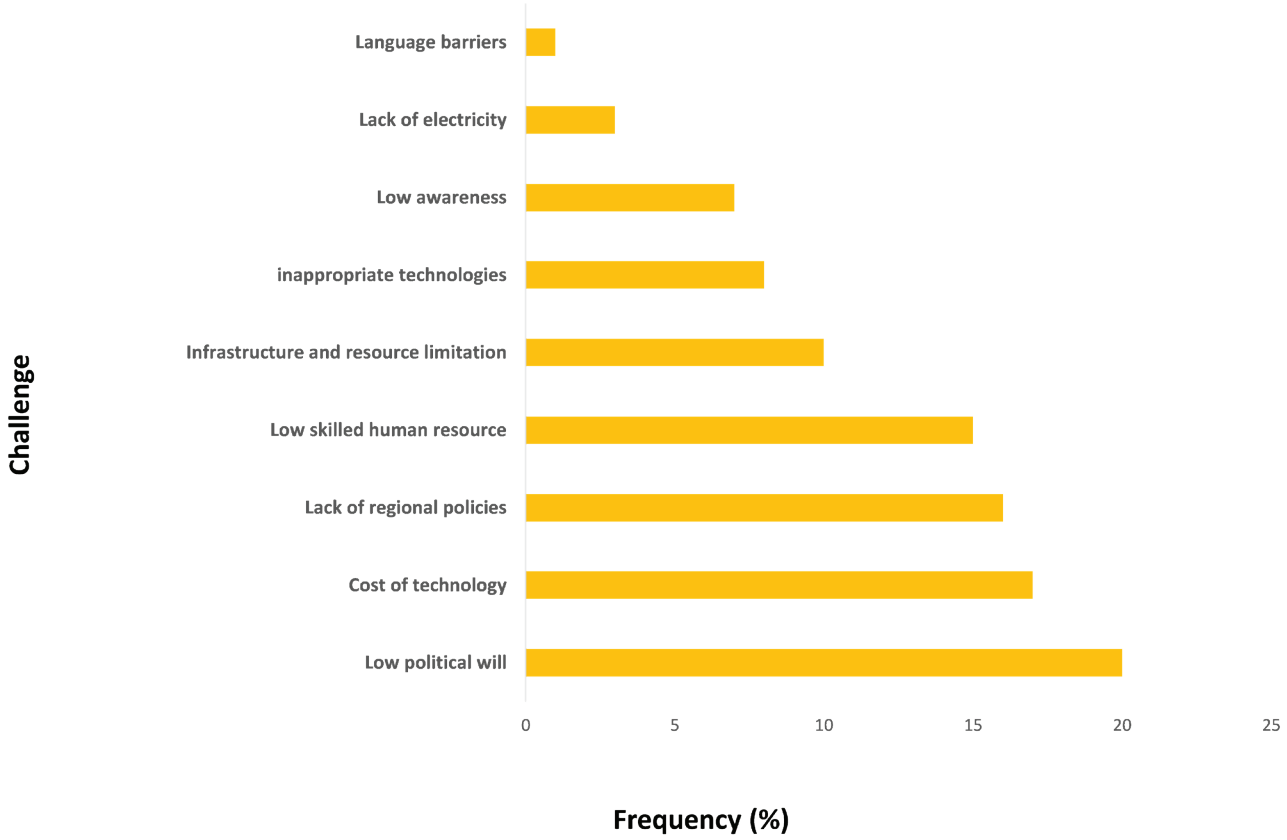


Figure 11: *Challenges faced by Regional Communities in technology adoption and transfer*

3.3 Infrastructural and resource challenges

Inadequate transportation networks, unreliable telecommunications, and intermittent electricity are also contributing to sluggish adoption of technologies in the livestock sector. As proposed by an E-discussion participant from Gabon there is need for NAES to be encouraged to improve the efficiency of its services, in particular the training of staff from the support-advisory services; also provide field and financial equipment. Stakeholders who find themselves in resource deficient environments may not be interested in the technology irrespective of its benefits. On the other hand, where government provides a certain minimum platform, it becomes easier for the NAES to convince stakeholders to use the innovation or technology being introduced. Most of the technologies requires electricity and internet connectivity and it is important to ensure that these basic facilities are available as much as possible.

3.4 Poor and Dysfunctional Training and Research Capacities

Other challenges include inadequate and underperforming Livestock and Farmer-Training Centres, conflicting methodology in extension delivery between public and private sector players as well as constrained access to agricultural information and technology due to gender inequality. Another challenge is the limited research in animal improvement within the indigenous animals using simple strategies such as selection of breeding males and females within the breed and continue improving the pedigree up to a level where their production can be close to exotic animals which are expensive to buy and maintain since they are big and produce more so small holder farmers are unable to maintain them. This is because there are a few animal breeders and most of them are in academia and not in research institutions where their contribution in breed development through selection could have been useful.

A stronger institutional collaboration may be useful in overcoming these challenges. Limited research, infrastructure and technical capacity in the development of technologies that can help to reduce or control animal diseases amongst the animal species and breeds will be useful in countries such as Malawi. This is so because livestock research in these countries focuses on animal production and productivity improvement through nutrition, cross breeding and use of exotic breeds and not vaccine or drug development to control some of the diseases that the country face.

3.5 Lack and/or Low Budget Availability

Sustainable capacity building of actors, poor financing the NAES to make an impact in the animal resources sector, insufficiency of technical advisory services, low motivation of NAES and insufficient training of NAES personnel remains is a challenge in many African countries including Guinea and Gabon. There is need maintain and improve the level of technical skills of NAES personnel and other actors on the technology uptake and transfer chain.

In Malawi for example, few technologies are being developed through the Department of Agricultural Research Services under Livestock and Pastures Commodity Group due to low funding towards technology development, lack of technical capacity, tools and infrastructure in the development of technologies that can improve livestock production and productivity and household and community levels. Most technologies developed focuses on animal nutrition through use of locally available raw materials so that the feed or ration developed should be cheap, affordable and readily available for sustainable livestock production across the country, most technologies developed focuses on animal nutrition through use of locally available raw materials so that the feed or ration developed should be cheap, affordable and readily available for sustainable livestock production across the country. There is thus a need to work as a team in developing livestock technologies so that animal productivity is improved through improved pasture establishment, development of balanced feed ration using locally available raw materials together with genetic improvement and disease control.

3.6 Inappropriate policy and legislative environment

Most of the countries in Africa do not have specific policy and regulatory frameworks targeted at use of technologies in agriculture or the animal resource sector in particular. There are policies and legislative instruments on science, technologies and innovations in general. Our review and discussion with keyholders working in various countries however indicate that some countries have incorporated the use of technologies in agriculture as a key strategic policy. Additionally, where policies exist, governments lack adequate administrative or financial capital to implement or enforce legislation. This constraint is even more acute for local governments. At the national level, livestock ministries are often politically marginalised and under-funded. In addition to the national legislative frameworks considered so far, there have been advances in bilateral and regional agreements to govern livestock mobility (especially in West Africa). There is also a regional scheme in Central Africa involving Chad, but no such agreements in East Africa. Niger has one of the more progressive legislative frameworks governing livestock mobility, however, there are problems of implementation, overly rigid productive land use conditions and pastoralist representation in local government (Dyer, 2018). Farmers' adoption of interrelated

innovations suggests the need to coordinate individual policies aimed at encouraging uptake of different technologies. For instance, animal health policies requiring regulatory compliance may lead to voluntary uptake of additional or complementary technologies which relate to not just meeting but exceeding standards of animal welfare and health practices (Liu et al. 2019). In general, the legal framework for animal health is a positive step for the dairy sector, especially as the exotic breeds and crossbreds are more susceptible to diseases than indigenous breeds. The policy on germplasm development is mainly based on three pillars: legislation (genetic improvement act, creation of CNAG), livestock development projects with a component on genetic improvement (PAPEL, PRODAM, PDESOC) and national AI programs (PNIA, PSIA and FNRAA-EISMV project in a lesser extent) (Seck et al., 2016).

Most African countries are at different levels with regard to animal welfare laws, legislation policies, and regulatory frameworks such as the OIE standards. Policies, standards and legislation are observed to be either lacking, inadequate, outdated or inadequately enforced. Similarly, despite all countries being signatories to the OIE standards, there is often limited understanding and subsequent minimal compliance with the standards primarily due to the lack of implementation capacity and the need for elaboration into country and context specific measures (AU-IBAR, 2017). National policies, although not legally binding, have their relevance in the context of national legal frameworks because they set forth national priorities and could set the basis for the implementation of existing legislation and the development of future national legislation and/or strengthen the existing one. National policies of relevance to AnGR generally focus on the agricultural sector and in particular the development of the livestock industry. There are several policy instruments with direct or indirect impact on management of animal genetic resources. These encompass land-use policy, agriculture policies and strategies, specific livestock development strategies, biodiversity strategies, human health protection, and policies related to governance and civil society organizations. Such policies provide a basis for setting developmental goals and objectives that influence the livestock sector as a whole, including the management of animal genetic resources. Agricultural policies also often contain goals for the sustainable development of rural areas, protection of the natural environment and cultural heritage. The livestock development policy/strategy may constitute an integral part of agricultural policy, or it may be adopted as a separate policy document establishing developmental goals for the livestock sector.

The most extensive legislation worldwide is in the area of animal health and prevention of animal borne diseases. The impact of such legislation on import/export and market access has been greatest for those countries, especially in the developing world, whose infrastructure and legislative framework was not sufficiently developed to face the challenge. Many developing countries have also suffered from rapid changes in the legislative framework of trading partners (mainly the EU). National legislation is relatively well developed to address specific aspects of animal breeding strategies and production, and certain aspects of land and farm management. Adequate legislation regarding the management of AnGR for use and conservation should address all issues involved and achieve a better balance of development in the different areas, to respond to country needs (Ingrassia et al., 2005).

Additionally, investors may not introduce certain technologies without appropriate policy and regulatory framework being in place. Drones have a broad applicability the business sectors of agriculture, health, mining, and infrastructure to support tasks such as surveying, humanitarian work, disaster risk management, and research. Being open-source technology that can flexibly reconfigure makes it challenging to develop policies and tools to support implementation (Ayamga et al., 2020).

CHAPTER 4: LESSONS LEARNT AND BEST PRACTICES

4.1 Advocacy and Awareness Creation

Africa needs as a matter of urgency to promote digital technology and drive e-extension services in the animal resources sector. The findings of the E-Survey indicates that almost a third (32%) of respondents call on national governments to provide appropriate infrastructure and encourage use of mobile phone, smart phones, tablets, digital green, GPS location of farmers and appropriate apps in agricultural extension services.

The need to pursue the most sustainable and appropriate technologies in animal identification, traceability, health monitoring, nutrition, reproduction including AI, drones for pasture management, automated machines and smart lighting was recommended by over a fifth of respondents (23%). A further 16% of respondents stressed the need to explore e-marketing, communication, online registration of farmers, clients, service providers, virtual meetings, development and sharing of standard templates of key messages for the digital services. A little over a tenth (12%) call for promotion of digital services to complement existing agricultural extension services transformation, massive sensitization on importance of E-Extension on radio and television, provision of reliable internet connectivity, supporting website development for service providers. Capacity building for NAES personnel, training of trainers and stakeholders was also recommended by 14% of respondents. The need for improved stakeholder/ private sector participation, needs assessment and categorization of farmers (2%) and expansion of electricity and solar energy (1%) were also recommended. For the adopted technologies, participants ranked the transfer or acceptance rate by the target group (farmers/animal breeders, processors and livestock traders) as follows (Figure 12): Excellent (1%); Very Good (11%); Good (42%); Average (37%); Poor (9%) justifying the need to improve on technology adoption and transfer.

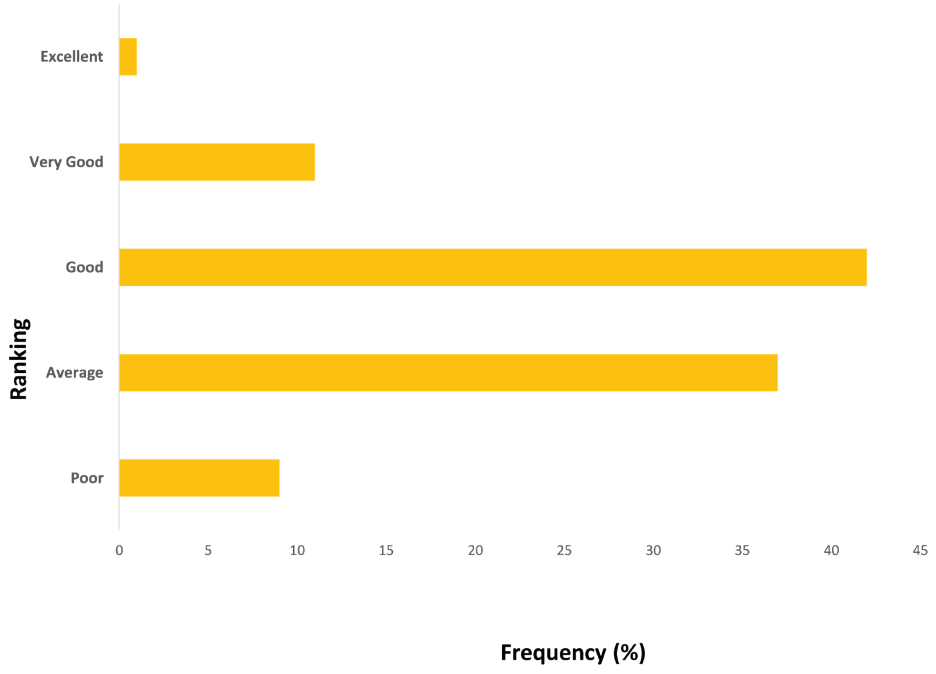


Figure 12: *Ranking of uptake of adopted technologies by stakeholders*

From our E-discussion, participants indicated the importance of digital technologies in agriculture including e-marketing tools, weather forecasting tools, e-extension, mobile money services among others. Digital tools can be used in applications for gross margin calculation to help farmers better understand their own costs and help improve on decision-making. E–finance services for mobile money transfers (MTN Momo, VFCash, airtel money, Mobicash, Money gram, Western Union, Orange money), payments, credit and savings; marketing tools and E–extension on specific species and breeds of livestock including farm management software newspapers; flyers; movies to help improve production are areas to explore. Additionally, E–marketing opportunities exist to provide access to information on pricing of agricultural inputs and animal products.

Community radios and online Apps can be used to promote sales of livestock products, especially poultry (eggs, feed, day-old chicks, veterinary inputs). In terms of animal health, E–veterinary services can provide stakeholders with information on how to prevent animal diseases including vaccinations, dipping, deworming and good animal husbandry. Digital platforms also offer unique opportunity to use electronic extension tools such as E–query redress to provide practical solutions and timely feedback to challenges and questions from livestock farmers. Many agricultural extension workers already have smartphones and thus could download information on animal husbandry including source of improved genetic material, feed resources, diseases, veterinary services, niche markets as well as information needed to respond to farmer queries. Automatic notifications can allow extension agents to alert farmers in their region when they are visiting them or conducting training sessions. Mobile phones could also be used to improve accountability among extension workers—for example, by allowing extension workers and their supervisors to set goals and track performance, enabling automatic collection of feedback from farmers, or tracking whether extension agents actually visit farmers. Finally, digital agricultural services can improve the functioning of agricultural supply chains. For example, these services could make it easier for farmers to check and compare input or output prices, potentially lowering mark ups; notify farmers whether inputs are in stock with particular dealers; and facilitate coordination among farmers in an area and with traders (Fabregas et al., 2019). Development and application of innovative and efficient methods of data collection including use of mobile phone technology will generate large amount of data from herds and flocks located at different places, and if georeferenced will enable such data to be linked with related global meta-weather and soil data thus enriching the dataset (Mrode et al., 2020).

4.2 Ownership

There is need to develop appropriate technologies and innovations with stakeholders to effectively promote the livestock sector and to resolve issues relating to animal health, animal feed, herd management and processing. A very good example of such fruitful partnerships from Morocco is the National Association for Sheep and Goat Breeders (ANOC) which since 1980 has supported small-scale farmers with improved genetics, feeding and other technical backstopping, Respondents of the E-Survey indicate key components of the animal value chain which are likely to adopt digital technologies as Animal Health/Disease Surveillance/Vaccination (25%); Breeding/Reproduction; (21%) Marketing (19%); Performance Recording/Traceability (12%); Feeding/Nutrition (11%); Conservation (10%); Processing

(2%). It is well established that farmers will invest in and implement sustainable technologies and farm practices if they expect their investments to be profitable, if they have the right education, information and motivation, and if government policies set clear goals. The challenge is to identify what technologies work best in specific circumstances, and define and provide the right incentive framework, so as to facilitate the achievement of sustainability goals in ways that enhance global welfare, in accordance with policy. Sustainable technologies are implemented at the farm level; thus, a key requirement is to engage farmers in the dialogue on technology adoption. Ideally, there should be a greater sense of "ownership" throughout the agri-food chain in the choice of technology. It is important to discourage the practice whereby research institutions constantly introduce new technologies to smallholder farmers with the view of improving their livelihood through increased production and productivity forgetting that farmers also have the ability to innovate and develop indigenous knowledge and technologies to address their specific problems.

Needs assessment of technology needs should be done and seek if it is possible to get these within country or from other African countries before importing from outside Africa. The human capacity/ institution building model must replace long term technical assistance in order to develop national research capacity (Ehui and Shapirro, 2011). National campaigns, local advertisements, training of animal resource farmers and free flow of information on available technologies on all media and how to access them should be popularised by government.

In terms of the success stories in technology adoption and transfer, participants enumerated the following reasons for successful adoption and transfer of technologies/innovations by the NAES (Figure 13) - increased production of animal products (17%); consistent donor support (15%); well trained and motivated NAES staff (13%); farmer co-operation (13%); ease of adoption of select technologies/ innovations (13%); Government political good will through budgetary allocations (11%); good collaboration between Technology service provider and NAES (11%); Community based support (7%), effective organisational set up of the NAES (0.3%).

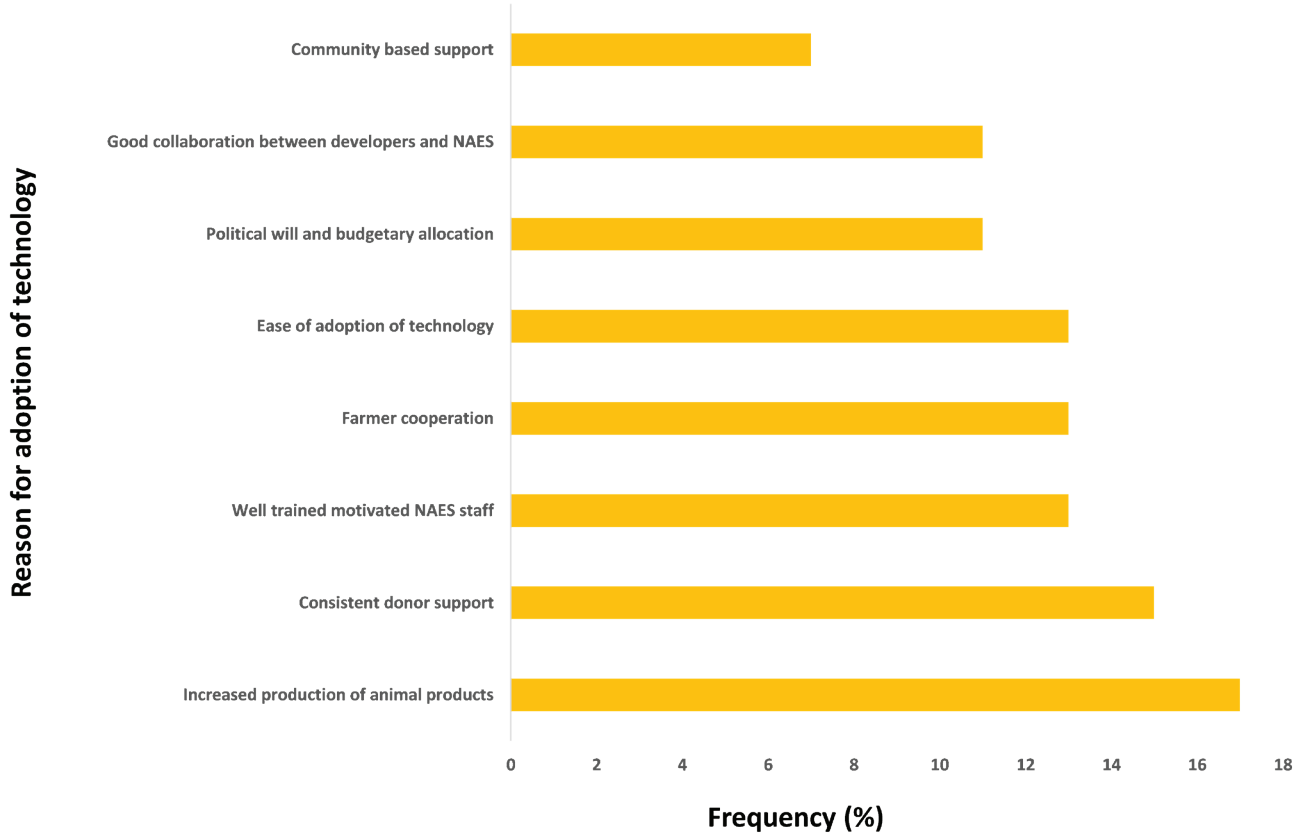


Figure 13: *Best practises for transfer and uptake of technologies and innovations by NAES*

4.3 Funding Mechanism

Given the major challenge of poor funding mechanism for technology adoption and transfer in Africa, participants of the E-Discussion provided best practices to drive governments to have a sustainable funding mechanism to improve the extension service delivery of NAES and other stakeholders:

- have a National Agricultural Extension Agency (NAEA) whose mandate shall be to mobilize and coordinate resources for technical support in disseminating technologies to implement the national plans and priority programmes;
- collaborate with international and regional partners to harness infrastructure and technology development, technology dissemination through knowledge aid as part of official development assistance which can focus on value-chain development schemes, foreign direct investment and project funding for industrial and physical infrastructure
- draft a summary document on the achievements of NAES over the past 20 years as a basis for attracting further donor funding for future programmes (the case of Guinea);

Again, it has to be noted that most of the support provided by governments come from donor funding and this lack of commitment by national governments need to change. There is therefore a need for a change in policy to establish a funding mechanism for the development, adoption and transfer of innovations to livestock farmers. Most of these technologies (84%) are imported into African countries with a few originating from the countries (16%). Imported technologies originate mostly from Europe and the UK (44%), other African countries (28%); America (18%) and Asia (10%). For successful development,

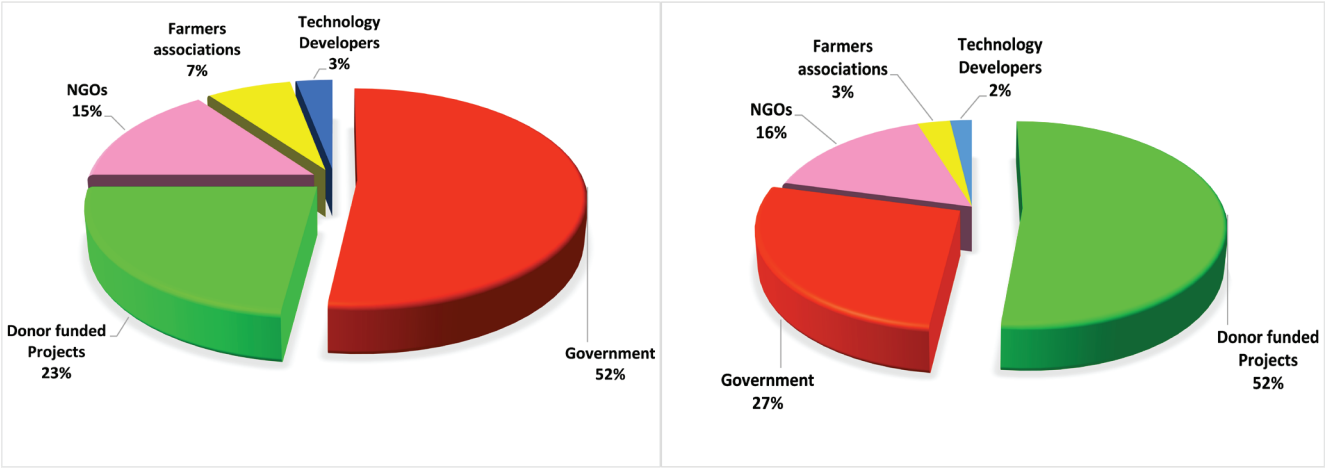
adoption and transfer of innovations/technologies, plans should be made to fund the entire process from conception, stakeholder consultation, development, adoption and transfer to end users.

Participants also expressed the following views on how best to incentivise the NAES to improve technology development, education and motivation of farmers to adopt new technologies in the animal sector. Sustained change in livestock development cannot be achieved relying on short-term and erratic donor support as livestock research often require large numbers of animals, laboratory facilities and inputs, considerable labour; financial resources and commitment by the federal and regional governments are required to fund long-term livestock research and development projects.

4.4 Capacity Building for technology uptake and transfer in the animal resources sector

Despite the efforts to promote adoption of innovative technologies (IT) by the Government and international development projects, the adoption rate among farmers has always been low in many African countries including Nigeria, Malawi, Tanzania, Sudan, Gambia, Gabon, Togo and Tunisia. To enhance the adoption of IT, national governments should as a matter of urgency educate young farmers with large cattle flock size and non-farm income (Dhraief et al 2018). Sustained training programmes for NAES personnel, farmers and other stakeholders should be well planned, implemented and monitored.

Technological innovations will help increase animal production and efficiency, reduce mortality and provide sustainable platforms for sharing important information to stakeholders in the animal resources industry. There is however the need to strengthen the capacities of support-advisory services at the national level through training of NAES agents. Additionally, research infrastructure, enhance professional and technical competencies; promoting entrepreneurship and innovation; and providing an enabling environment for technology development and dissemination in the country. Findings of the E-Survey underscores the importance of and need for regular capacity building on innovations and technology use in the animal resources sector. A good number of respondents (60%) reported of regular training on introduced/innovative technologies to farmers by the NAES. As shown in Figure 14, in terms of organisers of such training programmes, Government was dominant (52%) followed by Donor funded Projects (23%), NGOs (15%). Farmers associations (7%) and Technology Developers (3%). However, in terms of funding of the training, funded projects, Government and NGOs are the most dominant contributors (Donor funded Projects (50%), Government (27%), NGOs (15%), Farmers associations (2%), Technology Developers (2%), Farmers associations and Donor funded Projects (2%) and Individual Target Beneficiaries (1%)). In terms of financial commitment to technology uptake, transfer and use therefore, national governments need to improve and support farmer groups and associations to do same.



A. Organisers of Training Programmes **B. Organisers of Training Programmes**

Figure 14: *Organisers and Funders of Training Programmes on Innovations/Technologies*

4.5 Collaboration and Role of stakeholders

Technology innovation in agriculture and in animal resources sector no doubt has huge benefits. However, findings of both the E-Survey and E-Discussion indicate an urgent need for broad stakeholder consultation, contribution and commitment for this to become a reality in Africa. A resilient network inclusive of all the actors in the livestock value chain appropriately linked via innovative efficient online platforms will be crucial in this regard. Appropriate infrastructure should be put in place to encourage cell phone apps information system, use of subscription SMS for updates and agricultural information and use of radio and other telecommunication or broadcasting platforms. Notable stakeholders promoting innovation and technology uptake and transfer based on the findings of the E-Survey include Development partners/ NGOs (47%), Government (44%); Private sector (8.3%) and farmer cooperatives (1%) are the known actors.

Results of the E-Survey indicates that national governments through the NAES have a responsibility of helping farmers to improve productivity through support the following value chain technologies poultry (32%); Dairy Cattle (28%); Beef Cattle (17%); Sheep Production (11%); Goat Production (8%); Honey Bee Production (4%); Pig production (0.4%). At the same time, respondents agree that very remarkable (12%), some (39%) or sustained impact (35%) has been made in the past through adoption of various technologies in the animal resources sector whilst 14% of respondents fell little or no impact has been made. These ratios can be improved if key stakeholders reflect on their roles and commit to improving on their delivery in the quest for sustainable development, adoption and transfer of innovative appropriate technologies in the animal resources sector. As indicated by a contributor from Guinea in the E-discussion, strong collaboration (Box 4) between research and NAES, improved communication of research results to stakeholders to help identify relevant challenges and seek sustainable solutions should be pursued.

Box 4. Experience from Malawi

One best practice from Malawi is adoption and use of technologies related to animal nutrition, breeding and disease control and formation of a commercial dairy farmers association, the Milk Bulking Group. This provides a platform for farmers to market their milk as members are linked to a market where processors come to collect milk after bulking it at a cooling centre. The members have also been capacitated to keep improved breeds like pure breed Holstein/Friesian bulls to cross their local Malawi Zebu cows through Artificial Insemination (AI), feed their animals balanced rations and follow disease control measures like dipping. The Government of Malawi has a National AI Centre where fresh bovine semen is produced and supplied to farmers in the catchment area.

A strong research-extension-farmer linkage should be established through permanent consultation framework between research, the national extension system and cooperatives or farmer/breeders' groups. In connection with this, all livestock value chains should be studied and the relevant stakeholders engaged to identify the technology needs of breeders. In some cases, livestock farmers may be willing to adopt a technology such as AI but as individual may not meet the initial conditions required to use the technology but as a group this can be achieved. Therefore, African countries need to have dedicated directorates working with the NAES on identification of farmer's needs, development of appropriate technologies and a framework for sustainable transfer and adoption will be essential. The roles of the key stakeholders are discussed in the following paragraphs.

4.5.1 Role of Government

African countries and governments should show commitment by linking up with the private sector to have a reliable internet network, affordable gadgets for stakeholders including farmers to accept developed technologies and use them to improve their efficiency of production. National governments across Africa should develop livestock development policies with a bias towards E-Extension to encourage all stakeholders come on board and strategically (Box 5) positioned to eliminate the long-term bias and dominance of the crop sector.

Box 5 Clear Government Policy Direction is Essential

Tanzania's Livestock Plan has a clear policy direction to improve milk and dairy sector as follows: providing incentives and ease the bureaucracy for investors seeking to establish milk processing plants; promote establishment of high-capacity milk processing plants; promote the establishment of and strengthen the dairy cooperative/societies in high potential areas through training, sensitization, equipping and facilities; encourage/establish at least 150 milk collection centres/chilling plants; strengthen the Dairy Board to improve quality regulation and marketing of milk in milk shed areas; strengthen the capacity of the milk quality assessment and safety control laboratory; strength school-milk feeding programs to benefit 500,000 children in five years–starting from 100,000 children on the base year and adding new 100,000 children every year Extension services improvement interventions will provide training to livestock keepers and improved family dairy farmers on better husbandry, breed improvement and feeding practices. Feed improvement interventions will make land accessible for forage production for the commercial specialized dairy farms and forage producers; strengthen the existing forage/forage seed/quality control laboratories. In terms of animal health, it is hoped to improve availability of drugs, vaccines and medical equipment and support to enhance the effectiveness of private health service providers; Improve the availability of vaccines for foot-and-mouth disease, Rift Valley fever, contagious bovine pleuropneumonia, East Coastal fever and brucellosis (Michael et al., 2018).

At the same time, teaching curricula in secondary and tertiary institutions as well as in technical institutions should support training of more innovators and technology developers. Findings of the E-Survey stress on the need for national governments to help improve on participation of NAES in technology and innovation adoption in the animal resources sector in Africa (Figure 15). Plan and develop technology with and for the farmers, and engage the NAES and farmers throughout the process to ensure ownership and adoption (26%); Capacity building, adequate exposure of NAES personnel to innovation and technology (15%); political will and commitment to transform the livestock industry through digital technology (11%); allocate funds to support E-Extension (11%); improve stakeholder collaboration and corporation, appropriate packaging (10%); establish training centres for farmers, develop training materials, support farmer groups and associations and motivate them to adopt technologies (10%); establish sustainable digital technology infrastructure including internet connectivity (9%); public private partnership, support for niche markets and online marketing (5%); provide incentives, resources for NAES staff for their work (3%).

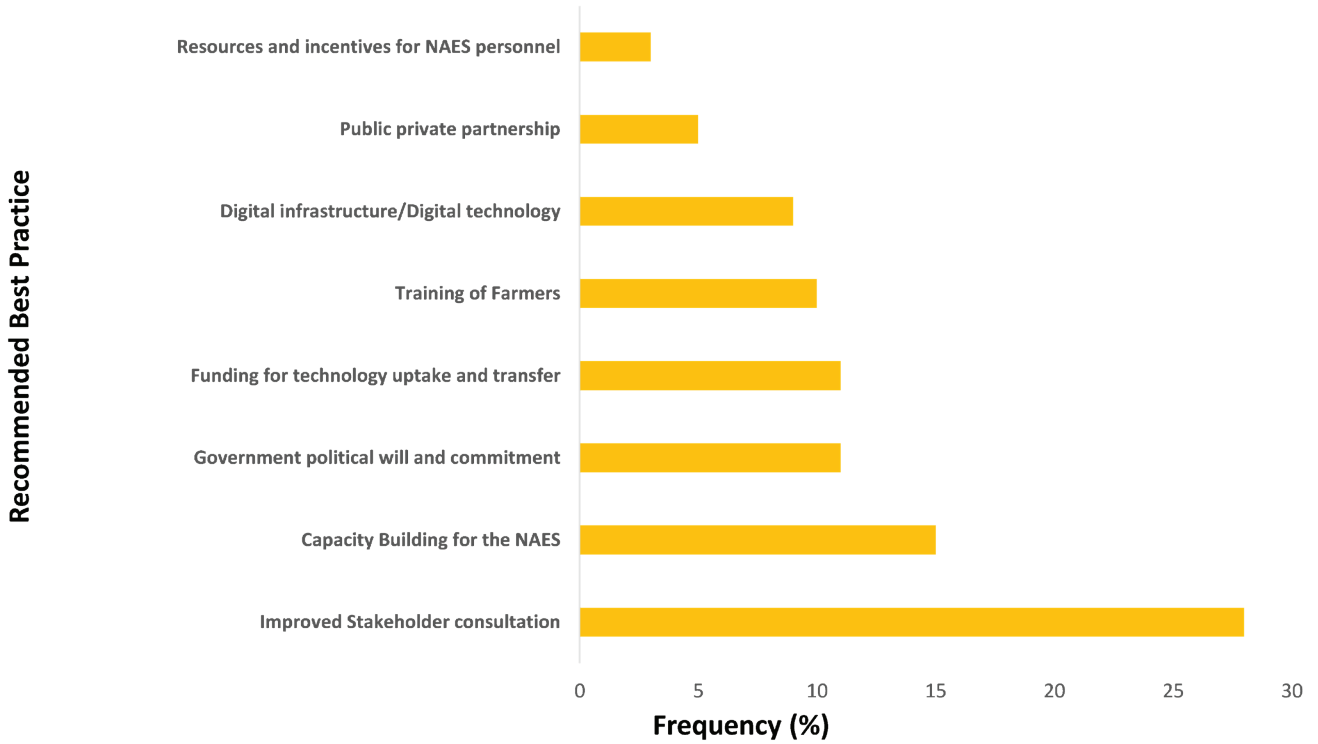


Figure 15: *Best Practices for improved participation of NAES in technology adoption*

Figure 16 depicts the relative importance of best practices suggested by E-Survey respondents. National governments should offer incentives to the NAES through capacity building and scholarships for personnel to upgrade knowledge (23%); involve private sector, improve collaboration, have a business partnership model aligned with animal resources policy of the country and international markets, develop sustainable extension packages and create awareness (19%); offer incentives to NAES personnel and other stakeholders promoting use of digital technologies and innovations in the animal resources sector (10%); provide gadgets and other inputs including internet access for successful adoption and transfer of E-Technologies (15%); have a sustainable funding for E-Extension development and adoption (11%); improve conditions of service of NAES personnel (9%); have a well-defined livestock policy, establish a national livestock extension service (7%); train farmers, support farmer associations, strengthen linkage between farmers and extension services (6%).

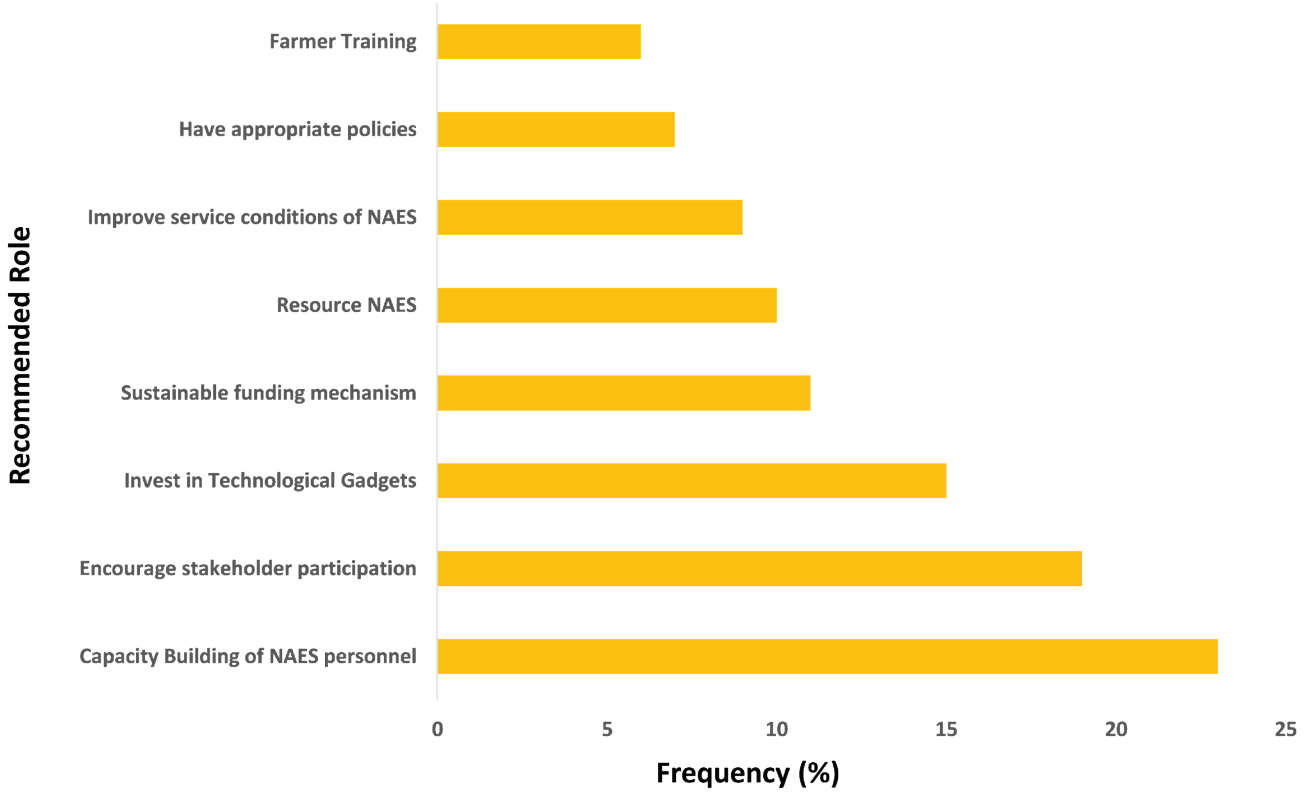


Figure 16: *Suggested roles in technology adoption and transfer by national Governments*

4.5.2 Role of the Private Sector

Approaches that can be adopted to drive E-extension services by the private sector as suggested by participants in the E-survey are as summarised in Figure 17. These include massive sensitization of E-technologies using all media (TV, Radio, technology service websites), establishment of information hubs linking stakeholders via the internet, development of easy to use apps, make available existing information(factsheets in digital format (28%); providing needed gadgets for digital technology (smartphones/tablets to extension officers,mobile phones),smart phone technology,internet connectivity (14%); putting in place policies to encourage public-private partnerships and improving stakeholder collaboration (13%); linking digital technology/PLA to animal farming, (digital ear tags, automation of feeding, health care, use of ODK technology, simple apps, drones for pasture monitoring, 11%); digital green, e-communication, e-marketing, online training and information sharing, farmer database (10%); budgeting, funding for E-Extension, subsidy on internet charges, MOU with internet service providers to make them affordable for farmers (10%); training of farmers and other stakeholders, farmer field schools (5%).

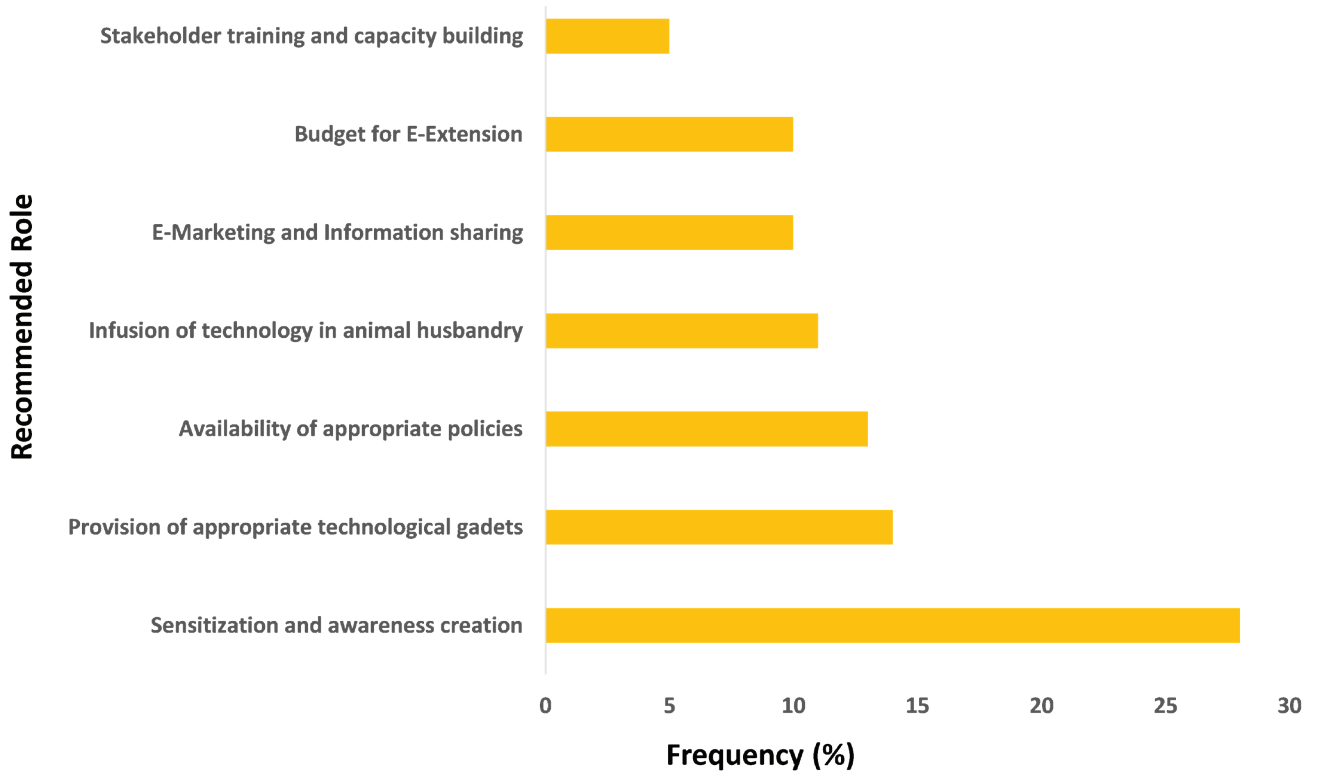


Figure 17: *Suggested roles in technology adoption and transfer by the Private Sector*

4.5.3 Role of Regional Communities

In promoting e-extension services, some best practices for the Regional Economic Communities (RECs) such as ECOWAS can follow according to findings of the E-survey are as follow (Figure 18). Massive sensitization on the importance of E-Extension via the electronic media including radios and televisions, awareness creation and development of suitable easy to use service providers websites for E-Extension (22%); adopting a regional framework on digital E-Extension and linking regional NAES staff via an official online platform to share information and receive appropriate training including WhatsApp Groups (21%); improving network coverage, reducing internet charges and supporting countries to establish online information hubs (16%); building capacity of NAES staff, education of personnel, establish a team of experts with adequate knowledge in each country, training of farmer and farmer groups (15%); providing mobile phone technology and linking them to appropriate E-Extension Apps, support member states with digital technology (11%); pursue E-Extension policies to encourage participation and investments by the private sector, provision of manuals, improved stakeholder participation, commercialization of E-Extension services and promotion of the business mode (6%); provide funding for E-Extension (5%); provision of electricity and development of solar energy (4%).

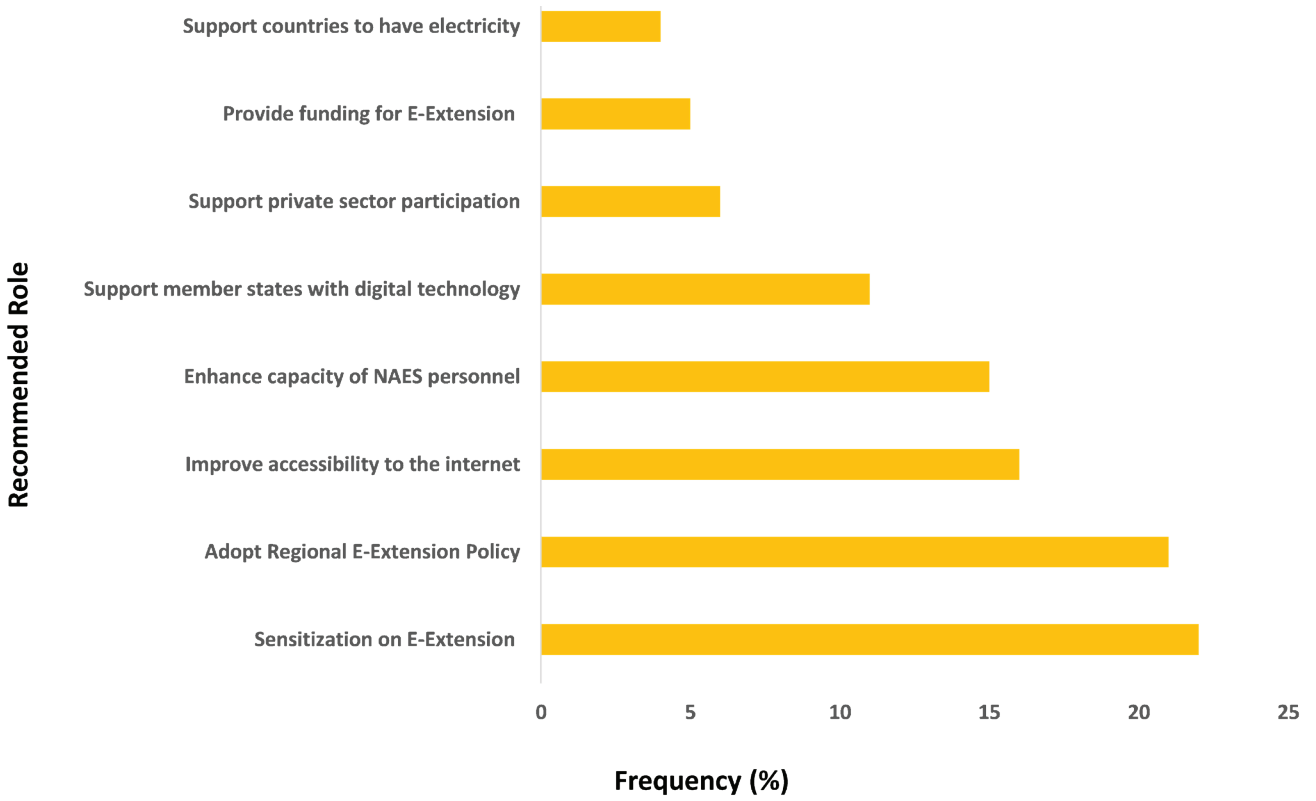


Figure 18: *Suggested roles in technology adoption and transfer by Regional Communities*

4.6 Strong Research-Extension-Farmer Linkages

As already indicated, weak research-extension-farmer linkages often lead to development of technologies which appear profitable at experimental stations but not under smallholder farmer conditions. In many instances, farmers lack the needed capital to purchase technological inputs (improved breeds, feed supplements, veterinary medicine, animal housing, etc.) and therefore will not adopt the technology irrespective of its advantages. For the technology to be adopted it has to fit into the socio-dynamics of the farmer. For instance, there should be sufficient family labour to manage the animals, and sufficient land so that improved forages (innovation) do not compete with staple crop production to guarantee adoption.

Furthermore, in addition to access to farm resources and potential benefits of the technologies, households require a reliable value chain that ensures access to the supply of technological inputs such as supplementary feed at reasonable price, reliable access to artificial insemination and veterinary services, a quality extension service, access to credit, insurance and assured markets to sell their before considering technology adoption. Additionally, good collaboration among key stakeholders is a prerequisite for successful technology/innovation adoption (Box 6). Studies have shown that farmers' decision to adopt or not to depend on their needs, cost incurred and benefit accruing from the adoption of the technology as well as the characteristics of the innovation (Dumeh, 2011). Farmers will abandon or discontinue the use of a technology if they feel that it is not beneficial either in the short or long run. The irony lies in the fact that the economic impact of the adoption of a technology cannot be known in advance with certainty (Dumeh, 2011).

Box 6. Strong Farmer Extension Research Linkages are important

In Guinea, good collaboration and adoption of extension packages by agro-pastoralists makes it possible to put in place favourable conditions for a sustainable NAES. Training of breeders/farmers on site (village level) allow easy acceptance of innovation and technological packages for sustainable management of livestock. In other countries such as Gabon however, the use of technologies in the livestock sector is very poorly developed as research does not always work in harmony with agricultural extension systems. The needs of producers (breeders) and the technologies on which research works are not always those expected by the final beneficiaries. Therefore, there is need to strengthen the framework for consultation between research, technology extension services and breeders, to better identify the issues and improve technology adoption.

4.7 Degree of corporation among tech developers and the NAES

In terms of the degree of co-operation between technology developers and the NAES in Africa, as shown in Figure 18, respondents indicated these mostly as average (41%) or good (34%), with the rest ranking this as very good (12%), poor (12%) or excellent (1%) which means there is still a lot of room to improve on collaboration among stakeholders. Unless this is done developing appropriate technologies for stakeholders in the animal resources sector will be difficult.

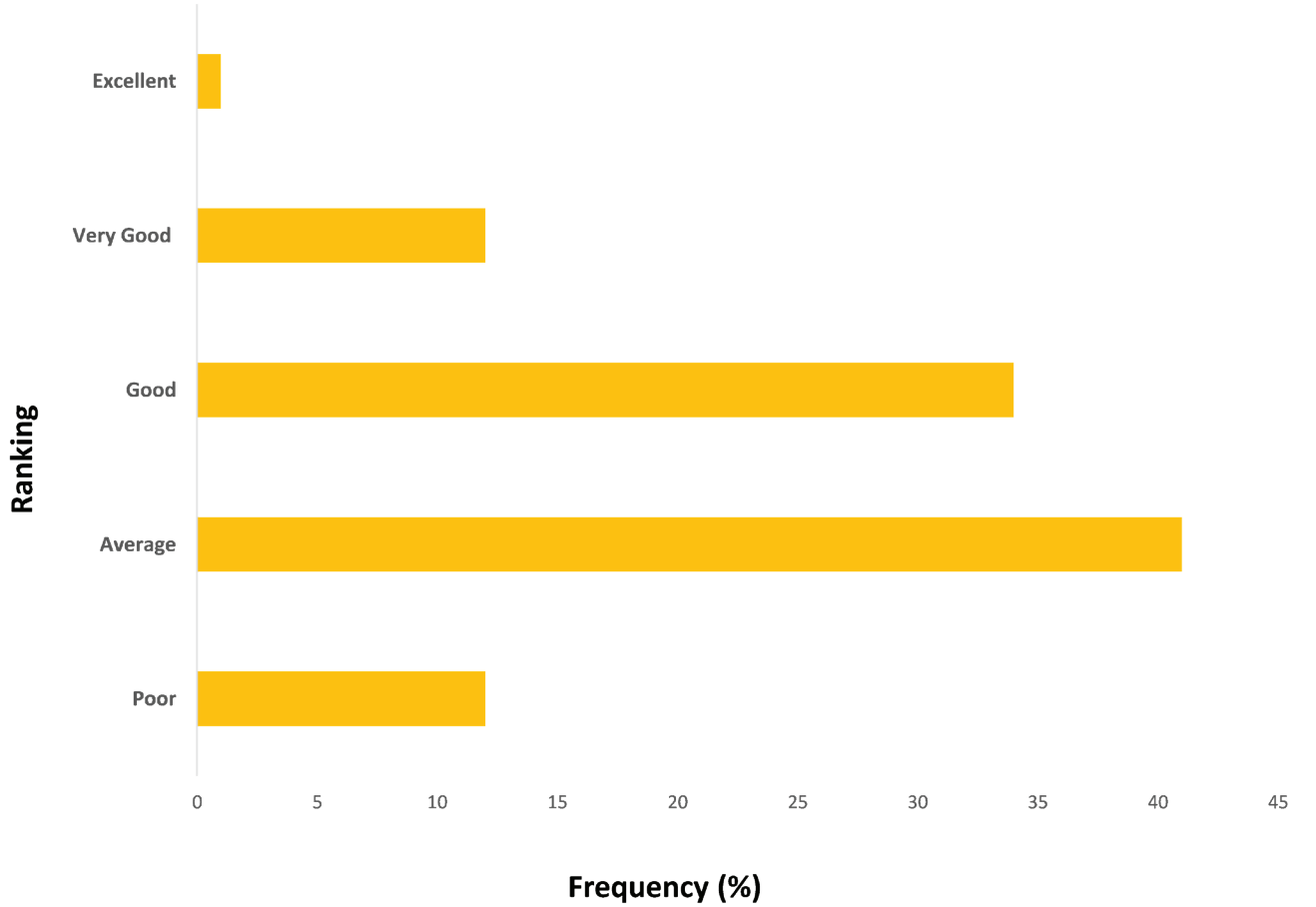


Figure 19: *Degree of co-operation between technology developers and the NAES*

The agricultural sector in Africa has an opportunity to employ a wide range of evolving technologies and farm practices across different farming systems to meet a variety of changing and heterogeneous demands from consumers and the public for food, fibre and other goods and services provided by agriculture, often with uncertain outcomes in terms of their effects on sustainability. Consequently, it is important to fully involve the NAES and farmer co-operatives/groups in the development of technologies in use in the animal resources sector. As expected, technology and innovation adoption and transfer will best be catalysed and successful when the product directly solves a problem faced by key stakeholders in this case the animal farmer. Best practice indicates that strong farmer-extension-research linkages need to be established to enable technology developers work in consonance with the needs of farmers and farmer associations. Our participants in the E-discussion indicate partial to no involvement of the NAES and the cooperatives/groups of herders in the development of technologies used in the animal resources sector. In instances where there is funding for strong research-extension-farmer linkages (Dumeh, 2011), transfer of needed technologies from national systems of research and development to the farmers have been a success. In the past (mid-80's), some collaborative research proposals/projects based on the needs of farmers/breeders have led to successful adoption of such technologies. Examples include the acceptance of exotic cattle semen for crossbreeding with local cattle on account of higher milk yields of the crossbreds in most African countries. Farmers have always looked to new technologies as a way to reduce costs. In addition, higher incomes, greater knowledge and improved channels of communication are leading consumers to demand low-cost food of higher quality increasingly produced through organic methods in many countries, with more variety, consistency and year-round availability. Therefore, appropriate diagnosis of producer challenges and limitations including on-farm studies should provide appropriate date for technology and innovation developers to invest in appropriate products for farmers and hence facilitate adoption and transfer by the NAES.

In countries where research and extension linkage committees (RELCs) exist, they enable proper evaluation of new technologies, their adoption and problems faced and also identify some critical problems that need to be addressed. In such instances, there is some involvement of the NAES and also farmer co-operative/groups in development of technologies. Two appropriate examples from the Gambia support this assertion - the Gambia Indigenous Livestock Multipliers' Association (GILMA) were initially incorporated into the functional operation of this ONBS; the biogas technology is still being studied at an institutional level in the Gambia but there is plan to involve farmers both as individuals and groups in its adoption. In spite of the importance of collaboration between technology developers in the animal resources sector and the NAES, this has been largely non-existent or not very well defined in most countries such as the case of Gabon, where research institutes work in isolation. In few cases particularly where the technology is funded by a project, collaboration between technology developers and the NAES has been good. Where there exists a national research system with a directorate responsible for the extension of research results with strong collaboration with the national agricultural extension system.

Participants in the E-Survey provided some of the primary causes for this poor cooperation (Figure 20) as weak extension-farmers linkages leading to inappropriate and unsuitable technologies which fail to

meet farmer expectation (25%), the NAES not being involved at an early stage (16%) of the technology development and low budgetary allocation/insufficient funding for technology development and transfer (15%). Other causes given by respondents include lack of trust (12%); lack of skilled human resources/ tech developers (11%); unstable organisational structure, lack of professionalism and tools/appropriate gadgets (10%); non supportive government policy, bureaucracy (6%); lack of information/awareness, poor communication and data sharing, lack of training for farmers, primitive and illiterate farmer population (3%); poor livestock e-tools, lack of immediate visible results (2%).

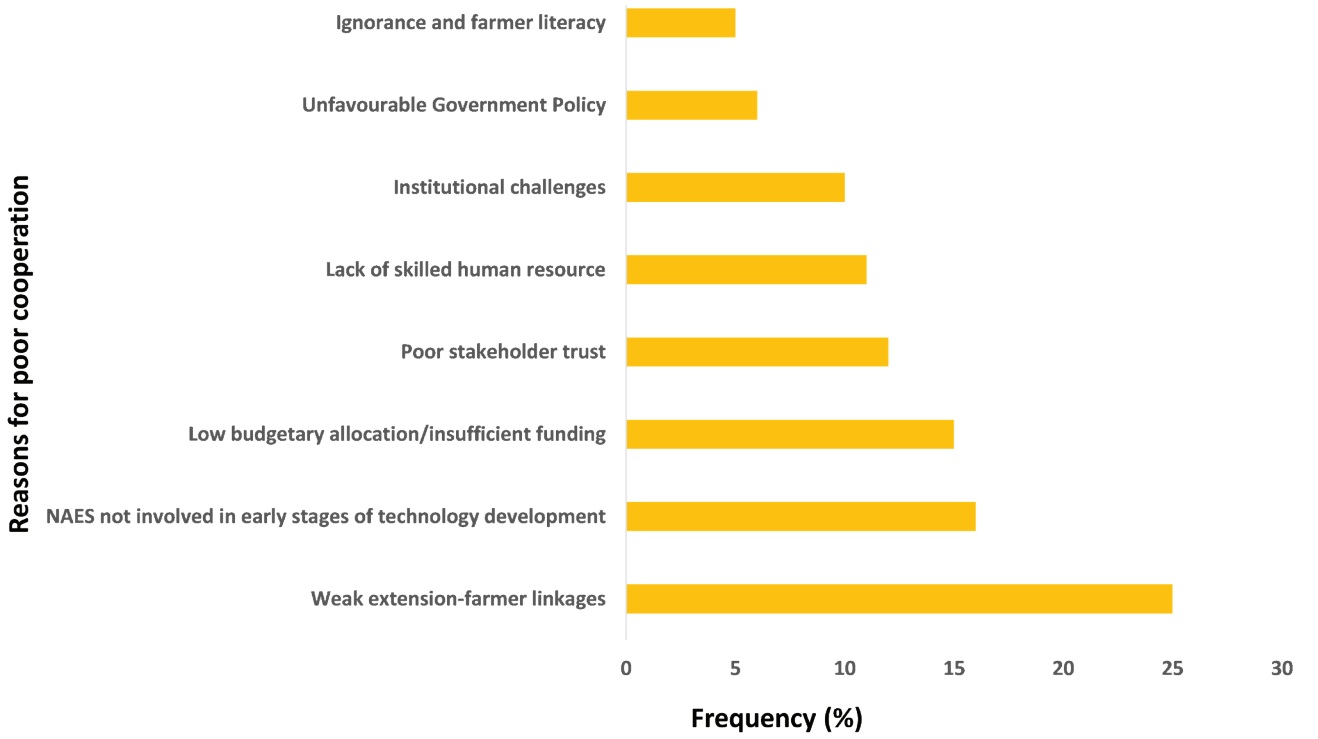


Figure 20: *Reasons for poor corporation among stakeholders*

In general, when the technology is part of a package or an output of a livestock intervention project, adoption rates are appreciable. For instance, as part of the Livestock Development Project in Ghana, the level of awareness of the improved production technologies among livestock farmers was high (95%) leading to high adoption rate of the technologies was 76% among the farmers (Dumeh, 2011). Furthermore, using farmer groups to enhance peer-to-peer learning, engagement in adaptation strategies and problem solving, and to increase trust and cooperation at the community level, may be an important function of extension services (Arslan et al., 2020). The number of groups/associations a livestock farmer belongs to has also been found to be positively correlated to the rate of adoption of an innovation or technology on account of positive peer influence (Dumeh, 2011) and therefore the need to strengthen such groups. Finally, to facilitate farmer adoption of improved technologies it is recommended that government through the ministry responsible for agriculture and other stakeholders make inputs available or direct farmers to places where inputs necessary for implementation of the improved technology can be purchased. It will also be helpful if subsidies could be given for those inputs, since the inputs may be available but the cost might be too high to the farmer (Dumeh, 2011).

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Globally, a large number of technologies and innovations have been developed to support the animal resources sector. While some of these technologies and innovations have been put to very good and productive use by the end-users, in Africa a large number of these technologies and innovations has not been utilized as intended, mainly due mainly to challenges and limitations of national agricultural extension services (NAES) in uptake and transfer of these technologies to stakeholders. This calls for commitment by African Governments and stakeholders to support a paradigm shift in the strategy of national agriculture services to enable them improve on technology adoption and transfer for a more robust animal resources sector.

This Handbook on Lessons Learnt and Best Practices on Technology Uptake and Transfer in the Animal Resources sector for National Agricultural Extension Services in Africa has brought into the limelight the availability and extent of utilization of innovative technologies in Africa. The main machinery for adopting and transferring these technologies to stakeholders and other end users, the national agricultural extension services have been discussed regarding the plethora of services they provide, the institutional and operational bottlenecks they face and the many opportunities we have in transforming the NAES into a more useful entities based on the lessons learnt. Public-private partnerships will play a very crucial role if Africa is to succeed in using technologies to upscale its fortunes in the animal resources sector for food security, improved livelihoods and wealth creation as envisaged in the United Nations (UN) Sustainable Development Goals (SDGs).

5.2 Recommendations

Based on an empirical analysis of specific case studies and experiences from the African region, the following are suggested as immediate key actions to be embarked upon today by national governments, stakeholders and development partners to upscale the adoption and transfer of innovations and technologies germane to the animal resources sector in Africa.

i. Countries should develop and implement appropriate policy, legal and regulatory framework to specifically support sustainable digitalization and use of innovations and technologies in the animal resources sector. Additionally, countries should adopt continuous evaluation of extension services in the livestock sector in order to have an efficient system in place at all times.
ii. Countries should establish a funding mechanism for adoption, transfer and use of innovative technologies and e-extension services in the animal resources sector in Africa. For instance, the annual budget for agriculture can be increased to enable implementation of policies which enable adoption and transfer of innovative technologies.
iii. Stakeholders should embark on regular sensitization , infrastructure development and maintenance, capacity building and linking e-services to profitability of animal farming. Revision of the curricula

used in training livestock extension personnel in various agricultural colleges and universities to incorporate current innovative technologies in the animal resources sector will be crucial.

iv. National Governments should invest massively in the livestock sector and ensure adequate and timely allocation of funds to execute the livestock agenda. In this regard there is need to provide appropriate infrastructure – good roads, electricity, health care system, communication, transport in the rural communities to ensure easy link and use of current innovative technologies. Sustainable energy solutions for example should be pursued as a matter of urgency by national governments. This should create an enabling environment for sustainable feed production including promotion of the organic value chain for food safety and nutrition.

v. Stakeholders should support the NAES to popularise existing technologies and encourage their adoption and transfer instead of investing in new technologies. Technology developers should be encouraged to come out with sustainable and affordable technologies which directly respond to local challenges in animal agriculture. For instance, climate-smart technologies should be encouraged to safeguard sustainable livestock production systems across Africa.

vi. Governments should collaborate with the private sector to promote annual Agri-Food Techs, a platform for technology developers and other stakeholders to showcase products and demonstrations to farmers whilst recognizing and awarding those who come up with adoptive technologies. In particular, small-scale livestock producers should be motivated and supported to come together in co-operatives to be able to access tailor-made technologies more cost-effectively.

vii. The NAES should be supported to utilize simple channels of communication and national media (radio, television, newspapers and various social media) to educate stakeholders on available technologies and how to access them. Technologies will only be used in animal agriculture if the farmers understand them, are capacitated to use them and most importantly can afford them. In this regard the NAES must identify the various farmer categories (early adopters, late adopters, innovators, women and youth farmers) and package appropriate communication tools for each of these groups.

viii. African Governments should recognise the importance of and use strategic partnerships and collaboration to ensure participation of all stakeholders right from technology development through popularisation, adoption, transfer and implementation. In particular, we need to involve farmers, youth and students in technology development (bottom-up approach) to ensure that proposed technologies/innovations are suitable for peculiar local situations.

ix. Africa largely has an ageing livestock farmer population and therefore special efforts should be targeted at encouraging the youth who thankfully are more digitally inclined, use all the innovative targets and are often looking for employment. Government through the NAES should provide incentives for the youth to enter into animal agriculture and encourage the use of technology from production through processing, storage and transport to marketing. In implementing this recommendation, African Governments will be creating many job opportunities should help reduce the unemployment challenge.

x. African countries should regularly work together, identify their technological needs, strengths and weaknesses and share resources in the conception, development, popularisation, adoption, transfer and utilization of appropriate innovative technologies in the animal resources sector for their

mutual benefit. Additionally, stakeholders should understand their unique roles and work together to ensure improved co-ordination between farmers, research, technology developers and the NAES.

xi. Countries should increase funding/budgetary allocation to the NAES and motivate the personnel by improving the service conditions, building their capacity and recognizing the dedicated NAES staff/ personnel who massively facilitate the adoption and transfer of innovative technologies in the animal resource sector . As the main engine for technology adoption in the animal resources sector, the NAES should be well resourced and its staff motivated to make it attractive especially to the youth. Regular training in emerging technologies and farmer motivation should be provided by national governments for NAES personnel.

xii. All countries should establish early warning systems in the animal resources sector which incorporates key elements of biosecurity, disease detection and digital information sharing to safeguard Africa's valuable animal genetic resources against epidemics and other hazards. In the development of such systems strategic collaboration and partnerships of the NAES with key stakeholders including the AU-IBAR, FAO, OIE, RECs, private sector, research institutions, youth groups and farmers/farmer associations will be crucial. The importance of supporting the small and medium scale farmers to use simple technologies to adhere to biosecurity and safety standards cannot be over-emphasised as they play an important role in pathogen transmission along the value chain.

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ANNEXES

Annex 1: Questions for E-Discussion

English Version

E-DISCUSSION ON LESSONS LEARNT AND BEST PRACTICES FOR TECHNOLOGY UPTAKE AND TRANSFER IN THE ANIMAL RESOURCES SECTOR FOR NATIONAL AGRICULTURAL EXTENSION SERVICES IN AFRICA

1. Introductory Note

Over the years, a large number of technologies and innovations have been developed to support the animal resources sector. In spite of several attempts made in the past to introduce new technologies into the production system, stakeholders have repeatedly failed to use or rejected these technologies. These reasons for failure of stakeholders to accept and use introduced technologies need to be well synthesised and documented to inform the development of future technologies and training of animal farmers. While some of these technologies and innovations have been put to very good and productive use by the end-users, a large number of these technologies and innovations has not been utilized as intended, mainly due mainly to challenges and limitations of national agricultural extension services in uptake and transfer of these technologies to stakeholders. This calls for a paradigm shift in the strategy of national agriculture services to enable them improve on technology adoption and transfer for enhanced animal production.

In line with this objective, AU-IBAR is implementing a 5-year project on "Sustainable Development of Livestock for Livelihoods in Africa - Live2Africa" aimed at promoting among others Technology adoption in the Livestock Value Chains. To achieve this, a handbook on lessons learnt and best practices for technology uptake and transfer in the animal resources sector is needed to ensure that of national agricultural extension services are fully equipped and guided to improve technology adoption in the animal resources sector in Africa. Given, their importance in the transfer and uptake of technologies and innovations, it is imperative to tap on the experiences of national agricultural extension services (NAES) and identify lessons learnt and best practises for future technology and innovations. Documentation of available technologies and their development, their appropriateness and profitability, best practices and lessons learnt, ease of use and adoption by various stakeholders along the livestock value chain will be a valuable resource in this regard. Such a handbook should provide a catalyst for improved technology transfer and utilization by stakeholders ultimately resulting in increased productivity of animal resources in Africa.

2. Objective

The main objective of this E-Discussion is to gather information on the Best Practices and Lessons Learnt in technologies and innovations for animal resources in Africa. Specifically, it is hoped to generate

interesting discussion among stakeholders on the lessons learnt and best practises for technology and innovation transfer and uptake in the animal resources sector with national extension services (public and private);

3. Methodology

This E-discussion is being organised with key stakeholders purposively sampled for this purposed and all colleagues on DADNET platforms for North, Wester, Central, Eastern and Southern Africa under the following four (4) themes each lasting two (2) weeks as follows:

Theme 1: Assessment of National Agricultural Extension Services in Africa (Monday 5th October to Sunday 18th October 2020);

Theme 2: Technology uptake and transfer in the Animal Resources Sector in Africa (Monday 19th October to Sunday 1st November 2020);

Theme 3: Assessment of the adoption and use of technologies in the Animal Resources sector in Africa (Monday 2nd November to Sunday 15th November 2020);

Theme 4: Adoption of digital solutions for sustainability of African Livestock value chains (Monday 16th November to Sunday 29th November 2020).

The Moderators will send you an invitation directly or via all the DADNET platforms in the North, Western, Eastern, Central and Southern Africa. The Moderators will share the summaries of findings at the end of each of the specific themes and also share the final report at the end of the entire discussion. Please we look forward to your active participation in the E-Discussion to help us gather all the important information needed for publishing an appropriate, factual and up to date handbook on the lessons learnt and best practices for technology uptake and transfer in the animal resources sector for national agricultural extension services in Africa. The E-Discussion will be moderated by Dr Richard Osei-Amponsah (Email: rich12668@yahoo.co.uk) of the University of Ghana with support from Dr Mary Mbole-Kairuiki (Email: mary.mbole-kariuki@au-ibar.org) and Dr Edward M (Email: edward.nengomasha@au-ibar.org) of AU-IBAR.

THANK YOU PLEASE.

Draft Questions for E- Discussion

An E-discussion will be organised on DADNET platforms for North, Western, Central, Eastern and Southern Africa under four (4) themes each lasting two (2) weeks as follows:

Theme 1: Assessment of National Agricultural Extension Services in Africa

a. What type of national agricultural extension service (NAES) exists in your country?

b. What are the key functions of the NAES in your country?

c. What are the strengths of the NAES with regard to technology uptake and transfer?

d. What are the key challenges or bottleneck facing the NAES with regard to technology uptake and transfer?

e. What recommendations will you make to help the NAES overcome these challenges?

Theme 2: Technology uptake and transfer in the Animal Resources Sector in Africa

a. List some of the technological tools in use in the animal resources sector in your country or region and indicate their focus of operation?

b. Who are the main developers of the available technologies and innovations?

c. How involved are the NAES and farmer co-operatives/groups in the development of technologies in use in the animal resources?

d. With reference to the major technology developers in the animal resources sector, how will you describe the collaboration between them and NAES in your country?

e. What are some of the Lessons Learnt and Best Practices in technology innovation, development, adoption and use in the animal resources sector in your country and region?

Theme 3: Assessment of the adoption and use of technologies in the Animal Resources sector in Africa

a. What is your assessment of use of technology in the animal resources sector in your country or region?

b. What are some of the key challenges and opportunities in the sustainable development and adoption of technologies in the animal resources sector in Africa?

c. Can you suggest some strategies to improve technology development, adoption and use by stakeholders in the animal resources sector?

d. How can the NAES be incentivised to improve technology development, education and motivation of farmers to adopt new technologies in the animal sector?

e. Any suggestion for improvement of technology innovation, popularization and use in the animal resources sector in Africa?

f. Share three recommendations to drive governments to financially support NAES and promote efficient serve delivery to all stake holders.

Theme 4: Adoption of digital solutions for sustainability of African Livestock value chains.

Following the outbreak of the COVID-19 pandemic, technology-based solutions have been advocated, there is an equal need to adopt digital technologies to enable efficient food systems to thrive

a. List at least three digital technologies that can be adopted in various components of the value chain (eg. e-marketing tools, weather forecasting tools, e-extension, mobile money etc)

b. In relation to promoting digital technology at the farmer level, identify three main approaches that can be adopted to drive e-based adoption and uptake by the;

i. National Extension services

ii. Private sector

iii. Regional communities

c. Briefly describe three main challenges that may be experienced with uptake of digital technologies by;

i. Livestock keepers

ii. Governments

iii. Private Sector

iv. Regional communities

d. What are the best bet strategies that can be adopted by NAES to spearhead the digitalization of the livestock sector in Africa?

French Version

DISCUSSION VIRTUELLE (EN LIGNE) SUR LES ENSEIGNEMENTS TIRÉS ET LES MEILLEURES PRATIQUES EN MATIÈRE D'ADOPTION ET DE TRANSFERT DE TECHNOLOGIES DANS LE SECTEUR DES RESSOURCES ANIMALES POUR LES SERVICES NATIONAUX DE VULGARISATION AGRICOLE EN AFRIQUE

1. Note d'introduction

Au fil des ans, un grand nombre de technologies et d'innovations ont été développées pour soutenir le secteur des ressources animales. Dans le passé, plusieurs tentatives d'introduire de nouvelles technologies dans le système de production ont été faites, mais ces tentatives ont échoué à plusieurs reprises, du fait que les parties prenantes les ont soit négligées soit rejetées. Les raisons de la défaillance des parties prenantes à accepter et à utiliser les technologies introduites doivent être bien synthétisées et documentées afin d'éclairer le développement de technologies futures et la formation des éleveurs. Si quelques-unes de ces technologies et innovations ont été utilisées de manière très satisfaisante et productive par les utilisateurs finaux, un grand nombre d'entre elles n'ont pas été utilisées comme prévu, principalement en raison des difficultés rencontrées et des imperfections des services nationaux de vulgarisation agricole en ce qui concerne l'adoption et le transfert de ces technologies aux parties concernées. Cette situation demande un changement radical de la stratégie des services agricoles nationaux pour qu'ils puissent améliorer l'adoption et le transfert de technologies en vue d'une augmentation de la production animale.

Dans le contexte de cet objectif, l'UA-BIRA met en œuvre un projet quinquennal sur le Développement durable de l'élevage pour de meilleurs moyens de subsistance en Afrique - Live2Africa qui vise à promouvoir, entre autres, l'Adoption des technologies dans les filières de l'élevage. Pour ce faire, un manuel sur les enseignements tirés et les meilleures pratiques pour l'adoption et le transfert de technologies dans le secteur des ressources animales est nécessaire. Il permettra de s'assurer que les services nationaux de vulgarisation agricole sont entièrement équipés et guidés pour améliorer l'adoption de technologies dans le secteur des ressources animales en Afrique. Compte tenu de l'importance services nationaux de vulgarisation agricole (SNVA) dans le transfert et l'adoption des technologies et des innovations, il est impératif d'exploiter leurs expériences et d'identifier les enseignements tirés et les meilleures pratiques

pour les technologies et innovations futures. La documentation des technologies disponibles et de leur développement, leur pertinence et leur rentabilité, les meilleures pratiques et les enseignements tirés, la facilité d'utilisation et d'adoption par les différentes parties prenantes tout au long de la chaîne de valeurs de l'élevage constitueront une ressource précieuse à cet égard. Un tel manuel devrait servir de catalyseur de l'amélioration du transfert et de l'utilisation des technologies par les parties prenantes, qui se traduiront en fin de compte par une augmentation de la productivité des ressources animales en Afrique.

2. Objectif

Le principal objectif de cette discussion virtuelle est de rassembler des informations sur les meilleures pratiques et les enseignements tirés par rapport aux technologies et innovations dans le secteur des ressources animales en Afrique. Plus précisément, on espère que cette discussion suscitera un échange d'idées intéressantes à propos des leçons apprises et des meilleures pratiques en matière de transfert et d'adoption de technologies et d'innovations dans le secteur des ressources animales entre les parties prenantes et avec les services de vulgarisation nationaux (publics et privés).

3. Méthodologie

Cette discussion virtuelle est organisée avec les principales parties prenantes échantillonnées à dessein à cette fin et tous les collègues des plateformes DADNET pour l'Afrique du Nord, l'Afrique de l'Ouest, l'Afrique centrale, l'Afrique de l'Est et l'Afrique du Sud, sous les quatre (4) thèmes suivants - chacun d'une durée de deux (2) semaines :

Thème No 1 : Évaluation des services nationaux de vulgarisation agricole en Afrique (Lundi 5 octobre - Dimanche 18 octobre) ;

Thème 2 No :Adoption et transfert de technologies dans le secteur des ressources animales en Afrique (Lundi 19 octobre - Dimanche 1 novembre 2020) ;

Thème 3 No : Évaluation de l'adoption et de l'utilisation de technologies dans le secteur des ressources animales en Afrique (Lundi 2 novembre - Dimanche 15 novembre 2020) ;

Thème 4 No :Adoption de solutions numériques pour la durabilité des filières de l'élevage en Afrique (Lundi 16 novembre - Dimanche 29 novembre 2020).

Les modérateurs vous enverront une invitation, directement ou via toutes les plateformes DADNET pour l'Afrique du Nord, l'Afrique de l'Ouest, l'Afrique orientale, l'Afrique centrale et l'Afrique du Sud. Les modérateurs partageront les résumés des résultats à la fin de chacun des thèmes spécifiques, et le rapport final à la fin de toute la discussion. Nous comptons sur votre participation active à la discussion virtuelle qui nous aidera à rassembler toutes les informations importantes nécessaires à la publication d'un manuel approprié, factuel et actualisé sur les enseignements tirés et les meilleures pratiques pour l'adoption et le transfert de technologies dans le secteur des ressources animales à l'intention des

services nationaux de vulgarisation agricole en Afrique. Le modérateur de la discussion virtuelle sera le Dr Richard Osei-Amponsah (Email : rich12668@yahoo.co.uk) de l'Université du Ghana avec le soutien du Dr Mary Mbole-Kariuki (Email : mary.mbole-kariuki@au-ibar.org).

NOUS VOUS REMERCIONS.

Projet de questions pour la Discussion virtuelle (en ligne)

Une discussion virtuelle sera organisée sur les plateformes DADNET pour l'Afrique du Nord, l'Afrique de l'Ouest, l'Afrique centrale, l'Afrique orientale et l'Afrique du Sud autour de quatre (4) thèmes, chacun d'une durée de deux (2) semaines, de la manière suivante :

Thème No 1 : Évaluation des services nationaux de vulgarisation agricole en Afrique

f. Quel type de service national de vulgarisation agricole (SNVA) existe dans votre pays ?

g. Quelles sont les principales fonctions du SNVA dans votre pays ?

h. Quels sont les aspects forts du SNVA en ce qui concerne l'adoption et le transfert de technologies ?

i. Quels sont les principaux problèmes ou goulots d'étranglement auxquels le SNVA est confronté en matière d'adoption et de transfert de technologies ?

j. Quelles recommandations ferez-vous pour aider le SNVA à surmonter ces défis ?

Thème No 2 : Adoption et transfert de technologies dans le secteur des ressources animales en Afrique

f. Énumérer quelques-uns des outils technologiques utilisés dans le secteur des ressources animales dans votre pays ou région et indiquer leur rayon d'action.

g. Qui sont les principaux développeurs des technologies et innovations disponibles ?

h. Dans quelle mesure le SNVA et les coopératives/groupes d'éleveurs sont-ils impliqués dans le développement des technologies utilisées dans le secteur des ressources animales ?

i. En ce qui concerne les principaux développeurs de technologies dans le secteur des ressources animales, comment décrirez-vous la collaboration entre eux et le SNVA dans votre pays ?

j. Quelles sont quelques-unes des leçons apprises et meilleures pratiques en matière d'innovation technologique, de développement, d'adoption et d'utilisation de technologies dans le secteur des ressources animales dans votre pays et région ?

Thème No 3 : Évaluation de l'adoption et de l'utilisation de technologies dans le secteur des ressources animales en Afrique

g. Quelle évaluation faites-vous de l'utilisation de technologies dans le secteur des ressources animales dans votre pays ou région ?

h. Quels sont quelques-uns des principaux défis et opportunités qui se présentent par rapport au développement durable et à l'adoption de technologies dans le secteur des ressources animales en Afrique ?

i. Pouvez-vous suggérer quelques stratégies pour améliorer le développement, l'adoption et

l'utilisation de technologies par les parties prenantes du secteur des ressources animales ?

j. Comment le SNVA peut-il être incité à améliorer le développement de technologies, l'éducation, et la motivation des éleveurs à adopter de nouvelles technologies dans le secteur animal ?

k. Avez-vous une suggestion à faire pour améliorer l'innovation, la vulgarisation et l'utilisation des technologies dans le secteur des ressources animales en Afrique ?

l. Partager trois recommandations pour inciter les gouvernements à soutenir financièrement le SNVA et à promouvoir une prestation de services efficace à toutes les parties prenantes.

Thème No 4 : Adoption de solutions numériques pour la durabilité des chaînes de valeurs du secteur de l'élevage en Afrique

À la suite de l'apparition de la pandémie à COVID-19, des solutions fondées sur les technologies ont été préconisées ; et il est tout aussi nécessaire d'adopter des technologies numériques pour permettre aux systèmes alimentaires efficaces de prospérer.

e. Énumérer au moins trois technologies numériques qui peuvent être adoptées aux divers maillons de la chaîne de valeurs (par exemple : les outils de commercialisation en ligne (e-marketing), les outils de prévision météorologique, la vulgarisation par voie électronique, les services de transfert/paiement d'argent par téléphonie mobile, etc.).

f. En ce qui concerne la promotion de technologies numériques au niveau des éleveurs, identifier trois approches principales qui peuvent être adoptées pour stimuler l'adoption et l'application par voie électronique/en ligne de ces technologies par :

iv. les services de vulgarisation nationaux

v. le secteur privé

vi. les communautés régionales

g. Décrire brièvement trois principaux défis qui peuvent être rencontrés lors de l'utilisation des technologies numériques par :

v. les éleveurs,

vi. les services gouvernementaux,

vii. le secteur privé,

viii. les communautés régionales.

h. Quelles sont les stratégies optimales que le SNVA peut adopter pour diriger la numérisation du secteur de l'élevage en Afrique ?

Annex 2 E-Survey Questionnaire

English Version

SECTION 1 - INTRODUCTION

Survey on Lessons Learnt and Best Practices for Technology Uptake and Transfer in Animal Resources Sector for National Extension Services in Africa

We have sent this questionnaire to you because you are our valued stakeholder. We recognize that you are busy and thus we have designed a short questionnaire that will take you 10-15 minutes to complete. We would also appreciate your sending it to your networks whom you have identified as stakeholders of the national agricultural extension services.

Definition of terms:

I. National Agricultural Extension Service (NAES): normally a government agency located in the Ministry of Agriculture with a vision of educating and training farmers to get the best out of existing technologies and motivating them to accept new and emerging innovations.

II. A technology: A technology in the Livestock Value Chain is a new method, system or device that has been developed through the use of scientific knowledge

III. Technology Uptake: Technology uptake or adoption refers to the acceptance, integration, choice to acquire and use a new invention, technology or innovation in society.

IV. Technology Transfer: refers to the process of conveying results of scientific and technological research to a target(farmer) group, market place and to wider society, along with associated skills and procedures, and is as such an intrinsic part of the technological innovation process to help boost their production efficiency.

ACRONYMS:

V. NAES – National Agricultural Extension Service

SECTION 2: BIODATA COMPILATION

1. Respondent details

Full Name

Gender

- Male
- Female

Country

City/County

Organization affiliated to:

Position in Organization (optional):

Age Group

- o Below 30 years
- o 31-40 years
- o 41-50 years
- o 51-60 years
- o Above 60 years

2. Select your specific region and its corresponding priority livestock value chain

- o Central Africa - Poultry Egg and Meat Value Chain
- o Eastern Africa – Dairy Value chain
- o IGAD – Meat and Live animals value chain
- o Northern Africa – Dairy Value chain
- o Western Africa - Poultry Value chain
- o Southern Africa – Meat and Live animals Value chain

3. What is your primary level of engagement in your region's priority livestock value chain?

Select ONLY ONE role that best describes your engagement across the value chain component

- o Production
- o Inputs and Services
- o Processing and Value Addition
- o Trade and Marketing
- o Regulation, Legislation, Co-ordination and Harmonization

SECTION 3: ASSESSMENT OF THE NATIONAL AGRICULTURAL EXTENSION SERVICE (NAES)

(Please where possible kindly provide additional information by attaching files and providing links to website addresses, etc)

1. What type of national agricultural extension service (NAES) do you have in your country?

- o Public
- o Private (including Farmer sponsored Extension providers, NGOs)
- o Both
- o Other

2. What are some of the basic services provided by the NAES in your country?

- o Support in dissemination of good animal husbandry/management practices
- o Support in veterinary/animal Health services
- o Support in value and processing techniques
- o Training on the utilization of various technologies and innovations
- o Support on marketing of animals and products
- o Support in the introduction to feed formulation and pasture management
- o Provision of access to demonstration sites and farms
- o Provision of training on record keeping

3. In your country, how can you describe the contribution of successful technology and innovation

uptake and transfer by the NAES?

o Excellent
o Very Good
o Good
o Average
o Poor

4. Name three major challenges you have faced during interactions with the NAES as a stakeholder in your respective livestock value chain

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5. What has been the reason/factors for successful adoption and transfer of the technologies/ innovations by the NAES?

o Consistent donor support
o Increased production of animal products
o Well trained and motivated NAES staff
o Government political good will through budgetary allocations
o Ease of adoption of select technologies/innovations
o Good collaboration between Technology service provider and NAES
o Farmer co-operation
o Community level support
o Other (Please specify) ……..

SECTION 4: ASSESSMENT ON TECHNOLOGY AND INNOVATIONS ADOPTION

1. Who are the major technology/innovation developers in the animal resources sector in your country?

o Government
o Private sector
o Research Institutions
o Vocational institutions
o Farmer Groups/Associations
o Other (Please specify) ……..

2. Select three (3) primary sources of funding for technology innovation and development in your country

o Government
o External donors/projects

o Private sector
o Farmer Groups/Livestock Associations
o Individual Farmer /Beneficiaries
o Technology Developer
o Other (Please specify) ……..

3. Rank the degree of co-operation between technology developers and the NAES in your country
o Excellent
o Very Good
o Good
o Average
o Poor

4. What are the main causes of poor co-operation between technology developers/innovators with the NAES?
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5. In your sector, are most of the technologies in use imported from outside the country?
o Yes
o No

6. If your answer is yes above, from which regions are most of the adopted technologies imported from?
o Africa
o Europe and UK
o America
o Asia
o Other (Please specify) ……..

SECTION 5: ASSESSMENT ON TECHNOLOGY UPTAKE AND TRASFER

1. What technologies in the dairy cattle sector have the NAES in your country successfully adopted and transferred to stakeholders including farmers?
(Tick all that apply)
o Artificial Insemination
o Embryo Transfer
o Oestrus synchronization
o Milking Machine

- o Robotic milking machine
- o Solar powered milking equipment
- o Milk pasteurising equipment
- o Other solar powered equipment (specify) …….
- o Drones for grazing management and other uses
- o GPS Ear Tags
- o Feed supplements
- o Hydroponics fodder machine
- o Tractor operated hay bailers
- o Breeding and selection programmes
- o Biogas production
- o Others (Please specify) …….

2. What technologies in the poultry sector have the NAES in your country successfully adopted and transferred to stakeholders including farmers?

(Tick all that apply)

- o Electric poultry incubator
- o Solar incubator
- o Co-operative Incubation
- o Ammonia production sensors
- o Automated layer management
- o Smart lighting for chicken houses
- o Smart cameras in chicken houses
- o Biogas production
- o Egg sexing
- o Integrating supply chain using digital technology
- o Automatic chick feeders
- o Smart Poultry houses
- o Ventilation fans to cool chicken houses
- o Artificial Insemination in chickens
- o Precision agriculture: feed intake and body weight monitoring
- o Automatic water drinkers
- o Protein enriched feed
- o Others (Please specify)…….

3. What technologies in the apiculture sector have the NAES in your country successfully adopted and transferred to stakeholders including farmers?

(Tick all that apply)

- o New bee hives
- o New products for bee and honey production and honey distribution
- o Honey processing equipment

o Others (Please specify) ……

4. Following the outbreak of the COVID-19 pandemic, technology-based solutions have been advocated, there is an equal need to adopt digital technologies to enable efficient food systems to thrive. List at least three (3) digital technologies that can be adopted in various components of the value chain.

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5. In relation to promoting digital technology at the farmer level, identify three (3) main approaches that can be adopted to drive e-based adoption and uptake by the Regional communities?

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6. Briefly describe three (3) main challenges that may be experienced with uptake of digital technologies by Livestock keepers.

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7. Briefly describe three (3) main challenges that may be experienced with uptake of digital technologies by Governments.

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8. Briefly describe three (3) main challenges that may be experienced with uptake of digital technologies by the Private sector.

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9. What are the best bet strategies that can be adopted by NAES to spearhead the digitalization of the livestock sector in Africa?

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SECTION 6: SUSTAINABLE USE OF TECHNOLOGIES AND INNOVATIONS IN LIVESTOCK VALUE CHAINS

NB: For each of the top 3 technologies selected please provide more information as follows:

1. Which of the following ACTORS actively supports technology development, adoption and uptake in your country?

o Government
o Development partners/NGOs
o Private sector
o Other (Please specify) ……

2. For the adopted technologies, how will you rank the transfer or acceptance rate by the target group (farmers/animal breeders, processors, livestock traders, etc)?

o Excellent
o Very Good
o Good
o Average
o Poor

3. In your view which value chain technologies have been the most supported by your government through the NAES to help the farmers improve productivity?

o Poultry
o Dairy Cattle
o Beef Cattle
o Sheep Production
o Goat Production
o Honey Bee Production
o Other (Please specify) ……..

4. How has adopted innovative technologies impacted on animal production activities?

o Little or no impact
o Some impact but not presently
o Sustained impact
o Very remarkable impact

o Other (Please specify) ……...

5. List three (3) major challenges that have you had with your national agricultural extension services (NAES) as an actor on the livestock value chain regarding technology adoption?

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6. Does the NAES offer regular training on introduced/innovative technologies to farmers?

o Yes
o No

If yes who provide/fund such training?

o Government
o Farmer Associations
o NGOs
o Technology developers
o Individual Target Beneficiaries
o Donor funded projects
o Other (Please specify) ……

7. Give three (3) recommendations that can be considered by National governments to offer incentives to the NAES.

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8. Give three recommendations to stakeholders to improve the participation of NAES in technology and innovation adoption in the animal resources sector in Africa?

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SECTION 7: APPRECIATION

You have completed our Questionnaire. We are very appreciative of the time that you have taken to assist us in collection of this information. We commit to treat all information that has been provided with the utmost confidentiality. Once again, we are extremely grateful for contributing your valuable time and for giving us this invaluable information.

Thank you AU-IBAR Live2Africa Team.

French Version

SECTION 1 - INTRODUCTION

Enquête sur les enseignements tirés et les meilleures pratiques en matière d'adoption et de transfert de technologies dans le secteur des ressources animales pour les services nationaux de vulgarisation en Afrique

Nous vous adressons ce questionnaire parce que vous êtes un précieux partenaire. Nous sommes conscients de votre horaire chargé, c'est pourquoi nous avons conçu un court questionnaire que vous pourrez remplir en 10 - 15 minutes.

En outre, nous vous saurions gré de bien vouloir transmettre ce questionnaire à vos réseaux que vous avez identifiés comme parties prenantes des services nationaux de vulgarisation agricole.

Définition des termes

VI. Service national de vulgarisation agricole (SNVA) – Il s'agit normalement d'un organisme gouvernemental qui relève du Ministère de l'Agriculture, dont la mission est d'informer et de former les éleveurs afin de les habiliter à tirer le meilleur parti possible des technologies existantes et de les motiver à accepter les innovations nouvelles et émergentes.

VII. Technologie – Dans la filière Élevage, une technologie désigne une nouvelle méthode, un nouveau système ou un nouveau dispositif qui a été mis au point grâce à l'utilisation de connaissances scientifiques.

VIII. Adoption de technologie - L'adoption ou l'utilisation d'une technologie désigne l'acceptation, l'intégration, le choix d'acquérir et d'utiliser une nouvelle invention, technologie ou innovation dans la société.

IX. Transfert de technologie - Il désigne le processus consistant à répercuter les résultats (ainsi que les compétences et procédures connexes) de la recherche scientifique et technologique à un groupe cible (éleveurs), au marché et à la société au sens large. Il constitue à ce titre une partie intrinsèque du processus d'innovation technologique qui contribue à maximiser l'efficacité des groupes ciblés dans la production.

ACRONYMES

X. SNVA – Service national de vulgarisation agricole

SECTION 2 : COMPILATION DES DONNÉES PERSONNELLES

4. Renseignements sur le/la répondant/e

Nom et prénoms

Genre

- Homme
- Femme

Pays

Ville/comté/district

Organisation à laquelle vous êtes affiliés :

Fonction dans l'organisation (facultative):

Tranche d'âge

- o Moins de 30 ans
- o 31-40 ans
- o 41-50 ans
- o 51-60 ans
- o Plus de 60 ans

5. Sélectionner votre région spécifique et la filière / chaîne de valeurs prioritaire correspondante du secteur Élevage

- o Afrique centrale : Filière « Œufs et Viandes de volailles »
- o Afrique orientale : Filière « Lait et Produits laitiers »
- o IGAD : Filière « Viandes et Animaux vivants »
- o Afrique du Nord : Filière « Lait et Produits laitiers »
- o Afrique de l'Ouest : Filière « Volailles »
- o Afrique australe : Filière « Viandes et Animaux vivants »

6. Quel est votre principal niveau d'engagement dans la filière / chaîne de valeurs prioritaire du secteur Élevage dans votre région ?

Sélectionner UN SEUL rôle qui décrit le mieux votre engagement aux maillons de la chaîne de valeurs.

- o Production
- o Intrants et services
- o Transformation et production de valeur ajoutée
- o Commerce et marketing
- o Règlementation, législation, coordination et harmonisation

SECTION 3 : ÉVALUATION DU SERVICE NATIONAL DE VULGARISATION AGRICOLE (SNVA)

(Dans la mesure du possible, fournir des informations complémentaires en joignant des fichiers et en indiquant des liens vers les adresses de sites internet pertinents, etc.)

6. Quel type de service national de vulgarisation agricole (SNVA) avez-vous dans votre pays ?

- o Public

o Privé (y compris les prestataires de services de vulgarisation agricole parrainés par les éleveurs, les ONG)
o Les deux
o Autre

7. Quels sont quelques-uns des services de base fournis par le SNVA dans votre pays ?
o Appui à la diffusion de bonnes méthodes d'élevage et de gestion des animaux
o Appui aux services vétérinaires/de santé animale
o Appui aux techniques de production de valeur ajoutée et de transformation
o Formation à l'utilisation de diverses technologies et innovations
o Appui à la commercialisation d'animaux et de produits animaux
o Appui à l'introduction de la formulation d'aliments pour animaux et à la gestion des pâturages
o Ouverture de l'accès aux sites et fermes de démonstration
o Formation à la tenue de dossiers

8. Dans votre pays, comment pouvez-vous décrire la contribution de l'adoption et du transfert réussis de technologies et d'innovations par le SNVA ?
o Excellente
o Très bonne
o Bonne
o Moyenne
o Faible

9. Citer trois grands défis auxquels vous avez été confrontés lors de vos interactions avec le SNVA en tant que partie prenante dans votre filière / chaîne de valeurs du secteur Élevage.
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10. Quels ont été les raisons et les facteurs de l'adoption et du transfert réussis des technologies/ innovations par le SNVA ?
o Soutien sans faille des bailleurs de fonds
o Augmentation de la production de produits animaux
o Personnel bien formé et motivé du SNVA
o Bonne volonté politique du gouvernement se traduisant par des allocations budgétaires
o Facilité d'adoption de certaines technologies/innovations
o Bonne collaboration entre le prestataire de services technologiques et le SNVA
o Coopération entre éleveurs
o Soutien au niveau communautaire

o Autre (veuillez préciser) ……..

SECTION 4 : ÉVALUATION DE L'ADOPTION DE TECHNOLOGIES ET D'INNOVATIONS

7. Qui sont les principaux développeurs de technologies/innovations dans le secteur des ressources animales dans votre pays ?

o Services gouvernementaux
o Secteur privé
o Instituts de recherche
o Établissements d'enseignement professionnel
o Groupes/Associations d'éleveurs
o Autre (veuillez préciser) ……..

8. Sélectionner trois (3) sources principales de financement de l'innovation et du développement technologiques dans votre pays.

o Services gouvernementaux
o Bailleurs de fonds externes/projets
o Secteur privé
o Groupes d'éleveurs/Associations d'éleveurs
o Éleveur / Bénéficiaires particuliers
o Développeur de technologies
o Autre (veuillez préciser) ……..

9. Classer le niveau de coopération entre les développeurs de technologies et le SNVA dans votre pays.

o Excellent
o Très bon
o Bon
o Moyen
o Faible

10. Quelles sont les principales causes de la mauvaise coopération entre les développeurs de technologies /innovateurs et le SNVA ?

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11. Dans votre secteur, la plupart des technologies utilisées sont-elles importées de l'étranger ?

o Oui

o Non

12. Si vous avez répondu « oui » à la question ci-dessus, de quelles régions sont importées la plupart des technologies adoptées ?

o Afrique
o Europe et Royaume-Uni
o Amérique
o Asie
o Autre (veuillez préciser) ……

SECTION 5 : ÉVALUATION DE L'ADOPTION ET DU TRANSFERT DE TECHNOLOGIES

10. Quelles technologies du secteur du bétail laitier ont été adoptées avec succès par le SNVA dans votre pays et transférées aux parties prenantes, y compris les éleveurs ?
(Cocher tous les éléments applicables)

o Insémination artificielle
o Transfert d'embryons
o Synchronisation de l'œstrus
o Trayeuse
o Robot de traite
o Matériel de traite à énergie solaire
o Équipement de pasteurisation du lait
o Autre équipement fonctionnant à l'énergie solaire (préciser)…….
o Drones pour la gestion des pâturages et autres usages
o Étiquettes d'oreille repérables par GPS
o Compléments pour aliments destinés aux animaux
o Machine pour fourrage hydroponique
o Presses à foin actionnées par un tracteur
o Programmes d'élevage et de sélection des animaux
o Production de biogaz
o Autres (veuillez préciser) …….

11. Quelles technologies du secteur des volailles ont été adoptées avec succès par le SNVA dans votre pays et transférées aux parties prenantes, y compris les éleveurs ?
(Cocher tous les éléments applicables)

o Incubateur électrique pour volailles
o Incubateur solaire
o Incubation de coopérative
o Détecteurs de production d'ammoniac
o Gestion automatisée des pondeuses
o Éclairage intelligent pour les poulaillers
o Caméras intelligents dans les poulaillers

- o Production de biogaz
- o Détermination du sexe dans l'œuf
- o Intégration de la chaîne d'approvisionnement en utilisant une technologie numérique
- o Nourrisseurs automatiques pour poussins
- o Poulaillers dotés d'intelligence artificielle
- o Ventilateurs pour le rafraîchissement de poulaillers
- o Insémination artificielle des poulets
- o Élevage de précision : surveillance de la consommation alimentaire & du poids corporel
- o Abreuvoirs automatiques
- o Aliments enrichis en protéines
- o Autres (veuillez préciser).....

12. Quelles technologies du secteur de l'apiculture ont été adoptées avec succès par le SNVA dans votre pays et transférées aux parties prenantes, y compris les éleveurs ?
(Cocher tous les éléments applicables)

- o Nouvelles ruches
- o Nouveaux produits pour la production d'abeilles et de miel et pour la distribution de miel
- o Matériel de transformation du miel
- o Autres (veuillez préciser).....

13. À la suite de l'apparition de la pandémie à COVID-19, des solutions technologiques sont préconisées ; et il est tout aussi nécessaire d'adopter des technologies numériques pour permettre aux systèmes alimentaires efficaces de prospérer. Énumérer au moins trois (3) technologies numériques qui peuvent être adoptées aux divers maillons de la chaîne de valeurs.

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14. En ce qui concerne la promotion de technologies numériques auprès de l'éleveur, identifier trois (3) principales approches qui peuvent être mises en œuvre pour stimuler l'adoption et l'utilisation par voie électronique au niveau des communautés régionales ?

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15. Décrire brièvement trois (3) principaux problèmes qui peuvent se poser à la suite de l'adoption de technologies numériques par les éleveurs.

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16. Décrire brièvement trois (3) principaux problèmes qui peuvent se poser à la suite de l'adoption de technologies numériques par les services gouvernementaux.

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17. Décrire brièvement trois (3) principaux problèmes qui peuvent se poser à la suite de l'adoption de technologies numériques par le secteur privé.

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18. Quelles sont les stratégies les plus prometteuses que le SNVA peut adopter pour diriger la numérisation du secteur Élevage en Afrique ?

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SECTION 6: UTILISATION DURABLE DES TECHNOLOGIES ET INNOVATIONS DANS LES FILIÈRES DE L'ÉLEVAGE

NB : Pour chacune des 3 premières technologies sélectionnées, veuillez fournir plus d'informations, de la manière suivante :

9. Parmi les ACTEURS ci-après, lequel soutient activement le développement, l'adoption et l'utilisation de technologies dans votre pays ?

- o Gouvernement
- o Partenaires au développement /ONG

o Secteur privé
o Autre (veuillez préciser) ……

10. Pour les technologies adoptées, comment classerez-vous le niveau de transfert ou d'acceptation par le groupe cible (exploitants agricoles/éleveurs, transformateurs, vendeurs/acheteurs d'animaux, etc.) ?

o Excellent
o Très bon
o Bon
o Moyen
o Faible

11. Selon vous, quelles (technologies des) filières ont été le plus soutenues par votre gouvernement par l'intermédiaire du SNVA pour aider les éleveurs à améliorer leur productivité ?

o Volailles
o Bovins laitiers
o Bovins de boucherie
o Production ovine
o Production caprine
o Production d'abeilles mellifères
o Autre (veuillez préciser) ……..

12. Quel est le degré d'impact des technologies innovantes adoptées sur les activités de production animale ?

o Peu ou pas d'impact
o Un certain impact, mais pas actuellement
o Impact durable
o Impact très remarquable
o Autre (veuillez préciser) ……...

13. Citer trois (3) problèmes que vous avez eu avec vos services nationaux de vulgarisation agricole (SNVA) en tant qu'acteur de la filière Élevage en ce qui concerne l'adoption de technologies ?

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14. Le SNVA offre-t-il régulièrement des formations sur les technologies introduites/innovantes aux éleveurs ?

a. Oui

b. Non

Dans l'affirmative, qui assure/finance cette formation ?

- o Gouvernement
- o Associations d'éleveurs
- o ONG
- o Développeurs de technologies
- o Bénéficiaires individuels visés
- o Projets financés par des bailleurs de fonds
- o Autre (veuillez préciser) ……

15. Donner trois (3) recommandations qui peuvent être prises en compte par les gouvernements nationaux pour offrir des motivations au SNVA.

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16. Donner trois recommandations aux parties prenantes qu'elles peuvent mettre en application pour améliorer la participation du SNVA dans l'adoption de technologies et d'innovations dans le secteur des ressources animales en Afrique ?

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SECTION 7 : APPRÉCIATION

Vous venez de terminer notre questionnaire. Nous vous remercions sincèrement pour le temps que vous avez pris pour nous aider à recueillir ces informations. Nous vous garantissons que nous traiterons tous ces renseignements avec la plus grande confidentialité. Encore une fois, merci infiniment de nous avoir consacré une partie de votre précieux temps et de nous avoir donné ces informations inestimables. L'Équipe Live2Africa de l'UA-BIRA.

Annex 3: List of Contributors

A 3.1 Participants of the E-Survey

No.	Name	Gender	Position/Role	Organization	Country
1	Richard Osei-Amponsah	M	Senior Lecturer	University of Ghana	Ghana
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5	Yassir Ahmed Hassan Nasr	M	Geneticist	Animal Production Research Centre	Sudan
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10	Abebe Hailu Kassa	M	Researcher	Ethiopian Biodiversity Institute	Ethiopia
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14	Mary Sitina Yapete	F	Deputy Director	Ministry livestock and fisheries	South Sudan
15	Hassan Ally Mruttu	M	National Coordinator for Management of Animal Genetic Resources	Ministry of Livestock and Fisheries	Tanzania
16	Samuel Mbuku	M	Senior Research Scientist	Kenya Agricultural and Livestock Research Organization	Kenya
17	Bueno Shanto Mokhutshwane	M	District Head, Department of Animal Production	Ministry of Agricultural Development & Food Security; Department of Animal Production	Botswana
18	Lamin Saine	M		Private Sector	Gambia
19	Cleopas Wahome	M	Manager	Naivasha Sheep and Goats Breeding Farm	Kenya

No.	Name	Gender	Position/Role	Organization	Country
20	Athumani Nguluma	M	Senior Livestock Research Officer	Tanzania Livestock Research Institute	Tanzania
21	Roland Partu Varkpeh	M	Director of Animal Production	Ministry of Agriculture	Liberia
22	Dennis Oningo Jacoyange	M	Lead farmer	Kakamega Dairy Co-operative Society	Kenya
23	Andrianatus Maseke	M	Senior Manager Quality Assurance Health and Safety	Meat Corporation of Namibia	Namibia
24	Tadesse Sori	M	Animal Production Focal Person for AGP	Ministry of Agriculture	Ethiopia
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No.	Name	Gender	Position/Role	Organization	Country
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57	Bongumusa Simelane	M	Nsalitshe Nguni Cattle Breeding Ranch Manager	Ministry of Agriculture	Eswatini
58	Christopher Mukasa	M	Technical Manager Breeding	National Animal Genetic Resource Centre and Data Bank, Entebbe	Uganda
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60	Andrew Chamisa	M	Acting Director	Department of Livestock Research	Zimbabwe
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64	Ondo-Azi Alain Serges	M	Chef de Service des Programmes et de la Valorisation	PRASAC/CEMAC	Chad
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67	Ibet Abbakaka	F	Director General	Complexe Nutritionnel Animal	Chad
68	Rasoarinorolalao Hariliva Tsimialisoa	F	Ingénieur d'Elevage, Responsable de l'élevage pour le développement de la filière "Bovin à viande"	Ministère de l'Agriculture, de l'Elevage et de la Pêche	Madagascar
69	Ngoteni Roger Ernest	M	Directeur de la production animale	Ministère de l'agriculture, de l'élevage et de la pêche	République du Congo Brazzaville
70	Tinguiano Bernard	M	Chef de Division Gestion des Ressources Animales	Direction Nationale des Productions et Industries Animales	République de Guinée
71	Misbahou Yahaya	M	Technicien en production Animale	Ministère de l'Agriculture, Peche et Environnement	Comores
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73	Andrianasolo Hanta	M	CHEF DE SERVICE D'APPUI AU DÉVELOPPEMENT DES RACES ET CONTRÔLE ZOOGENETIQUE	MINISTERE DE L'AGRICULTURE, DE L'ELEVAGE, ET DE LA PECHE	Madagascar
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No.	Name	Gender	Position/Role	Organization	Country
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78	El Amiri Bouchra	F	CHERCHEUR	INRA	Maroc
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No.	Name	Gender	Position/Role	Organization	Country
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94	Mohamed	M	veterinary	minister de l,Agriculture	Djibouti
96	Bacar Djassi	M	Point Focal de Ressource Genetique Animal	Direction Generale de L'elevage	Guinee-Bissau
97	Gomes João	M	Chef de Repartition d'Appui à la Prodution Animal	Ministère de l'Agriculture	Guinee-Bissau
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A 3.2 Participants of the E-Discussion

No.	Name	Country
1	Mouyabi Jean Jacques	Gabon
2	Boubaccar Diallo	Guinea
3	Solomon Abegaz Kebede	Ethiopia
4	Djomtchaigué Bamaré Herbert	Chad
5	Olawale F. Olaniyan	Gambia
6	Tebug Tumasang	Cameroon
7	Dackson Zulu	Zambia
8	Atouga Djaba	Togo
9	Mazanga Suzanna Mhame	Malawi
10	Richard Osei-Amponsah	Ghana
11	Mary Mbole-Kariuki	Kenya
12	Edward Nengomasha	Kenya

A 3.3 Participants of the E-Validation Meeting

No.	Name	Country
1	Davika Saddul	Mauritius
2	Anatole Ntelo	Congo
3	Donald Rugira-Kugonza	Uganda
4	Mame Nahe Diouf	Senegal
5	Neema Urassa	Tanzania
6	Ousmane Nialibouly	Mali
7	Aloysious Zinnah Momo	Liberia
8	Muna Issawy	Sudan
9	Hassan Ally Mruttu	Tanzania
10	Diresh Ramlugun	Mauritius
11	Cleopas Okore	Kenya
12	Cleopas Wahome	Kenya
13	Abraham Tuji	Ethiopia
14	Sitina Mary Yapete Arionje	South Sudan
15	Philip Justine Waya	South Sudan
16	M'Naouer Djemali	Tunisia
17	Richard Osei-Amponsah	Ghana
18	Dennis Owusu Adjei	Ghana
19	Atouga Djaba	Togo
20	Bueno Shanto Mokhutshwane	Botswana
21	Sylvere Mboumba	Uganda
22	Veeranee K. Ramsay	Mauritius
23	Arvind Rajiv Shimady	Mauritius
24	Khaled Fantazi	Algeria
25	Mary Mbole-Kariuki	Kenya
26	Khale Oun	Lybia
27	Kolowale Odubote	Zambia
28	Misbahou Yahaya	Comoros
29	Melchoir Butoyi	Burundi
30	Carine Nyilimara	Rwanda
31	Roland Varkpeh	Liberia
32	Khalid Boukhan	Morocco
33	Tebug Thomas Tumasay	Cameroun
34	Bongani Magagula	Swaziland
35	Victoria Norgbey	Ghana
36	Anthony Akunzule	Ghana
37	Olawale F. Olaniyan	Gambia
38	Patricia Mayuni	Malawi
39	Beatrice Adhiambo	Kenya
40	Aboubakar Adamou Dit Kimba	Niger

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