LEAP-Agri
A Long term EU-Africa research and innovation Partnership on food and nutrition security and sustainable Agriculture

EUROPEAN UNION

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Development of a medium to long-term joint research and innovation agenda

Feeding the AU-EU long-term partnership in research and innovation on food and nutrition security and sustainable agriculture (FNSSA)

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GLOSSARY

Africa-EU Partnership (2000) / AU-EU Partnership

Brussels, 17-18 October 2017, Senior Officials of the AU-EU High Level Policy Dialogue on Science, Technology and Innovation, agree to change the name of the Policy Dialogue from EU-Africa to AU-EU High Level Policy Dialogue on Science, Technology and Innovation, to take full account of the regional dimension of the dialogue and align it to the AU-EU Summit terminology, and modify the HLPD Terms of Reference accordingly.

The AU-EU Partnership is the formal political channel through which the EU and the African continent work together, engage in political and policy dialogues and define their cooperative relationship. It was established in 2000 at the first AU-EU Summit in Cairo.

The partnership is guided by the Joint AU-EU Strategy (JAES) of 2007. The JAES is implemented through multiannual roadmaps and action plans, adopted after each AU-EU Summit of Heads of States and Governments.

Following the 5th AU-EU Summit (2017), cooperation currently focuses on four priority areas (1. 'Investing in people' (incl. education, science, technology and skills development); 2. 'Resilience, Peace, Security and Governance'; 3. 'Migration and mobility'; 4. 'Investments').

AU-EU cooperation in Science, Technology and Innovation (from 2007 onwards)

AU-EU cooperation in STI is embedded in the JAES and the new 2017 priority area 'Investing in people'. Within this priority, the EU is committed to foster skills, innovation and research by strengthening the mobilisation of European and African expertise in research and innovation, in particular by reinforcing the implementation of the AU-EU R&I Partnership on Food and Nutrition Security and Sustainable Agriculture (see below).

The AU-EU HIGH-LEVEL POLICY DIALOGUE (HLPD) on STI serves as the venue for regular exchanges on research and innovation policy and priorities. The HLPD is supported by bi-continental Expert Working Groups for the successful implementation of thematic Partnerships such as the Partnership on FNSSA (see below).

AU-EU Research and Innovation Partnership on FNSSA (from 2014 onwards)

FNSSA was the first theme in which both sides agreed to work together towards a long term and structured Research and Innovation Partnership. To that end, the HLPD mandated a bi-continental Expert Working Group to prepare a Roadmap towards a jointly funded EU-Africa Research & Innovation Partnership on FNSSA.

AU-EU Research and Innovation Roadmap (2016-2026)

A Roadmap was adopted in 2016 at the 3rd meeting of the HLPD. This Roadmap, which has a duration of 10 years, identifies 3 priority areas as a basis for a joint research agenda, together with a group of cross-cutting issues of major importance. It also envisages the establishment of a monitoring and evaluation mechanism. The Roadmap intends, in particular, to increase coherence between and build upon the many projects in the FNSSA domain at the national, bilateral or bi-continental (Europe, Africa) level. It also provides an opportunity for alignment of the many networks linked to agriculture research that currently exist.

LEAP-Agri (2016-2021) https://www.leap-agri.com/

LEAP-Agri is an ERA-Net Cofund project co-funded by the EU Horizon 2020 programme that brings together European and African public research funds to support collaborative research and innovation projects in the FNSSA domain. The project also explores principles and elements for the development of a LONG-TERM AU-EU R&I PARTNERSHIP AGENDA ON FNSSA, in coherence with the Roadmap. LEAP-Agri is considered as one of the first major initiatives contributing to the implementation of the R&I Roadmap on FNSSA.

LEAP4FNSSA (2018-2022) https://www.leap4fnssa.eu/

LEAP4FNSSA is another Horizon 2020 funded project supporting the implementation of the R&I Roadmap. The general objective of Leap4FNSSA is to establish a sustainable structure, or 'Platform', for the efficient and coherent implementation of the AU-EU Research and Innovation Partnership as described in the Roadmap. It operates under the aegis of the HLPD and its Bureau.

1 EXECUTIVE SUMMARY

Africa and Europe share global challenges to improve food systems on sustainable development pathways in line with the targets of the SDGs and more specifically SDG2 sustainable development goal "Zero hunger". The first of these challenges is to end hunger and ensure access to safe and sufficient food for all, especially people in vulnerable situations including children throughout the year. According to the World Food Programme, 135 million people suffer from acute hunger largely due to man-made conflicts, climate change and economic downturns and more than 800 million suffer from malnutrition. The COVID-19 pandemic could now double that number, putting an additional 130 million people at risk of suffering acute hunger by the end of 2020.

Also, a profound change in the global food and agriculture system is needed if we are to feed the 690 million people who suffer from hunger today and the additional 2 billion people the world will have by 2050. Increasing agricultural productivity capacities and strengthening sustainable food production systems are necessary to help reduce the problem of hunger, including agricultural products and food waste decrease. At the same time, it is needed to implement resilient agricultural practices that increase productivity and production, contribute to the preservation of ecosystems, strengthen the capacity to adapt to climate change, extreme weather events, drought, floods and other disasters, and progressively improve land and soil quality, conserve water resources and biodiversity.

It is also challenging to ensure the proper functioning of food and derivatives markets and to facilitate rapid access to market information, including food reserves, in order to help limit extreme food price volatility. Moreover, it is important to prevent trade restrictions and distortions in global agricultural markets.

In this context, Africa and Europe have decided to increase investment in rural infrastructure, agricultural research and extension services and the development of new technologies to strengthen their agricultural productive capacities while protecting the environment, managing renewable resources, decreasing waste and providing healthy food for their people. The two continents are also seeking to improve trade to ensure a supply of essential foodstuffs for each other even when they cannot be produced locally (e.g. tea, coffee, cocoa for Europe, wheat, durum wheat in tropical Africa).

Sustainable food systems' transformation needs to build on the right to food and scaling of a systems approach. For evidence-based decision-making, investment into research and innovation plays a critical role. However, for it to be effective, research needs to be actor-oriented and despite the problems being of concern to both continents, solutions need to be context-specific and co-developed, including multiple stakeholder groups. To reach these goals, research programming and implementation capacities need to be strengthened across Africa through the development of a joint AU-EU R&I agenda on FNSSA. Moreover, understanding funding constraints and adjusting current funding mechanisms to facilitate equal partnership development is a crucial step towards consolidating the long-term AU-EU Partnership and the HLPD.

In this framework, LEAP-Agri is a joint Europe Africa EranetCofund project, dedicated to FNSSA Research and Innovation, involving 24 European and African Ministries and Funding Agencies, and 6 research organizations, with a financial support of the EC. Work package 6 of the LEAP-Agri project supports the development of the long-term AU-EU research and innovation partnership on FNSSA. It is directly linked to the HLPD road map's ambition to "align, under a shared vision, research and derived innovation activities of a broad range of partners, irrespective of their funding mechanisms or legal instruments". It also aims at further connecting research and innovation networks to local multi-stakeholder research and innovation processes.

This cross-cutting deliverable, to the five tasks of WP6 and coordinated by IRD, provides inputs for the development of a medium to long-term joint R&I agenda on FNSSA. A jointly elaborated agenda needs to highlight both thematic and procedural guidelines. In this way, the analysis of this deliverable has been structured around mapping the institutional landscape and framework conditions of current research collaborations as well looked into thematic aspects and the way projects feed into generally endorsed developing agendas, such as the SDGs, AU agenda 2063, or STISA 2024. The deliverable does not go as far as proposing this agenda in terms of objectives, targets and indicators of achievement. This will be done by the LEAP4FNSSA project in cooperation with the HLPD.

Based on the previous partnership programs, such as CAAST-NET, ERAfrica and RINEA and by analyzing on the one hand all the scientific articles on the FNSSA published and present in the Web of Science database (WoS) and on the other hand the 191 proposals received in the LEAP-Agri call for proposals as well as the 14 research projects funded by AURG and the 27 LEAP-Agri, WP6 was able to:

- Draw up an overview of continental and regional African institutions interested in research and innovation in Africa and the main programs conducted at the continental level.
- Identify active research networks between the two continents and the leading institutions for research and innovation on the themes of the FNSSA.
- Map the partnerships developed in AURG and LEAP-AGRI research projects (countries and institutions).
- Map the themes implemented by these projects.
- Identify the strengths and weaknesses of partnerships and understand the motivations and ways for improvement.
- Investigate how research projects' ambitions and their theory of change relate to different agendas: Stisa 2024, United Nations 2030, and African Union 2063.
- Propose a concept to assist programming and encourage partnerships in research and innovation, i.e. the Programme and Innovation Management Cycle (PIMC).
- Revisit the "Research Fairness Initiative" (RFI) implemented during CAAST-NET and already adopted or in the process of being adopted by both African and European institutions.

Finally, some key messages emerged from all this work. They should feed into the AU-EU partnership in the long term and be used to develop a medium and long term joint research and innovation agenda for FNSSA. They are ten in number:

1. KM1: **Bi-regional STI cooperation is considered as an effective level for designing and implementing programmes that combine different tools and different stakeholders in the search for appropriate agro-ecological solutions**. This cooperation allows not only the fund raising necessary for large multidisciplinary scientific projects, but also bringing together diverse skills and experiences and allowing win-win exchanges. Even if research collaborations have produced practice-oriented results, topics covered by international collaborations still need to be more systematically linked with the SDGs while being coherent with national, European and Pan-African development agendas.

2. KM2: **Current research cooperation projects might be too experimental and not concerned enough with "bread and butter" issues**. Collaborative research projects currently implemented under the umbrella of the AU-EU FNSSA Partnership are predominantly experimental. They often fall short in following transdisciplinary approaches, which not only dissolve disciplinary boundaries but are also inclusive to actors from practice when complex real-world problems are at stake. Indeed, FNSSA is a complex, multi-dimensional, multi-sectoral issue which is interlinked with multiple aspects, including health, markets, trade, economic development, power relations, governance, as well as socio-cultural dimensions and the natural environment. STI cooperation has the potential to operate in multiple dimensions

and via numerous impact pathways. Yet, the major focus of research projects tends to be on developing isolated data/knowledge bases in different sectors of agriculture production, nutrition or natural resources. Social innovations, including sustainable knowledge and information sharing platforms are scarce and only a few projects take an actor perspective and are dedicated to address challenges of food availability, utilisation or market.

3. KM3: **Research partnerships between the two regions need to become more diverse while continuously evaluating the priorities and mutual benefits of bi-regional research partnerships for FNSSA**. The paucity of data on soils and water scarcity, and the need for improving yields, as reported by several leading organisations including the FAO, suggest that future research collaborations for tackling the global FNSSA challenge might do well to target this basic ecological dimension of FNSSA. Further applied research is needed into the mechanisation aspects (including irrigation) of FNSSA, in particular the role of small and medium-scale energy-efficient equipment and machinery. Since only a small percentage of projects currently appear to focus directly on food access, more attention is also needed for infrastructural development such as farm-market linkages as well as storage and warehousing systems. In addition, along with issues such as risk assessment for minimising the introduction of pathogens into predominantly European food markets, intellectual property rights and bio-based extracts for cosmetics, food safety is important for Africa and needs further attention under the FNSSA partnership.

4. KM4: **Existing networks and successful research collaborations need to be strengthened while creating conditions that allow for more participation of countries**. In terms of geographic participation, the main food insecure countries are located in West Africa, Central Africa and in the Horn of Africa whereas the majority of the Sub-Saharan African project participants are located in South and East Africa. Western and Central African countries are seldom represented, perhaps reflecting poor STI capacities and networks between these countries and European counterparts. This provides a starting point from which to build broader collaborative efforts, even though as part of this consideration should be given to utilising funding mechanisms that minimise a “winner takes all” scenario. This will encourage the pursuit of high quality scientific endeavours based also on insights and capacities from “outliers'' within Africa as well as (at both the organisational and country levels) to address the global FNSSA challenges. On the European side there tends to be low engagement from Eastern European countries even though they face their own related challenges such as food safety and quality, EU market access/penetration, poor infrastructure, and poor policy instruments, and as such could surely benefit from collaborating with African counterparts dealing with similar challenges. **A key challenge for AU-EU partnership in FNSSA is to include AU such as EU underrepresented countries, and to build processes and tools to facilitate such integration**.

5. KM5: **Private sector involvement is lacking in AU-EU funded projects.** For successful FNSSA projects, participatory approaches involving all stakeholders are essential throughout the project cycle. Utilization of research results is much higher when research teams, private sector actors (including farmers’ organisations, SMEs, and intermediaries) and decision-makers are connected from the beginning and co-develop solutions. A major barrier to private sector engagement has been the differing motivations of business enterprises and research institutions and the limited follow-through on research outputs after projects ended. The transfer and dissemination of knowledge also remained limited, as the private sector often does not see the direct benefits of research cooperation projects, suggesting a dearth of mechanisms for making the knowledge available, understandable and convincing. Complexity of EC and REA (Research Executive Agency) rules could also refrain private companies from embarking on EU cofounded R&I projects.

6. KM6: **Innovation processes need to be fostered by strengthening African scientific and institutional capacity** (e.g. access to research infrastructures), especially for those countries and institutions currently left behind. To achieve greater impact on the global FNSSA challenge—as duly recognised by the African governing institutions such as the AUC and NEPAD, together with African research coordinating platforms on agriculture (e.g. FARA and scientific research organisations)—capacity development in STI in Africa has to be improved. Agriculture services support organisations such as agricultural schools are key to facilitate research innovation transfer and adoption by farmers; they should then be part of the supported organizations. Complementary possible solutions could for instance include the implementation of more joint AU-Europe doctoral programmes such as the ARPPIS-DAAD Ph.D. scholarships scheme in Kenya, or building upon expert consultations in thematic domains to support multi-disciplinary knowledge sharing, joint priority setting, planning and implementation as exemplified by the FNSSA partnership.

7. KM7: The implementation of LEAP-Agri highlights the limits of the ERANet co-funding instrument and the need to design more user-friendly and flexible cooperation mechanisms so that administrative and financial rules could better support R&I projects implementation. **Future modes of funding need to be built on a long-term vision and made more conducive to ensure equal participation of countries and institutions**.

8. KM8: An open **partnership platform** needs to be created to work in a more coordinated way. Such a platform should be open to the entire research of innovation chain actors and should address the fragmentation of initiatives on FNSSA by embedding activities in the HLPD policy process. This platform, which is under construction by the LEAP4FNSSA project, should be based on a long-term knowledge management, communication and governance mechanism. An opened and shared data repository including information on funding initiatives along with better ways to measure output and impact should be part of the platform.

9. KM9: The **Programme and Innovation Management Cycle** (PIMC) is proposed to be adopted by the HLPD as a tool for partnership programming and evaluation and as a support for partnership platform elaboration.

10. KM10: To improve partnerships and in order to support fairness and equity in projects elaboration and implementation, HLPD could further promote **the Research Fairness Initiative (RFI)** as an instrument for systematically improving research cooperation involving collaborators from African such as European countries.

2 INTRODUCTION

Early 2000s, there has been an emphasis on equitable partnerships between African and European countries that promote common interests and mutual benefits to jointly address global challenges (JAES, 2007)[1]. Over the past decade, AU-EU strategic partnerships have contributed to a large body of scientific literature.

Launched in 2016, LEAP-Agri is a cooperation project to support the AU-EU Research and Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture (FNSSA) within the Joint AU-EU Strategy (JAES). The LEAP-Agri project consortium brings together 24 funding agencies and 6 research institutions with the ambition to contribute towards developing the EU-AU Research and Innovation Partnership on FNSSA. The project does so by focusing on two main pillars, (i) funding R&I projects on FNSSA, and (ii) Feeding the long-term AU-EU Partnership on FNSSA.

Being part of the second pillar, the activities of Work Package 6 (WP6) particularly address the support of the development of the long-term EU-AU Research and Innovation Partnership on FNSSA. In line with the ambition of the HLPD roadmap towards a jointly funded EU-Africa Research & Innovation Partnership on FNSSA to "align, under a shared vision, research and derived innovation activities of a broad range of partners, irrespective of their funding mechanisms or legal instruments", WP6 has implemented a range of stakeholder consultations and conducted different analyses of ongoing research collaborations, to map the current situation of the partnership and to reveal barriers and enablers as well as strategies for the development of a medium to long-term joint research and innovation agenda to build the EU-AU FNSSA Partnership.

In form of a public report, this Deliverable 6.1 connects several outputs of the five WP6 tasks to highlight progress towards the development of a medium to long-term joint research and innovation agenda. The need to develop an EU-AU Research and Innovation Agenda on FNSSA is driven by prevailing global hunger and nutritional imbalances and rising incidences of non-communicable diseases due to poor diets. In light of an increasing number of people affected by hunger in the world, with 690 million people in the world (8.9 percent of the world population) being undernourished in 2019 and the estimation that based on average estimated incomes more than 3 billion people in the world could not afford a healthy diet in 2017[2], there is an urgent need for transforming food systems towards greater sustainability and resilience. While the food and agriculture sector being a driver for climate change, it embeds great potentials towards climate change mitigation and adaptation. Hence, there is a vital role of FNSSA research and innovation.

Research and innovation (R&I) programming needs to address instant problems and issues and reconnect to past research and innovation while, at the same time, pave the way to anticipated future demands in FNSSA. In the frame of global challenges, identifying common strategic areas of medium- and long-term interest for Europe and Africa is particularly important. Setting strategic priorities should be based on reinforcing synergies among different regional agendas and build on the current landscape of projects to ensure balanced cooperation and just partnerships providing mutual benefits for all involved partners. Joint prioritisation will enhance the delivery of research results for practice and policy-making.

Despite the EU and AU having launched several joint agricultural programmes in recent years, there still remain obstacles, such as the lack of coordination between initiatives, limited mobility of

[1] https://africa-eu-partnership.org/en/partnership-and-joint-africa-eu-strategy

[2] FAO, 2020, SOFI Report http://www.fao.org/3/ca9692en/online/ca9692en.html#chapter-executive_summary

researchers, insufficient knowledge sharing and administrative barriers of funding mechanisms, highlighting limited synergies between the R&I agendas and priorities of both, the AU and EU. Hence, current cooperation between AU and EU on Science Technology and Innovation for FNSSA is still challenged by a fragmentation of efforts, disrupted communication channels and insufficient knowledge mobilization to sustain initiated innovation processes.

Further topics:

1. Need to update the FNSSA Roadmap, which was designed for 10 years
2. Address difficulties in joint funding
3. Address the challenge to identify research demand
4. Need to fund knowledge management to reach target groups
5. Identify strategies to sustain the network

This report highlights priorities for implementing research in the frame of building the AU-EU R&I Partnership on FNSSA, and provides recommendations for overcoming current challenges in partnerships. Through the provided analysis, WP6 contributes to the development of a joint medium to long-term research and innovation agenda as part of the overall EU-AU R&I partnership on FNSSA. This agenda should include not only the long-term research priorities, but also proposals for a partnership mechanism to facilitate effective implementation of these priorities, as well as a set of principles to perform collaborative research. Such an agenda is meant to guide future AU-EU cooperation initiatives in research and innovation on FNSSA.

The first section gives an in-depth overview on the history and context of the medium and long-term EU-AU Partnership on FNSSA. Thereafter, we present an analysis of current research collaborations in the context of the AU-EU Partnership on FNSSA. In particular, the following analysis have been achieved:

- The partnership shown by a bibliographic review,
- The geographic, institutional and thematic mapping of two important calls for projects launched by the AU / EU,
- The partnership and collaboration challenges raised by research project coordinators.

Based on this analysis, the Program Management and Innovation Cycle (PIMC) is presented as a concept to overcome fragmentation of R&I programming and sustain research investments and partnerships. Hence, a way for improving the medium and long-term programming activities in the scope of the AU-EU Partnership on FNSSA. Finally, possible pathways for consolidating the network and building a vision for future collaborations are presented.

3 CONTEXT OF THE MEDIUM AND LONG-TERM PARTNERSHIP ON FOOD SECURITY, NUTRITION AND SUSTAINABLE AGRICULTURE (FNSSA) BETWEEN THE TWO CONTINENTS

3.1 Global Context

From the beginning of socialisation, the need for food has structured human societies. Kings, emperors and governments have a duty to ensure that people are fed and food production and trade are protected. With the expansion of empires and colonies (Christian Grataloup, 2017[3]) the concept of protection and exchange of food became globalized. "Tea? Coffee? Chocolate?" - This morning litany, formulated in all the hotels of the world, evokes to each one an immutable daily ritual of the first meal

[3] Christian Grataloup 2017 Le monde dans nos tasses : L'étonnante histoire du petit-déjeuner. Armand Colin Editeur.

of the day. Indeed, who can imagine waking up without the stimulating smell of coffee, the enveloping warmth of tea or the comforting sweetness of hot chocolate? And yet, these drinks, so familiar everywhere in the world are produced by plants growing only in tropical climates. Likewise, wheat bread or durum wheat pasta become indispensable foods in tropical areas that are not conducive to growing wheat.

The intensification of trade in food goods extends back to the 19th century with Ricardo's theory of comparative advantage (Caron Patrick, 2020)[4]. De facto governance is instituted with the establishment of a market. In spite of crises (wars, great depression, 1973, 2008, 2020) and the temporary setbacks/failures that resulted, nation states or civil organizations of these states, proposed solutions to respond to the failures (food stamps, creation of global institutions such as the World Food Programme WFP, etc.). However, in spite of these solutions, the right to food (enshrined in the Universal Declaration of 1948) remains difficult to be guaranteed for the world's population. The right to food protects the right of all human beings to be free from hunger, food insecurity and malnutrition (Jean Ziegler, 2012)[5].

The issue of food is still not settled; indeed, 1 child dies of undernutrition every 30 seconds in the world and this fatality tends to disappear from the media for a while and then reappears through dramas and alerts but it is unfortunately too late. This issue is too often "delegated" to the charity sector and therefore to the emergency sector, whereas planning and anticipation seems to be the best solution.

The paradox of the food issue is that rural populations, who are supposed to feed the world, are the most affected by hunger. Indeed, Africa remains the continent most affected by poverty and hunger leading to undernourishment, famine and death. On the other hand, countries such as China and Brazil have made a spectacular leap forward in their development and have reduced the precariousness of their populations.

To give some figures, chronic undernutrition affects 793 million people in 2014 (of which 54% in East and South Asia and 28% in sub-Saharan Africa) and the prevalence of undernutrition is 19% in 1990-92 and remains at 10% in 2014-2016 (counting the fact that the population has doubled in the meantime). Despite a decrease in this population, which was hungry for a few years, it started to increase again in 2017 with 815 million people affected (Horn of Africa and Yemen in particular)[6]. This population is tending to stabilize but the problem still remains.

The world population doubled between 1961 and 2005, from 3 to 6 billion people. In addition, biomass production increased 2.5 times over the same period, which means that food availability per person per day has increased. Despite this achievement, people remain chronically hungry. This impasse shows that access to food is very unequal around the world. At the same time, agricultural transformation has allowed new problems related to the environment, climate, social justice and the emergence of new forms of malnutrition such as obesity.

From the 1970s onwards, there was a need to talk about food security and a first definition was given in 1974, at the time of the first oil shock with a food crisis in the Sahel affected by a terrible drought and the explosion of the world population. The fight against hunger was organized around three key words: supply, worldwide and control. It was essentially a race to modernize agriculture to ensure that it can meet world needs (“green revolution”). Governance was not called into question and the issues were dealt with in specific forums, in silos. This organization in silos is implicitly called into question

[4] Oral communication, webinar

[5] Ziegler, Jean (2012), Right to Food. Website of the former Special Rapporteur, archived from the original on 6 June 2012.

[6] https://www.who.int/fr/news-room/detail/11-09-2018-global-hunger-continues-to-rise---new-un-report-says

with the 2030 agenda of the United Nations. In addition to this, sanitary standards were being put in place regarding the circulation of food products (e.g. foot and mouth disease in pigs).

The redefinition of food security in 1983 emphasizes the individual access to resources and food. At the second Food Summit in 1996, the definition was again modified to include 4 dimensions: availability (quantity and quality, local and global), access to resources for all households, adequate diet (biological and cultural) and stability, even in times of crisis.

Naively, food security has often been equated with answering the question: "Is increased food production sufficient to meet the growing demand due to population growth?" This question implies two assumptions, the first being that there is a global food deficit and the second being that this increase would solve nutrition problems. Both assumptions are wrong, as shown above: the increase in biomass and the persistent hunger. This issue has been implicit in recent decades and seemed to be justified in view of the world population explosion. However, it is not adapted to the tomorrow challenges, such as the capacity to ensure food security for all and to solve the problems that agriculture will have to face in the near future.

For the UN 2030 agenda, it is therefore important to reformulate the question: not to ask "How to feed 10 billion human beings?" but rather "What pathways, modalities and consequences for feeding the planet?" and we have to think about consumption, distribution, ecological footprint of production and the associated exchanges. The United Nations World Report on Sustainable Development, 2019 (GSDR)[7] indicates the need to transform agriculture to meet future needs and challenges. These include product quality and associated diseases, nutritional security (highly processed products), energy used to produce (greenhouse gas emission), the destruction or generation of agricultural jobs and the environmental impact of agriculture (water resources, land degradation, loss of biodiversity…).

Food systems also need to be rethought by adapting diets (less meat and junk food that pervades all societies, balance in nutrients), reducing waste, consuming locally with short circuits. The agricultural production system with its environmental, societal and health impacts must be profoundly reviewed. This review must be radical, intersectoral, adapted to each context and must be thought out in the long term, knowing that there is no universal miraculous solution. The reform of food systems is a fantastic lever to reach SDG n°2 "Zero hunger" and all the related SDGs. A shift in thinking is needed to put food systems at the heart of human and ecosystem health and social justice issues.

The GSDR identifies many obstacles and barriers to change: the inability to implement the right to food, global sovereignty with the establishment of markets, power asymmetries (large corporations controlling and regulating flows), conflicts of interest (tobacco, alcohol) and polarization. A paradigm shift is indispensable, a new governance must be put in place with the management of trade-offs and political arbitrations, the prevention of opportunistic behaviour and the removal of the barriers and obstacles described above. Coherent actions at different levels are to be favoured over "scaling-up". Indeed, where scaling-up transposes local solutions to other contexts, targeted and coherent actions in the given context allow local innovation and territorial development with solutions adapted to the needs and available resources.

Since 1974, scientists have been meeting annually in Rome at the FAO to analyse food systems and produce advice. They form a high-level panel of experts (HLPE) on food security and nutrition with a mission to act as an interface between science and public policy decision-making. The HLPE was established to produce scientific evidence on various issues to inform decisions and assist public policy. This group of outstanding scientists seeks to understand the controversies and oppositions between stakeholders and organizes dialogues, exchanges and negotiations. Report writing by the HLPE is a long

[7] https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf

process with public consultation, peer review and integration of various forms of knowledge. In addition, HLPE's reports are different from academic productions by the treatment of controversies and the analysis of distinctions and currents of thought. This establishes a new relationship between science and politics by taking complexity as it is. This new relationship between science and society makes it possible to conduct negotiations on the basis of knowledge and to build on disagreements. The diversity of opinions brings debates to a high level of mediation to make all voices heard, be understood and make the controversy fruitful.

Within this general framework, Africa, which is the continent most concerned by food and nutrition security issues, has placed FNSSA research and innovation as a driver for the development of its states since their independence and at the centre of its regional, continental and international cooperation actions.

3.2 Ownership of FNSSA research and innovation in Africa

Eradicating hunger and achieving food and nutrition security and sustainable agriculture (FNSSA) is one of the six priorities areas of STISA-2024[8]. The idea that "agriculture in Africa is too important to be outsourced" has led to the creation of several platforms, operating at continental and sub-regional level, aiming at encouraging African countries to invest in sufficient scientific capacity to support agricultural transformation. This reflects the understanding that investments into FNSSA should target the local, national and subregional demand, i.e. international research programmes should contribute to the agenda of the targeted geographic region. Some funding and research institutes follow the compulsory principle that research can only be launched in collaboration with partners from the targeted subregion, e.g. Research-Fora. The authors of this text highlight the landscape of Fora and Agenda and promote the consideration for the design of programmes.

Examples of these platforms include the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)[9], the Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles/West and Central African Council for Agricultural Research and Development (CORAF/WECARD)[10] and the Centre for Coordination of Agricultural research and Development for Southern Africa (CCARDESA)[11] operating at continental and sub-regional level. These platforms coordinate the implementation of such programmes by facilitating collaboration among stakeholders and carrying out capacity building initiatives. Additional key functions of these platforms include knowledge management and dissemination, as well providing direct inputs into policy making organs at national, regional, continental, and international levels, including the African Union Commission (AUC), the New Partnership for Africa's Development Agency (NEPAD), the European Union (EU), and the World Bank. In addition, many African governments, regional bodies, and organisations have been deeply involved in implementing strategic food policies and exploring research priorities.

While the need to increase food supply by raising production capacities, harnessing trade and improving natural resources management are priorities, these organisations also recognised the need for a better application and optimisation of new technologies, and for improving the diversity and quality of diets. Priorities for FNSSA in Sub-Saharan Africa are much broader than just increasing availability: poverty, food insecurity, poor health and malnutrition are interrelated issues also affected by governance, the lack of political stability, environmental degradation and limited technical capacities. All these areas impact food productivity and are intended to be addressed.

[8] Science , Technology and Innovation Strategy for Africa.
https://au.int/sites/default/files/newsevents/workingdocuments/33178-wd-stisa-english_-_final.pdf
[9] https://www.asareca.org/
[10] http://www.coraf.org/?lang=fr
[11] http://www.ccardesa.org/

The "Comprehensive Africa Agriculture Development Programme" (CAADP), set up by the United Nations, as well as the "Framework Programme for Food Security in Africa" (FAFS) established by NEPAD define the policy framework for the transformation of African agriculture. Both recognized the need to make better use of emerging technologies, optimize existing technologies, diversify and improve plant-based food (proteins and micronutrients). These two programmes define Africa's policy framework for agricultural transformation, wealth creation, food security and nutrition, economic growth and prosperity for all: "*Agriculture is everyone's business: national independence depends on its development because it enables us to escape the scourge of food insecurity that undermines our sovereignty and fosters sedition; it is a driver of growth whose leverage is now acknowledged by economists and politicians; it is the sector offering the greatest potential for poverty and inequality reduction, as it provides sources of productivity from which the most disadvantaged people working in the sector should benefit.*"[12] In March 2015, forty one (41) African Union member States signed CAADP Compacts, of which 33 have developed investment plans for national agriculture and food security. These plans are used to frame medium-term food security expenditures with a view to improving agricultural planning. At the regional level, four of the eight Regional Economic Communities (RECs) have signed regional compacts. Of the four signatories, three have developed comprehensive investment plans. As a result, public expenditure on agriculture has grown at an average of over 7% per year in Africa since 2003. In other words, public expenditure on agriculture has almost doubled since the launch of CAADP[13].

CAADP provided the framework for developing an ambitious research and innovation project on the FNSSA both at the level of African states and international cooperation. CAADP has provided the framework for developing an ambitious research agenda for FNSSA at the three levels, national (National Agriculture Research and Education Systems, NARES), regional (Agriculture Sub-Regional Organisations, SROs) and pan-African (NEPAD). This agenda is known as the Science Agenda for Agriculture in Africa (S3A). Its rationale is given in figure 1. "*The development of the Science Agenda for Agriculture in Africa (S3A) under the auspices of FARA is an important step on the road to the transformation of Africa's agriculture. This Science Agenda is all the more important because it is Africa-owned and Africa-led. For a very long time Africa has outsourced much of the Science. Preamble for its agriculture thereby undermining its own capacity to fully mobilise this science for improving the livelihoods of its people, particularly towards deriving the solutions that address needs peculiar to Africa*."[14]

[12] Ibrahim Assane Mayaki, Chief Executive Officer of the NEPAD Agency

[13] https://www.un.org/en/africa/osaa/peace/caadp.shtml

[14] Kanayo F. Nwanze, D Sc Chairman and Patron of the Expert Panel Commissioned to develop the Science Agenda in Science Agenda for Agriculture in Africa, "Connecting Science" to transform agriculture in Africa, 2014, FARA Accra, 96p.

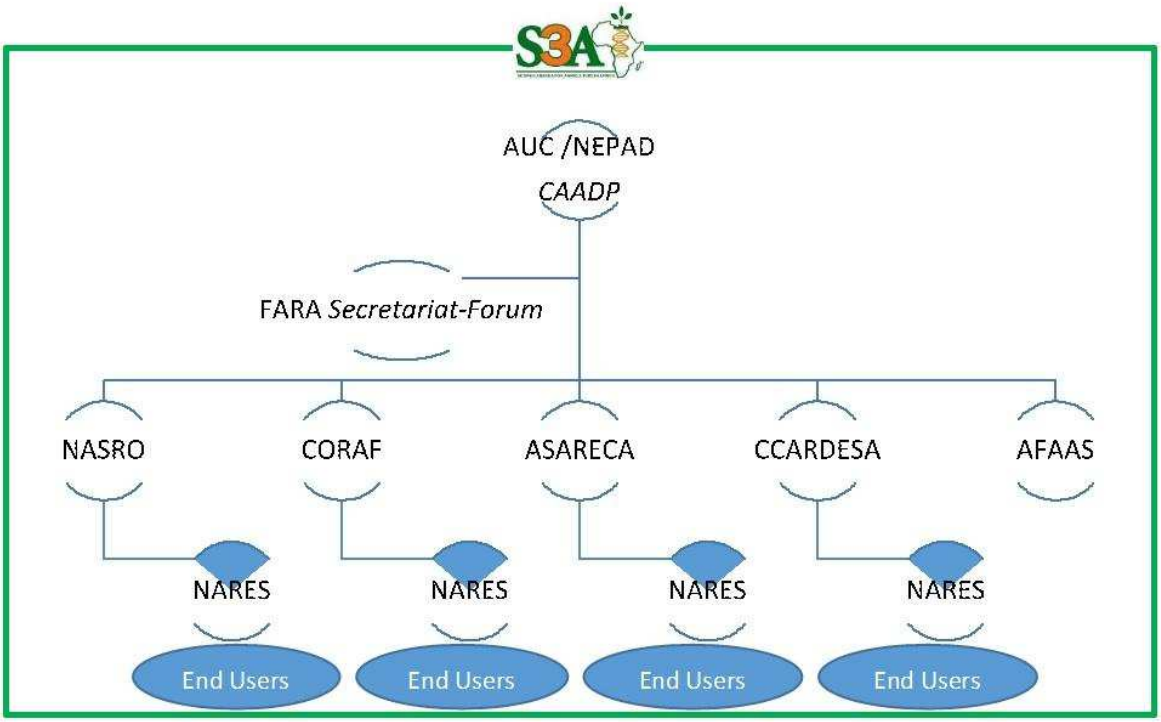


Figure 1: S3A Rational (from Dr. Annor-Frempong, FARA, oral presentation)

S3A is a framework that identifies challenges and best-bet options for Agricultural transformation through science. It refers to the science, technology, extension, innovations, policy and social learning Africa needs to apply in order to meet its evolving agricultural development goals. It identifies the key strategic issues that will impact on science and agriculture and presents a suite of high-level actions/options for increasing and deepening the contributions of science to the development of agriculture at all levels in Africa. It is also an instrument for mobilising the physical, human, institutional, financial, and policy resources required to increase the application of science, technology and innovation to achieve agricultural development goals and targets. Its vision is: "*By 2030 Africa ensures its food and nutrition security; becomes a recognised global scientific player in agriculture and food systems and the world's bread-basket*". To reach the vision S3A strategic goals are:

1. Short-term: increase domestic, public and private sector spending and create the enabling environment for sustainable application of science for agriculture.
2. Medium-term: Build basic science capacity at national and regional levels with special attention to the youth and women.
3. Long-term: Doubling the current level of agricultural productivity by 2025 while respecting the environment, biodiversity and without significantly increasing greenhouse gas emissions.

S3A is based on four priority topics:

1. Sustainable productivity in major farming systems.
2. Food systems and value chains.
3. Agricultural biodiversity and natural resource management:
    a. Conservation and enhancement of agricultural biodiversity,
    b. Land and water resources, irrigation and integrated natural resource management.
4. Mega trends and challenges for agriculture in Africa:
    a. Climate Change, variability, adaptation and mitigation,
    b. Responses to policy and institutional shifts,
    c. Responses to changes in livelihoods of rural communities,
    d. Gender.

S3A considers three cross-cutting enablers to those priorities; (i) Sustainable intensification, (ii) Biosciences, information and communication technologies, (iii) Foresight capabilities.

Evolved into the framework for enhancing the application of science, technology and innovation to achieve CAADP goals, with focus on improving productivity, S3A is the framework for achieving Priority 1 (Eradication of hunger and achieving food security) of the Science, Technology and Innovation Strategy for Africa (STISA)[15]. In this respect, S3A is intended to be the framework for inter-African and international cooperation in agricultural research in the broad sense and rural development. It is also in line with the African Union's Agenda 2063 and the United Nations' Agenda 2030. Figure 2 shows the place of S3A in the research and innovation ecosystem in Africa and particularly in Sub-Saharan Africa.

Figure 2: Place of S3A in the research and innovation ecosystem in Africa (from Dr. Annor-Frempong, FARA, oral presentation)

In this ecosystem of research and innovation for the FNSSA, the AU-EU partnership and in particular the partnership between the EU and the AU holds an important and historic place.

3.3 The EU Food 2030 initiative

FOOD 2030[16] is the EU research and innovation (R&I) policy response to major international policy developments addressing the Sustainable Development Goals (SDGs) and the commitments of COP21 and was launched after the 2015 Milan World Expo[17]. It addresses Food and Nutrition Security (FNS) challenges with R&I policies designed to future-proof food systems to make them sustainable, resilient, diverse, inclusive and competitive for the benefit of society[18]. The EU research-programme Food 2030 is a systemic approach aiming at connecting, scaling-up and boosting EU R&I to provide solutions to four overarching FNS priorities, likewise reflecting globally relevant and indispensable approaches:

1. NUTRITION for sustainable and healthy diets,

[15] https://au.int/sites/default/files/newsevents/workingdocuments/33178-wd-stisa-english_-_final.pdf
[16] https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=food2030
[17] https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=food2030
[18] https://fit4food2030.eu/wp-content/uploads/2018/02/food2030-future_proofing_our_food_systems.pdf

2. CLIMATE smart and environmentally sustainable food systems,
3. CIRCULARITY and resource efficiency of food systems,
4. INNOVATION and empowerment of communities.

Priority one focuses on R&I on nutrition for sustainable and healthy diets and tackles challenges such as the triple burden of malnutrition while explicitly supporting healthier and more sustainable diets in Africa. This priority links to EU food safety policies, the EU Nutrition Policy Framework and relevant targets of the Sustainable Development Goals[19].

Generally accelerating public and private investments and open science, the Food 2030 priorities are likewise addressed through increased global cooperation. Food 2030 connects the 'whole food value chain' and promotes scaling up, digitisation, open innovation, education and skills. Endorsing the interrelated economic, social and ecological aspects to achieve the SDGs, Food 2030 conceives economies and societies as embedded within the biosphere. Thus, moving development away from a sectorial approach, which takes social, economic, and ecological development as separate parts, towards an economy that serves society within the planetary boundaries. Likewise, all the sustainable development goals are directly or indirectly connected to sustainable and healthy food. FOOD 2030 frames a coherent food-system approach, whereby R&I can flourish, European competitiveness can grow, and global challenges can be addressed[20].

As it has been recognized that FNS R&I policy coherence and coordination between food security, public health and environmental protection is still weak, Food 2030 creates the opportunity to overcome the still fragmented landscape of research and innovation policy. Food 2030 strives for R&I policies on FNS to be better integrated to improve the efficiency and effectiveness of used resources. Thus, supporting to improve the actual impact of R&I policies on private sector investment, market uptake and adoption of emerging technologies and new ways of doing science[21].

The priorities of Food 2030 relate to the four priority areas of the FNSSA Roadmap[22]: i) sustainable intensification; ii) agriculture and food systems for nutrition; iii) expansion and improvement of agricultural markets and trade; iv cross-cutting issues (improved coordination, supporting innovation, strengthening collaboration, social and cultural contexts). Hence, from the perspective of joint R&I for FNSSA, this European programme certainly addresses issues of FNSSA in all priority areas and synergies between projects implemented within both frameworks should be strengthened. Moreover, especially the focus on circularity and the empowerment of communities is an excellent input and synergy to the FNSSA agenda and should also be a pillar of future joint FNSSA agendas. The approaches of Food 2030 trigger transdisciplinary projects, i.e. co-creation and involvement of multiple actor groups to contribute experiences, knowledge and research from FNSSA related topics. For the implementation of research- and evidence-based recommendations for FNSSA for both Africa and Europe, it is essential to link research actors to practitioners from policy, development and production to co-develop sustainable solutions and empower relevant actor groups to put research into use. This is an important factor also elaborated in the Programme and Innovation Management Cycle (PIMC) developed through LEAP-Agri as described further below.

This initiative has inspired the food component (cluster 6) of the Horizon Europe programme.

[19] ibid

[20] ibid

[21] https://fit4food2030.eu/wp-content/uploads/2018/06/KI0716013ENN.en_.pdf

[22] https://ec.europa.eu/research/iscp/pdf/policy/eu-africa_roadmap_2016.pdf

3.4 Bi-regional scientific cooperation on FNSSA

In the framework of an EU project on scientific partnerships between AU countries and EU countries (CAASTNET Plus[23]), Jean Albergel *et al*, 2018[24] take stock of FNSSA research and innovation in Sub-Saharan Africa and the partnerships developed with the EU.

Collaboration between the AU and EU on STI dates back to the EU's international cooperation research programmes, launched by the EC in 1983. The importance of this collaboration is confirmed by the large number of joint research projects funded, a significant part of which focus on agriculture and on food and nutrition security. The volume of funding, the number of participating organizations and the results produced are increasing despite the disappearance of programmes dedicated to cooperation (INCO programme), which disappeared with the 7th Framework Programme. This programme was replaced in Horizon 2020 by specific international cooperation measures. International cooperation is present in all three main pillars and is part of the Horizon 2020 programme's cross-cutting issues, among the actions of societal challenge 6, “Europe in a changing world: inclusive, innovative and reflexive societies”. There are nevertheless calls specifically dedicated to international cooperation that are part of the continuation of the INCO actions of the 7th Framework Programme, in each societal challenge. In this framework, a number of calls for proposals on FNSSA targeted at Africa in challenge 1 "health, demographic change and well-being" or in challenge 2 "food security, sustainable agriculture and forestry, marine and maritime research and research on inland waterways"[25].

The EU supports continental (FARA) and sub-regional (e.g. ASARECA) research coordination platforms that specifically address food and nutrition security and feed into the S3A described above. The EU also supports bilateral AU-EU platforms such as PAEPARD (AU-EU Partnership Platform on Agricultural Research for Development).

In 2007, the JAES[26] was adopted in response to geopolitical changes, globalisation and integration processes on both continents: it was the expression of a new kind of partnership, clearly political, which differed from previous initiatives between Africa and Europe in that, for the first time, all actors recognised the need to define priorities jointly and to implement a more egalitarian and mutually beneficial cooperation. The characteristics of this new mode of cooperation for science, technology and innovation can be found in the programme launched by the African Union High Commissioner for Human Resources for Science and Technology (AUHCRST)[27] supported by the EC: "The African Union Research Grant (AURG)". It is composed of open calls for proposals designed to mobilize African scientific excellence and to promote Intra-Africa and international cooperation in research and capacity building. AURG focuses on priority areas as articulated in the CPA: (i) Post-harvest and Agriculture, (ii) Renewable and Sustainable Energy, and Water and Sanitation. Two calls for Proposals valued at €14 million have been already launched. Financed by EC and the ACP Group of States, AURG innovatively brings African researchers to form supranational networks and scientific consortia. The 20 lead institutions received a grant ranging from €500,000 to €750,000 to do research in 46 locations of Africa, involving a network of 54 research institutions established between Africa, Europe and New

[23] https://cordis.europa.eu/project/id/311806

[24] Albergel Jean, Alpha Arlène, Diaby Nouhou, Francis Judith Ann, Lançon Jacques, Sers Jean-Michel, Viljoen Johan. 2018. Bi-regional scientific cooperation on food and nutrition security and sustainable agriculture. In: Africa-Europe research and innovation cooperation: global challenges, bi-regional responses. Cherry Andrew (ed.), Haselip James (ed.), Ralphs Gerard (ed.), Wagner Isabella E. (ed.). Cham: Palgrave Macmillan, 65-79. ISBN 978-3-319-69928-8

[25] https://www.horizon2020.gouv.fr/cid76675/les-mesures-specifiques-cooperation-internationale-dans-horizon-2020.html

[26] https://africa-eu-partnership.org/sites/default/files/documents/eas2007_joint_strategy_en.pdf

[27] https://au.int/fr/hrst

Zealand. The AURG's long term objective is to create a competitive system of research grants as a pan African Union financial instrument to support scientific research and to adopt AUC procedures for grants management and mobilisation of more resources for the implementation of AU STI policy. Compared to LEAP-Agri, AURG is a transitional initiative managed by AURC. Table 1 gives the number of applications to the AURG calls and the awards.

Table 1: Number of applications to the AURG calls and the awards

Regions	Applications 1st call	Applications 2nd call	Award from the 2 calls
East Africa	102	107	3
West Africa	78	55	4
Southern Africa	24	24	4
North Africa	5	17	2
Central Africa	9	9	4
Europe	16	37	0
Total	234	249	19

In this new context of cooperation, positive contributions from research to development are emerging. Similarly, the role of scientific and technological innovation, as well as the structuring role of research capacities for economic and social growth and for poverty reduction, is evident - particularly with regard to the creation of knowledge societies and the response to societal challenges that are not only global but also of common interest. The High Level Policy Dialogue (HLPD), which sets the agenda for the EU-Africa Partnership on STI and assesses its progress, is also a forum for sharing and disseminating ideas and contributing to development policies at national and regional level. The HLPD serves as a platform for regular exchanges on research and innovation policy and aims to formulate and implement long-term priorities to strengthen AU-EU cooperation on science, technology and innovation. The dialogue is co-chaired by the European Union (represented by the European Commission, DG Research) and the African Union (represented by the Specialised Technical Committees (STC) on science and technologies) and brings together the S&T representatives from the 27 EU Member States and the 55 African countries.

At the request of the EU-Africa Summit of 2014, an EU-Africa Expert Group was tasked, under the guidance of the HLPD, to draft a Roadmap towards an EU-Africa R&I Partnership on Food and Nutrition Security and Sustainable Agriculture (FNSSA). This Roadmap was adopted by the HLPD Senior Officials Meeting in Addis Ababa in April 2016 and is structured around four main pillars: (i) Sustainable intensification, (ii) Agriculture and food systems for nutrition, (iii) Expansion and improvement of agricultural markets and trade and (iv) Cross-cutting issues. For the successful implementation of the Partnership, an AU-EU FNSSA Working Group was set up in March 2017, supported by the Research and Innovation Network for Europe and Africa (RINEA)[28]. The Group provides oversight of the implementation of the Roadmap, including on future activities, in order to ensure coordination between the different instruments and stakeholders between 2015 and 2018.

With the launch of the FNSSA roadmap by the HLPD, progress on this issue is undeniable and cooperation between the two continents is no longer limited to the field of agricultural production: it has extended to nutrition, which is becoming a priority issue in Africa as well as in Europe. Several AU-EU partnership projects have been launched on FNSSA related topics by the Horizon 2020 programme. Research co-financing projects with roles shared by all partners and at all stages, from the call for proposals to evaluation, are multiplying. The AURG Grants co-financed bilaterally were already mentioned. LEAP-Agri (Long Term Partnership for Research and Innovation on FNSSA)[29] is a

[28] https://www.africa-eu-sti-portal.net/en/589.php

[29] https://www.leap-agri.com/

cooperation project between Africa and Europe launched in 2016 within the framework of the AU-EU Partnership on FNSSA under JAES. FNSSA is approached in a holistic manner, addressing not only the productivity of value chains, but also the sustainability of production and processing systems and their impacts on societies and the environment. Other concerns are also integrated, such as the creation of added value, job creation, the efficiency of production models (large or small-scale agriculture), market access and entrepreneurship, or food systems.

LEAP-Agri organized a call for R&I proposals on FNSSA which was launched on 15 March 2017 and 191 pre-proposals were submitted. Based on an Independent Review Panel (IRP) evaluation and ranking of the proposals, and in relation to the 24 Funding agencies possibilities, 27 projects were selected for funding by the Group of Funders. A total budget of 22.7 million € was dedicated to the funding of the projects. The European Commission contribution (33% of the total budget) had been allocated to the funding agencies (on behalf French ANR, LEAP-Agri coordinator) so that they could fulfil their commitments. The LEAP-Agri call invited consortia composed of at least four research organizations and/or private and public practitioners from four of the partner countries (two African and two European) to submit project proposals in the countries concerned with an added value for the AU-EU partnership on FNSSA. Applicants represented research and higher education entities, companies, and other legal entities such as NGOs. An inflexion toward farmers' organisations participation, especially smallholders' representatives' was encouraged. The 27 selected projects involve 250 African and European teams from 20 countries, and they cover a large range of thematic related to the food system. Each project involves at least two teams from African countries and two teams from European countries. Some projects have much more participating teams including associated partners. Each national team in all 27 projects is funded by its national funding agency. Some European funding agencies decided to contribute to the fund of African teams. Projects started their activities on 1st September 2018, for a 36 months duration.

Under the aegis of the HLPD and its Bureau, building upon former EU funded projects such as RINEA, CAAST-Net Plus, ProIntensAfrica[30] and linking with the ongoing ERANet Cofund LEAP-Agri, a Coordination and Support Action (CSA) was launched under H2020 to provide a tool for European and African institutions to engage in a Sustainable Partnership Platform for research and innovation on Food and Nutrition Security, and Sustainable Agriculture (FNSSA). This CSA, known as "LEAP4FNSSA" (**L**ong-term **E**U-**A**U research and innovation **P**artnership for **F**ood and **N**utrition **S**ecurity and **S**ustainable **A**griculture)[31], aims to achieve its main objective through:

- Increased synergies and coherence between actors, research and innovation projects, initiatives and programmes, through the development of institutional alliances and clusters of projects.
- An enhanced learning environment and large knowledge base, including monitoring and evaluation activities, and established communication and links between different initiatives in order to improve European-African cooperation in Science, Technology and Innovation (STI).
- A well-established long term sustainable partnership and co-funding mechanism.

LEAP4FNSSA has 4-years duration, from November 2018 to October 2022.

Despite these many actions welcomed by all stakeholders, the HLPD meetings highlight important challenges that remain to be addressed. The first of these challenges is that all available knowledge should be better used to inform policies, improve food systems, broaden the range of products, their markets and trade, and support innovation for social and economic gains in both Europe and Africa. The scientific partnership projects between the two continents do little to address the issue of food stability, which CAADP believes is essential and calls for the involvement of the private sector.

[30] https://cordis.europa.eu/project/id/652671/fr
[31] https://www.leap4fnssa.eu/about/

However, the participation of the private sector in the EU Research Framework Programmes remains low (around 15.5% of participants) as does that of civil society (only 1.5% of participating organisations) (Albergel et al. 2018)[32]. Although encouraged to participate by the Horizon 2020 programme, commercial companies are less motivated than state research institutions, particularly because research results are followed up shortly after the end of the projects. The transfer and dissemination of knowledge is limited, as the beneficiaries (farmers in particular) often do not see the direct benefits of cooperative research projects. In general, mechanisms to make knowledge available, understandable, convincing and therefore usable are absent in cooperation programmes.

African and European HLPD experts propose that cooperation in the field of FNSSA should develop mechanisms to improve the accessibility of results and knowledge to a wider audience. In addition, the significant increase in skills and knowledge generated by cooperative projects should be better taken into account to support public policies and strategies developed in the field of STI, agriculture or FNSSA on both continents. The objective is to foster synergies between policy makers, funding agencies and implementing agencies. Beyond existing initiatives, there is a need to foster greater continental, regional and national ownership of FNSSA's research programmes and policies, and this must be reflected in the development of research infrastructure (particularly in Africa).

Recent events linked to the COVID 19 crisis legitimately question the resilience of the solutions put in place for FNSSA and of bi-regional cooperation as practised. This deliverable was to be produced after a stakeholders' meeting to be held in Dakar last June. The abrupt cessation of air exchanges forced the team to change the focus and replace this meeting by interviews.

3.5 Anticipated impacts of the COVID-19 crisis on FNSSA in Sub-Saharan Africa and on bi-regional cooperation

COVID-19 began as a health concern that quickly escalated into global economic challenges with multiple and widespread impacts also on food systems. According to World Bank forecasts, the global economy will shrink by more than 5%[33] and it has been estimated that the number of people in extreme poverty may increase by up to 150 million[34]. The economic impact of the pandemic exacerbates expected hazards and pre-existing food security challenges. Mainly, imposed lockdown measures and mobility restrictions, and as a consequence subsequent loss of income and purchasing power additionally threaten people's food security, nutrition and health[35]. The World Food Program's (WFP) August 2020 situation report highlights how food insecurity across Africa is substantially deteriorating[36]. For example, in East Africa, the number of acutely food insecure people may almost double, from 24 million pre-COVID-19 to 41.5 million before the end of 2020, whereby the most

[32] Albergel Jean, Alpha A., Diaby N., Francis J., Lançon J., Sers J.M., Viljoen Johan. Coopération scientifique sur la sécurité alimentaire, nutritionnelle et l'agriculture durable entre l'Afrique et l'Europe. In : Cherry A. (dir.), Ralphs G. (dir.), Haselip J. (dir.), Wagner I.E. (dir.), Albergel Jean (dir. trad.). Coopération Afrique-Europe en matière de recherche et innovation : défis mondiaux, réponses bi-régionales. Paris (FRA) ; Marseille : EAC ; IRD, 2018, p. 55-71. ISBN 978-2-7099-2652-2

[33] https://www.worldbank.org/en/news/press-release/2020/06/08/covid-19-to-plunge-global-economy-into-worst-recession-since-world-war-ii

[34] rr63 1 - IFPRI Publications - IFPRI Knowledge Collections

[35] https://link.springer.com/article/10.1007%2Fs12571-020-01076-1 COVID-19: safeguarding food systems and promoting healthy diets

[36] COVID-19

vulnerable people affected are urban poor. Thus, COVID-19 is deepening global food and nutrition insecurity, and without effective interventions possibly leading into a global food emergency[37].

However, at the same time, the few available studies show, wherever located in Africa, that food systems can be resilient, especially in rural areas, and that there is a medium-term concern, especially in cash crop regions (coffee, tea, cocoa, etc.). Patrick Dugué, an agronomist and expert in the diversity of African farming systems at CIRAD analysed the impacts of COVID-19 on food security in Sahel and West Africa[38]. With the COVID-19 pandemic and continued insecurity linked to terrorism or crop pest invasions (locusts, armyworms, etc), several African countries are facing a range of threats to food security. However, those along the coast of West Africa — Côte d'Ivoire, Benin, Togo, etc —, along with southern Mali and Burkina Faso, are proving to be relatively resilient as regards the effects of the pandemic, and the health crisis will probably have a limited impact on their food production. There are several reasons for this. Firstly those countries have a high potential to produce food crops such as cassava, plantain, yam and sorghum, which are generally grown non-intensively, with very limited use of fertilizers and pesticides. They have therefore not been affected by input supply issues. As for market gardening and maize growing, which require mineral fertilizers and pesticides, inputs are available from shops and producers' organizations and the current very low oil price has fostered a drop in the price of fertilizers in time for the second growing season in coastal countries, and probably even more so for the 2021/2022 agricultural campaign.

Given the current supply difficulties from abroad and the fall in fuel and transport costs inside African countries, urban consumers change their buying patterns. Poor and middle classes in the cities can buy more local products, local cereals, cassava, yam or banana rather than imported cereals or imported frozen or canned food. "Moreover, some governments have decided to build up their emergency food stocks, primarily cereals, to cope with any possible hiccups on the global rice market in the short and medium term. Producers' organizations, for instance those in Benin, have recently been able to sell their remaining stocks from the 2019/2020 harvest at an acceptable price." (Patrick Dugué, 2020)[39]. However, there have also been reports on price hikes for local products (e.g. fish in Kenya), which creates problems especially for urban poor. They are especially vulnerable to higher prices and, if also dependent on day labor jobs, which are reduced due to lockdown measures, their situation is even more critical[40].

François Ruf from CIRAD, in collaboration with observers from the NGO SADRCI and the German International Cooperation Agency (GIZ) analysed the impacts on cocoa producers in Côte d'Ivoire and showed that the secondary subsistence crops provided immediate resilience for the concerned populations, but the closure of borders was a problem for the cocoa harvest that was underway. The decline in world consumption by the chocolate industry is expected to have an impact on the price of cocoa and dramatic drops in income for the populations concerned, forcing the Ivorian government to take price support or subsidy measures.[41]

At present, far too many parameters remain unknown for a reliable analysis of this pandemic and its precise and long-term impacts on food systems and food and nutrition security. It is certain that both in Africa and Europe food purchasing habits and perhaps diets have changed, but it is too early to say

[37] COVID-19 Responding to COVID-19 food disruptions in Africa The Impact of COVID-19 on Food Security and Nutrition

[38] Covid-19 and food security | How African agriculture could hold its own in the face of the crisis

[39] Patrick Dugué, agronome: «Face à la crise, l'agriculture africaine se montre résiliente»

[40] https://www.google.com/url?q=https://www.ifpri.org/blog/ifpris-new-covid-19-food-price-monitor-tracks-warning-signs-stress-local-markets&sa=D&ust=1599232391311000&usg=AFQjCNGt7t5VmjwkQshPIW9i7804-LMhVQ

[41] Covid-19 and food security | Cocoa planters in Ivory Coast fear a drop in their income

whether these changes will last and to make comparisons between countries or continents. There is no doubt that there are specificities in the modes of propagation of the pandemic and in the modes of production that will explain the different profiles of the pandemic and impacts in the various contexts (according to parameters structurally linked to the context, but also according to the measures taken, more or less adapted, more or less timely, more or less respected, etc.). In the coming months, we will probably have the first elements of explanation, thanks to surveys, and thanks to sufficient hindsight. There is no doubt that these studies will provide an opportunity to learn lessons from each other.

However, as the COVID-19 pandemic has exposed the fragility of food systems, international stakeholders call for concerted action and the transformation towards sustainable food systems and healthy diets as a critical component of a global, inclusive, green and resilient recovery[42]. Despite many food systems being severely disrupted, others have been more resilient[43], pointing towards important learning opportunities. For improving evidence-based policy decisions, making relevant and reliable data available and building stronger strategic partnerships in R&I play an important role.

European research has been mobilised against COVID-19[44]. As one of the 3 pillars of the EU's global response to the coronavirus crisis, the EU has intensified its efforts to join forces with partner countries, including support to the Global Research Collaboration for Infectious Disease Preparedness (GLoPID-R) network, the Coalition for Epidemic Preparedness Innovations (CEPI) and the European and Developing Countries Clinical Trials Partnership (EDCTP), whereby the latter has particular projects focusing on Africa[45]. Furthermore, €10 million have been provided by the EU towards the implementation of the Africa Joint Continental Strategy for COVID-19 Outbreak[46]. At the end of January, the Commission opened an exceptional Horizon 2020 call to respond to the coronavirus pandemic. Out of 91 projects submitted, 17 were selected. In the end, total EU funding reached €47.5 million, compared to €10 million initially planned. However, cooperation and specifically cooperation with Africa on the impacts of the pandemic was not taken into account. Yet in several African countries the authorities are very concerned about an excess of "non-COVID deaths", much more than those linked to the virus itself, although they remain cautious. This raises concerns on the future dedication of funding towards bi-regional EU-AU R&I cooperation on FNSSA. While seeking for medical remedies towards this pandemic, impacts on the food sector and along with it on health and nutrition of populations must not drift out of sight. The ongoing pandemic reiterates the need to establish effective and lasting funding structures that ensure constant support and progress in the field of FNSSA research.

Questions which can at present not be answered are of course diverse. Funders alliances will have to analyse, how well current R&I agendas in the field of FNSSA capture and cope with sudden global challenges and how much these agendas contribute to the required resilience of local/global food systems. At present, it is not known in what way COVID-19 affects the AU-EU Partnership.

[42] COVID-19: safeguarding food systems and promoting healthy diets , The Impact of COVID-19 on Food Security and Nutrition

[43] rr63 1 - IFPRI Publications - IFPRI Knowledge Collections

[44] Coronavirus: Commission boosts urgently needed research and, Coronavirus research and innovation | European Commission

[45] Global cooperation

[46] EU supports Africa's continental COVID-19 response

Indeed, to contain the coronavirus pandemic, both European and African countries have put in place strict border closures and containment measures. The area of bi-regional cooperation projects, which involves regular travel in Europe and Africa, has been affected. Cancelled events, closed infrastructures, postponed meetings... Numerous articles and conferences (webinars) have been produced anticipating the effects of this major health crisis on FNSSA in Africa.

At present funders and researchers jointly try to assure that ongoing affected research projects can proceed or efficiently be finalised. If, as before COVID-19 collaborations were very much based on travel between nations, new forms of collaboration have now to be invented. These new forms of collaboration will require concepts for virtual communication and also approaches to better fund isolated research and build local capacities. In fact, it will not be possible to rely only on virtual communications as long as there are obstacles such as digital divides or electricity cuts... The development of a future joint medium and long-term R&I agenda on FNSSA needs to take stock of lessons learned from this pandemic and its effects on both food systems and the way international research cooperation is conducted. Recognizing the interrelatedness of systems and to improve resilience towards future unforeseen shocks, FNSSA agendas need to facilitate the transformation towards healthy and sustainable foods systems while grounding equitable and inclusive research partnerships.

4 ANALYSIS OF CURRENT RESEARCH COLLABORATIONS IN THE CONTEXT OF THE AU-EU PARTNERSHIP ON FNSSA

4.1 Material and Methods

To analyse current collaboration between the two continents on FNSSA, we conducted two studies at different scales:

1. On a large scale considering both bilateral scientific cooperation between countries of the two continents and through AU or EU projects, a bibliographical analysis of the articles on the FNSSA produced in co-authorship between African and European researchers.
2. On the scale of recent partnerships set up under the HLPD umbrella, an analysis of the research proposals and the research projects funded by the LEAP-Agri and the two AURG calls for projects. We have restricted the analysis to these two programmes and have not taken all the calls from Horizon2020, because they are more characteristic of the new forms of cooperation initiated by the HLPD. These two programmes operate at two different levels of cooperation, AURG being a direct partnership between the two AU & EU commissions. LEAP-Agri is a cooperation scheme set up by a bi-regional consortium with a certain independence from the commissions (ERANET COFUND instrument). So on the same theme (FNSSA) we have an original example of two cooperation programmes. LEAP-Agri and the AURG are considered as medium-term outputs of the FNSSA Roadmap. This paper intends to give insight into the experience and also perspectives arising from the research funded through these funding schemes, which are within the sphere of influence of the LEAP-Agri and AURG partners. The data was complemented by an online survey addressed to these projects.

While Task 6.3 worked on the mapping of submitted proposals and accepted projects, Task 6.5 carried out an exhaustive analysis of Web of Sciences publications to determine the most effective cooperation networks between Africa and Europe. Methodologies for the mapping and for bibliography analysis are explained below.

The approach was planned to be based on a 4 steps process. The first step was the bibliographic review and mapping the institutional landscape and the geographic distribution of projects, the second step was the analysis of partnerships through a structured online questionnaire (the questionnaire remained online from March to June 2020), the third step was deducting recommendations to

overcome the underlying challenges and strengthen the mechanism of bi-regional partnerships and the final step was planned as a priority setting workshop. A presentation of the results and a discussion with the stakeholders should have led to recommendations for planning a long term partnership in FNSSA. With the measures taken to combat the COVID-19 outbreak, the fourth stage was postponed and replaced by personal interviews via phone with project coordinators. Three AURG project coordinators agreed to be interviewed as part of their response to the questionnaire. The interviews have been transcripted and the common and different points of view have been highlighted in a document (see Annex). The workshop to discuss priorities with stakeholders will take place when possible (back to back with the LEAP-Agri general meeting) and will be the subject of a separate note.

We first conducted a review study on scientific publications related to the main themes addressed by the AURG and LEAP-Agri projects in Africa (55 countries) and in Europe (27 countries) : (i) “sustainable intensification", (ii) "agriculture and food systems for nutrition" and (iii) "expansion and improvement of agricultural markets and trade". We also enlarged the research to selected categories in FNSSA based on the Thomson Reuters Web of Science (WoS) database, which is known to cover a wide range of relevant journals and high-quality peer-reviewed articles. Although we recognize the availability of various other databases provided in SCOPUS, we acted according to the methodological approach of previous research. Publications in WoS are classified in 254 categories or 152 Research Areas. Additional useful metrics are sources/journals, authors, affiliation institutions, affiliation countries, citations, funding agencies, organisations, editors. It is important to highlight that in our search we excluded all countries that have cooperation with African organisations like China, India, USA, Japan, and Canada. We focused only on European, African, and international organisations.

Mapping the theme “Sustainable intensification” by the request ([TS = ("sustainable intensification ») AND CU= (ALGERIA or Egypt or LIBYA or… or TOGO)), means searching for publications with the string «Sustainable intensification» appearing in the title, the abstract or as keywords, and CU is the Address of the country. The time span or period of publication we considered was 2010 - 2020.

The publications with the topic “sustainable intensification” were classified into categories depending on how the paper was indexed: we listed the top ten micro-domains. An important information about partner institution or funder is the name of the organisation which appears in the address of the publication or in the acknowledgements. Some international institutions based in Kenya have their headquarters in other countries like the International Maize and Wheat Improvement Centre based in Mexico or International Crops Research Institute for the Semi-Arid Tropics based in India.

The grouped bibliometric networks were presented by adopting the approach of visualization of similarities (VOS) using an algorithm optimized from VOSviewer 1.6.5[47]. The different colors indicate the clusters of articles. In addition, a specific weight was assigned to each article according to the strength of the total link of the publication and the number of citations received. To enlarge our community of researchers in FNSSA, it was recommended to not only use topics but also to include micro-domains or categories related to FNSSA. In the two previous requests, the WoS identified appropriate domains. Among the 254 categories provided by WoS, we selected the following sub-categories: “Agricultural Engineering“, ”Agriculture, Dairy & Animal Science“, “Agriculture, Multidisciplinary“, “Food Science & Technology“, “Nutrition & Dietetics“, ”Agronomy“, ”Plant Sciences”, “Fisheries”, and “Soil Science“.

In a second step, the mapping was done for the proposals and funded projects of the LEAP-Agri project as well as the projects funded by the AURG that are currently in progress in the field of FNSSA. Afterwards, an analysis of the existing landscape was conducted to identify gaps and overlaps as well. All the proposals submitted to LEAP-Agri were analysed, the pre-proposals submitted in the first round,

[47] https://www.vosviewer.com/

the full proposals submitted in the second round including those selected for funding. It should be noted that this may be the first time that such work has been carried out on unsuccessful proposals. All proposals required the establishment of a network of researchers and stakeholders to put forward a research and innovation idea to solve a well-identified problem. A database was created for the 191 proposals submitted to the call of LEAP-Agri which included 83 second stage full proposals and 27 actually funded projects, and the 19 projects funded by AURG on FNSSA theme over 2 calls in 2016 (9 projects) and 2018 (10 projects).

In this database the projects were categorised according to involved countries, partner institutions and their theme and focus of research. The two programmes LEAP-Agri and AURG dealt with the same topics: "Food and Nutrition (AURG)" / "Agriculture and food systems for nutrition (LEAP-Agri), "Sustainable Agriculture (AURG)" / "Sustainable intensification of agriculture (LEAP-Agri)" and "Trade and Market (AURG)" / "Expansion and Improvement of agricultural markets and trade (LEAP-Agri)". However they differ in two important aspects:

1. The number of possible participants: in Leap-Agri was only the countries that are part of the consortium, while in AURG all AU and EU countries were eligible.
2. The funding method was also different: only one funding agency for AURG, 24 funding agencies in LEAP-Agri, each agency funding its national teams, except few agencies funding different national teams.

The mapping that was based on the created inventory of projects was divided into 3 forms:

1. QGIS[48] software was used to create maps (for the 191 LEAP-Agri proposals and 19 AURG projects) to visualize geographically how actively the involved countries participated.
2. Stacking graphs and charts (for the 191 LEAP-Agri proposals and 19 AURG projects) to illustrate the research focus of the projects by presenting the share of each country in the three priority areas which were identified as well as the types of participating institutions.
3. Gephi diagrams (for the 27 funded LEAP-Agri projects): the Gephi software[49] was used to map the bi-regional network on FNSSA initiated by LEAP-Agri projects. Nodes represent capitals of the 24 countries and links, also called edges or connections represent the acronym of the 27 projects used in this analysis. To visualise the network based on the frequency of partner countries represented in implemented projects we used the plugin "Fruchterman Reingold" of Gephi, which displays nodes in circular representation.

The next step was investigating the challenges facing these projects and their theory of change through a structured questionnaire addressed to the funded LEAP-Agri and AURG projects. 38 projects replied to the online questionnaire (25 LEAP-Agri and 13 AURG) and 3 coordinators accepted to be interviewed for additional information.

This questionnaire was divided into 3 main sections which were:

- Part 1: Questions to situate the projects.
- Part 2: Questions to analyze the theory of change in relation to the objectives of the three agendas 2030 (United Nations), Africa 2063 and STISA 2024.
- Part 3: Questions to analyze ways to ameliorate bi-regional cooperation on FNSSA and to make it sustainable.

[48] https://www.qgis.org/
[49] https://gephi.org/

4.2 The evolution of scientific co-publications between European and African institutions on FNSSA

The aim of this bibliometric review in the field of FNSSA is to examine the evolution of scientific production and to identify AU-EU collaborations engaged in research for the transition to sustainable food systems and nutrition security (including intensification). To accelerate research and amplify its impact in this difficult period impacted by new challenges such as climate change, pest epidemics and the emerging crises such as of COVID-19, it becomes urgent to identify the European and African scientific teams working in closest collaboration to increase their research capacities and to implement a long-term a new strategy to overcome unsteady funding problems and mobility constraints. The presented analysis was undertaken not to analyse research subjects and their impact, but to consolidate and strengthen the LEAP-Agri community and networks in food and nutrition security and sustainable agriculture research. We first focus on bibliographic research on main themes, which are developed in the projects with topics on “sustainable intensification", "agriculture and food systems for nutrition" and "expansion and improvement of agricultural markets and trade".

We ranked the top ten countries (table 2), top-ten categories and top-ten organisations (table 3). Regarding the number of records by country, their sum is greater than 286, because of co-publications involving researchers of different nations.

Table 2: Publications records on “Sustainable intensification” for the 10 first African countries

N°	Countries	Number	Web of Science Categories	records	%
1	Kenya	120	Agriculture Multidisciplinary	90	31.469
2	Ethiopia	52	Environmental Sciences	75	26.224
3	South Africa	40	Agronomy	51	17.832
4	Tanzania	30	Green Sustainable Science Technology	47	16.434
5	Ghana	28	Food Science Technology	24	8.392
6	Zimbabwe	28	Agricultural Economics Policy	16	5.594
7	Nigeria	24	Plant Sciences	15	5.245
8	Uganda	18	Agriculture Dairy Animal Science	8	2.797
9	Rwanda	17	Development Studies	8	2.797
10	Malawi	14	Soil Science	8	2.797

Table 3: Publications records “Sustainable intensification” for the 10 first research African organisations or International organisations working in Africa

N°	Organisations	Number	%
1	Wageningen Univ (Netherlands)	53	24.385
2	International Institute Of Tropical Agriculture (Nigeria)	28	9.790
3	International Maize And Wheat Improvement Center (CIMMYT,Mexico)	39	13.692
4	International Livestock Research Institute (Ilri, Kenya)	21	7.343
5	World Agroforestry Centre Icraf (Kenya)	20	6.993
6	International Livestock Research Institute (Ilri, Kenya)	19	6.643
7	International Crops Research Institute For The Semi-Arid Tropics (ICRISAT, India)	15	5.245
8	Michigan State Univ	13	4.545
9	Commonwealth Scientific Industrial Research Organisation (Csiro)	12	4.196
10	International Center For Tropical Agriculture (Colombia)	10	3.497

To this request, Kenya is in first rank followed by Ethiopia, South-Africa and so on. The publications with the topic “sustainable intensification” were classified into categories depending on how the paper was indexed, we listed the top ten micro-domains. An important information about partner institution or funder is the name of the organisation which appears in the address of the publication or in the acknowledgements. Some international institutions based in Kenya have their headquarters in other

countries like the International Maize and Wheat Improvement Centre based in Mexico or International Crops Research Institute for the Semi-Arid Tropics based in India.

We listed the top ten countries (table 4), top-ten research and innovation organisations (table 5) from the 103 records obtained. It is important to note that publications on "food systems for nutrition" or "food systems for food security" or "sustainable intensification" are rather recent. Only one paper was published on "food-systems for nutrition", while there are more for the second category.

Table 4: Publications records on "Agriculture and food-systems for nutrition" for the 10 first African countries

N°	Countries	Number of Pub.	Web of Science Categories	records	%
1	Kenya	36	Environmental Sciences	24	23.301
2	South Africa	32	Environmental Studies	21	20.388
3	Ghana	10	Green Sustainable Science Technology	20	19.417
4	Malawi	8	Agriculture Multidisciplinary	16	15.534
5	Uganda	8	Food Science Technology	15	14.563
6	Ethiopia	6	Nutrition Dietetics	7	6.796
7	Mali	6	Agricultural Economics Policy	6	5.825
8	Tanzania	6	Development Studies	6	5.825
9	Burkina Faso	5	Agronomy	5	4.854
10	Egypt	3	Ecology	5	4.854

Table 5: Publications records "Agriculture and food-systems for nutrition" for the 10 first research African organisations or International organisations working in Africa

N°	Organisations enhanced	records	%
1	International Food Policy Research Institute Ifpri	16	15.534
2	International Livestock Research Institute Ilri	14	13.592
3	World Agroforestry Icraf	13	12.621
4	University Of Cape Town	10	9.709
5	Alliance Of Bioversity International The International Center For Tropical Agriculture Ciat	9	8.738
6	Biovers Int	9	8.738
7	International Crops Research Institute For The Semi-Arid Tropics Icrisat	8	7.767
8	University Of Oxford	8	7.767
9	International Center For Tropical Agriculture	7	6.796
10	International Water Management Institute Iwmi	7	6.796

Mapping the scientific production in the 27 European countries on FNSSA leads to a record of 220428 published papers for the period 2010-2020. Most publications (36.46%) were in «Food Science Technology». The leading countries were Germany, Spain and France (Table 6), INRA (France) was the leading organisation (Table 7).

Table 6: Publications records on "FNSSA" for the 10 first EU countries

N°	*Countries*	*Number*	*.%*	*Web of Science Categories*	*records*	*%*
1	*Germany*	*49990*	*18.438*	*Food Science Technology*	*80373*	*36.462*
2	*Spain*	*47792*	*17.627*	*Plant Sciences*	*53275*	*24.169*
3	*France*	*34821*	*12.843*	*Nutrition Dietetics*	*32282*	*14.645*
4	*Italy*	*34383*	*12.681*	*Agriculture Dairy Animal Science*	*25212*	*11.438*
5	*Poland*	*20030*	*7.388*	*Agriculture Multidisciplinary*	*22786*	*10.337*
6	*Netherlands*	*17907*	*6.605*	*Agronomy*	*22007*	*9.984*
7	*Sweden*	*12066*	*4.450*	*Forestry*	*17613*	*7.990*
8	*Belgium*	*11693*	*4.313*	*Soil Science*	*15031*	*6.819*

9	*Denmark*	*11631*	*4.290*	*Automation Control Systems*	*48*	*0.022*
10	*Czech Rep.*	*11295*	*4.166*	*Computer Science Artificial Intelligence*	*32*	*0.015*

Table 7: Publications records on"FNSSA" for the 10 first research European organisations

N°	*Organisations*	*records*	*%*
1	*Institut National de la Recherche Agronomique (INRA, France)*	*9114*	*4.135*
2	*El Consejo Superior de Investigaciones Científicas (CSIC, Spain)*	*6990*	*3.171*
3	*Swedish University of Agricultural Sciences (Sweden)*	*3897*	*1.768*
4	*Wageningen University & Research (Netherlands)*	*3202*	*1.453*
5	*Polish Acad Sciences Inst Fundamental Technological Research (Poland)*	*3038*	*1.378*
6	*University of Copenhagen (Danemark)*	*2941*	*1.334*
7	*University of Helsinki (Finland)*	*2828*	*1.283*
8	*Ghent University (Belgium)*	*2657*	*1.205*
9	*Consiglio Nazionale Delle Ricerche (CNR, Italy)*	*2625*	*1.191*
10	*Technical University of Munich (Germany)*	*2614*	*1.186*

Mapping the scientific production in the 55 African countries on FNSSA led to a record of 37775 published papers for the period 2010-2020. Most publications were in " Plant Science". The leading countries are South Africa, Egypt and Nigeria (Table 6), South African Universities were the leading organisation (Table 9).

Table 8: Publications records on "FNSSA" for the 10 first African countries

Rank	Countries	Num	.%	Web of Science Categories	records
1	South Africa	9356	18.438	Plant Sciences	10941
2	Egypt	5504	17.627	Agronomy	7709
3	Nigeria	4929	12.843	Food Science Technology	7695
4	Tunisia	3059	12.681	Agriculture Dairy Animal Science	4199
5	Kenya	2751	7.388	Agriculture Multidisciplinary	3692
6	Ethiopia	2175	6.605	Nutrition Dietetics	2675
7	Ghana	1443	4.450	Soil Science	2533
8	Morocco	1341	4.313	Forestry	2513
9	Algeria	1259	4.290	Agricultural Engineering	1170
10	Cameroon	974	4.166	Fisherie	903

Table 9: Publications records on "FNSSA" for the 10 first research African organisations

N°	leading organizations	records	%
1	University of Kwazulu Natal (Durban, South Africa)	1847	4.889
2	University of Pretoria (South Africa)	1600	4.236
3	Stellenbosch University (South Africa)	1563	4.138
4	Universite de Carthage (Tunisia)	893	2.364
5	University of The Free State (South-Africa)	708	1.874
6	National Research Centre Nrc (Egypt)	700	1.853
7	Cairo University (Egypt)	688	1.821
8	University of Ibadan (Nigeria)	683	1.808
9	Universite de Tunis El Manar (Tunisia)	681	1.803
10	University of Cape Town (South Africa)	637	1.686

The grouped bibliometric networks presented in Figure 3a and the different figures (3b, 3c, 3d, 3e, 3f and 3g) below, present the main clusters of publications in FNSSA, the size of the circles represent the number of copublications in the topics and subtopics defining the FNSSA.

Clusters are represented by different colors and highlight the institutions working more closely together and publish frequently together on the topics related to FNSSA.

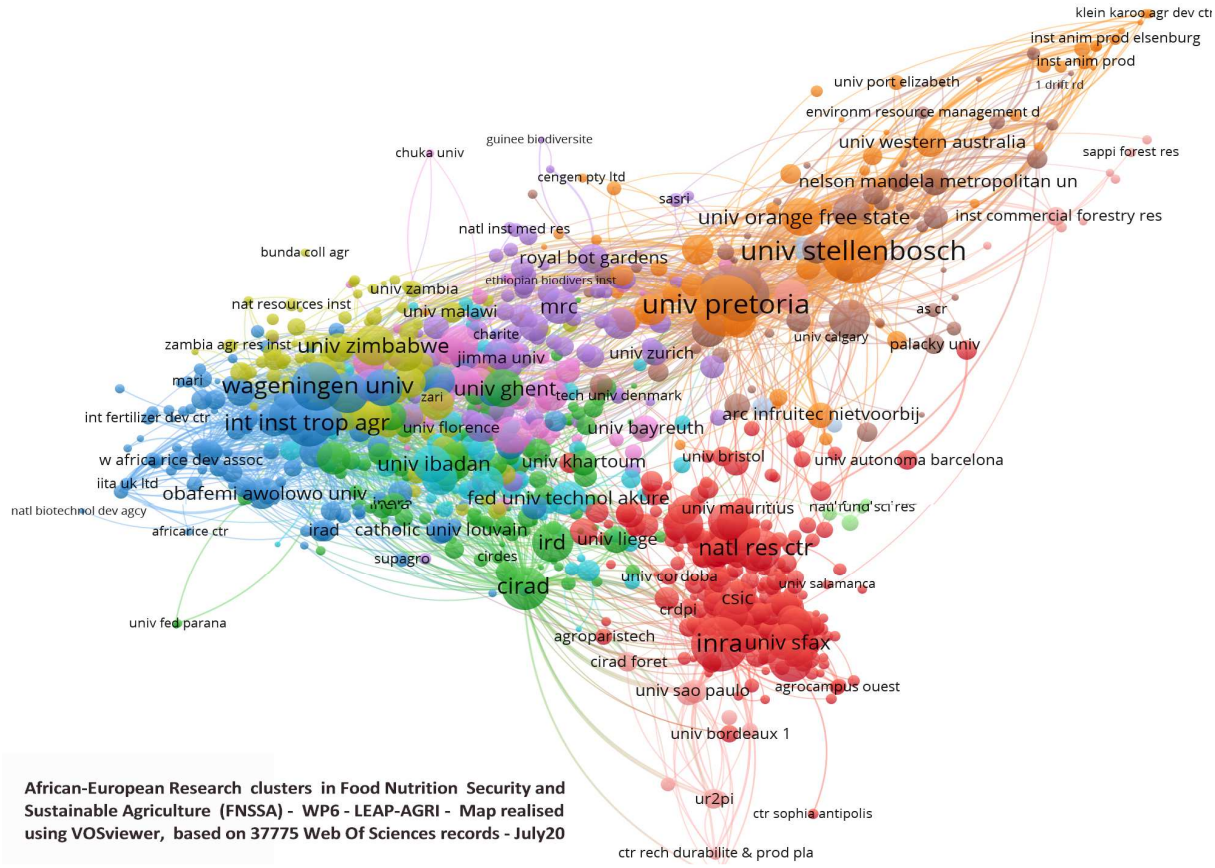


Figure 3a: Main African and European clusters of publications in FNSSA and their network

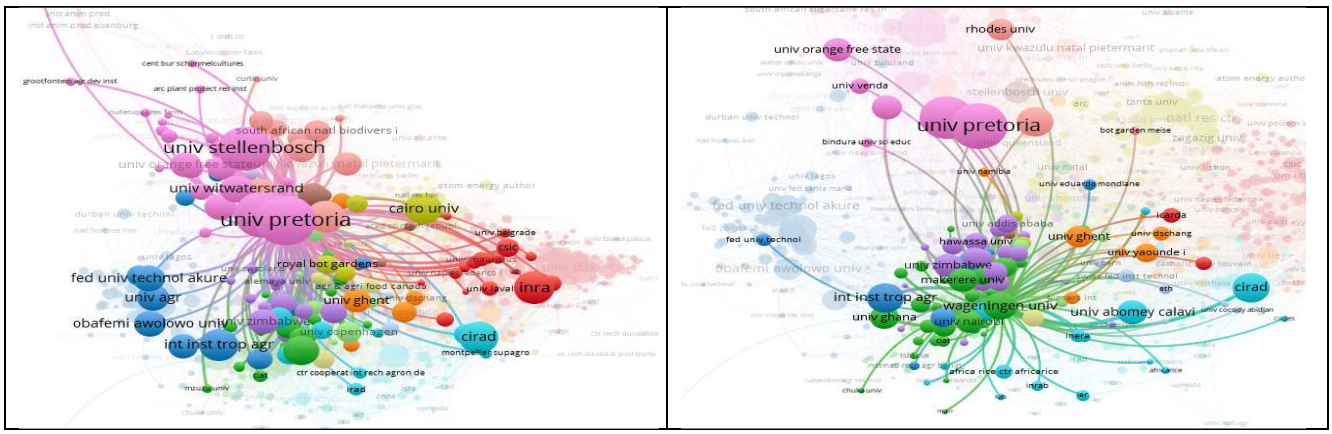


Figure 3b : Cluster University of Pretoria	*Figure 3c : Cluster Univ. Wageningen (Netherlands)*

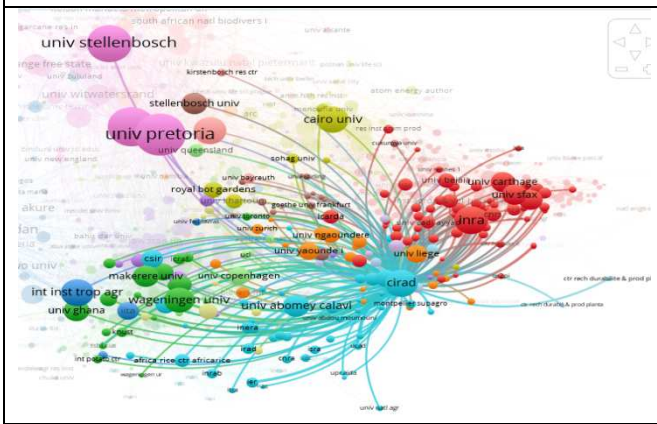
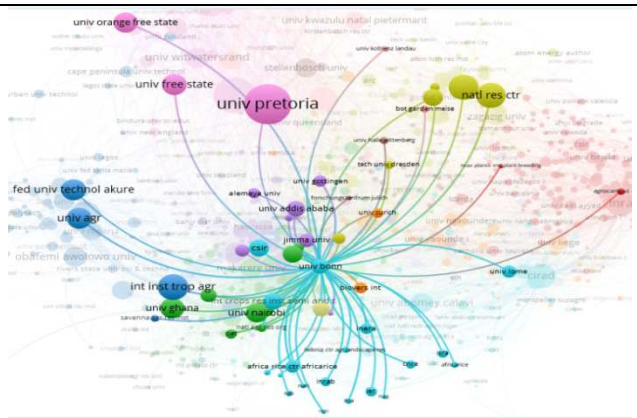

	

Figure 3d : Cluster CIRAD (France)	*Figure 3e : Cluster University of Bonn (Germany)*

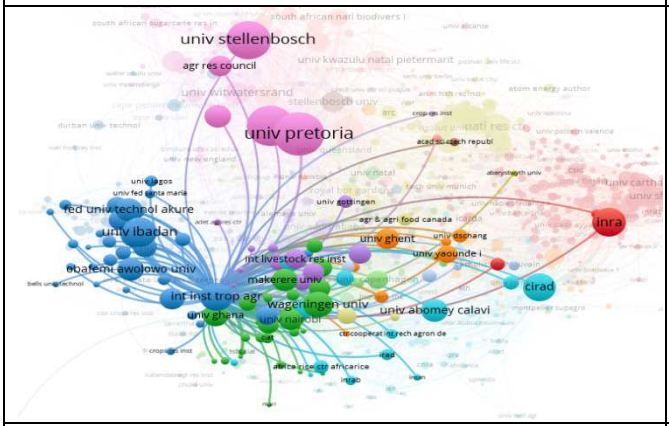
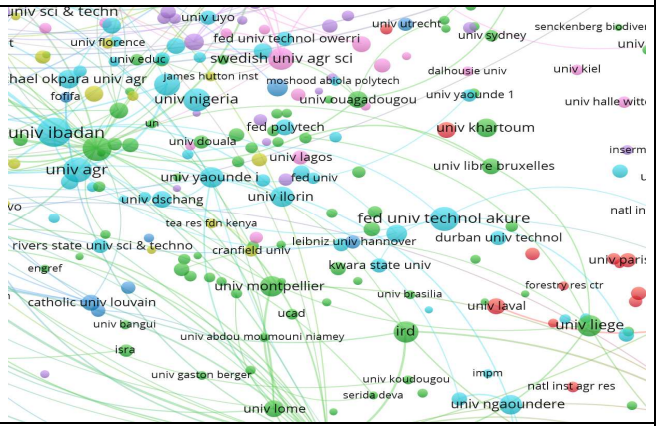

	

Figure 3f : Cluster Int. Institut Tropical Agriculture	*Figure 3g : Example of zoom in the global map*

The analysis of author affiliations suggests that research on FNSSA and agro-food sustainability transitions is performed mainly in European institutions and research centres, especially the Institut National de la Recherche Agronomique (INRA, France), El Consejo Superior de Investigaciones Científicas (CSIC, Spain), the Wageningen University and Research Centre. In Africa, the champions are South African universities (Durban, Pretoria and Stellenbosch).

There is a predominance of English-speaking institutions, whether from Africa or Europe. The numerous NGOs and support institutions are based in Kenya or Ethiopia (International Livestock Research Institute, World Agroforestry Center (Icraf), International Livestock Research Institute). South African Universities are present in all clusters, and the University of Pretoria is involved in all networks. Despite the large number of their publications, North African universities (Egypt, Tunisia) do not appear in the foreground for lack of citations or co-publications. Research in food security and publications are more concentrated between South Africa, Kenya, Ethiopia and Ghana where there are many links, probably facilitated by NGOs and International Institutions.

The research networks shown on the above clusters are known, built on the basis of bilateral scientific and cooperation agreements or in a more "bottom up" way by researchers from both continents, either on the basis of training exchanges or calls for projects. We can see the importance of these research networks by the volume of publications that increased from year to year and we can imagine the funds that they generate. In the framework of the HLPD, a group of researchers led by the German DLR has already started under the CAAST-Net+ project to think about a model to organize these scientific partnerships without being restrictive, respectful of the freedom of researchers and which can be used by donors (see below, the PIMC).

This work conducted on WoS publications allows to identify the research institutions which could be the pillars for the long term partnership in FNSSA for teaming and twinning mechanisms which seems the best tools for a long-term partnership to reach targets of Agenda 2030 and Agenda 2063 Africa we want. A number of research networks are listed, but it does not imply that not mentioned networks do not perform better work. The objective remains to address the entire value-chain in strengthening capacity-building (human, access to research infrastructures) and innovation through researchers involved in the LEAP-Agri and AURG projects and by extension to all researchers left behind the projects initially submitted proposals (191 in LEAP-Agri). This strategy will be further investigated in LEAP-Agri WP 6.5.

In April 2016, back to back to the Senior Officials of the AU-EU HLPD in Addis Ababa, where the roadmap for FNSSA was adopted, CAAST-Net +, held a stakeholder forum focusing on the next steps for the implementation of the roadmap. Emerging from this forum, one of the key recommendations was the need for "a flexible network of stakeholders and partnerships, with clear rules of engagement and interaction between the partners". This network of "active communities of practice" should develop structured access to AU-EU FNSSA knowledge, including outputs and lessons learned from various initiatives and research projects in the field and foster communication between all actors. A need for communication strategies, not only for the implementation of the roadmap itself but also for the transfer of knowledge into solutions has been expressed. For this purpose, such a communicating system would address notably national decision-makers and potential investors in research and innovation – industry as well as entrepreneurs – but also researchers, farmers, fishers and other role-players in the field operating at all levels of engagement with the challenges of food security.

4.3 Mapping ongoing FNSSA research projects geographically

Figure 4 illustrates the participation of countries in the LEAP-Agri call (pre-proposals, full proposals and funded projects). The figure links the proposals to a geographic context, highlighting the most dynamic countries. As seen, on top of the list of African countries are Kenya, Uganda, South Africa, Ghana, Burkina Faso, Senegal, and Egypt respectively. For the EU countries, Germany, France, Netherlands, Belgium, and Spain are the most active.

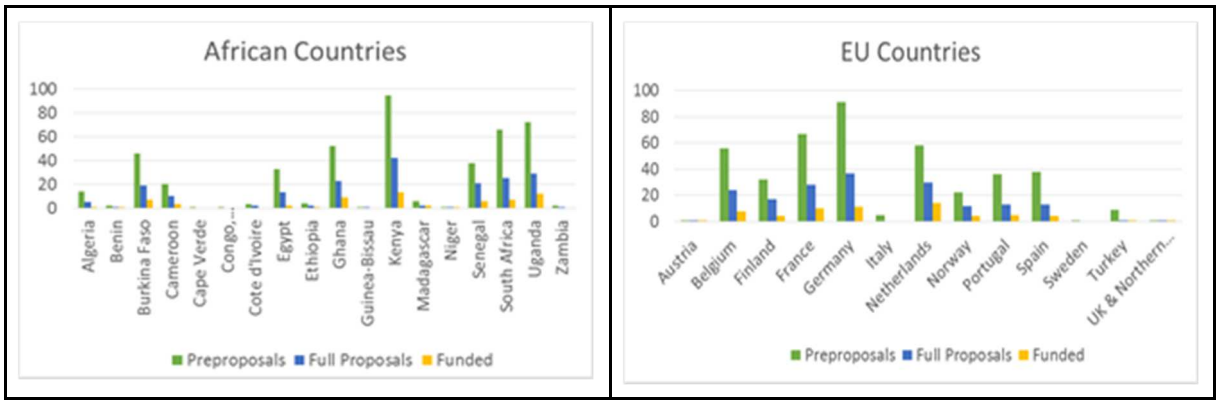


Figure 4: number of proposals submitted by different countries (LEAP-Agri projects)

Figure 5 shows national institutions in their respective country and the amount of their projects funded either in the frame of LEAP-Agri or through AURG.

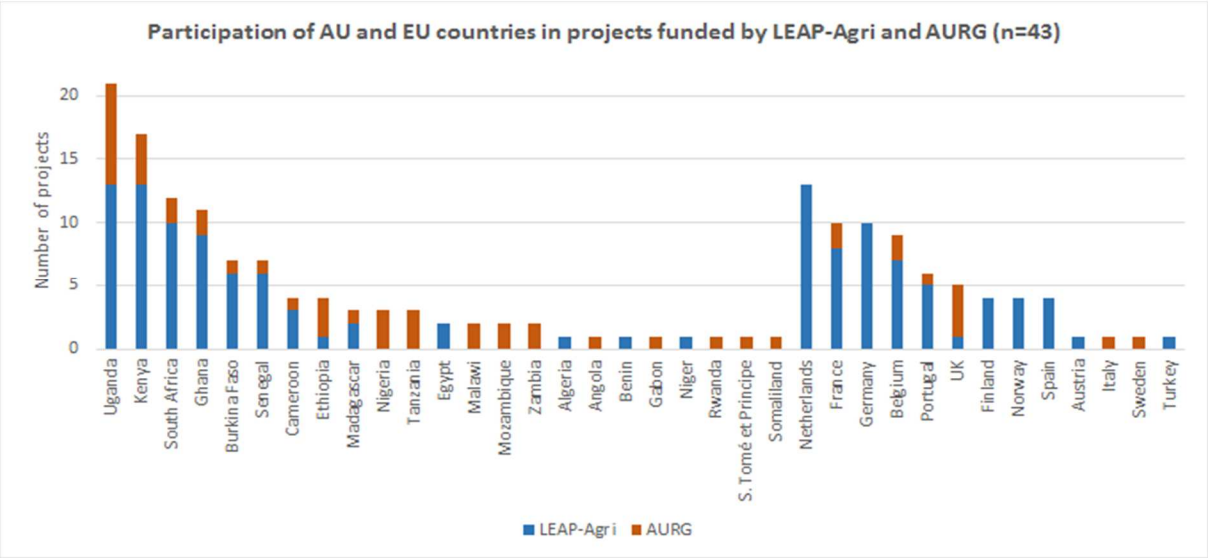
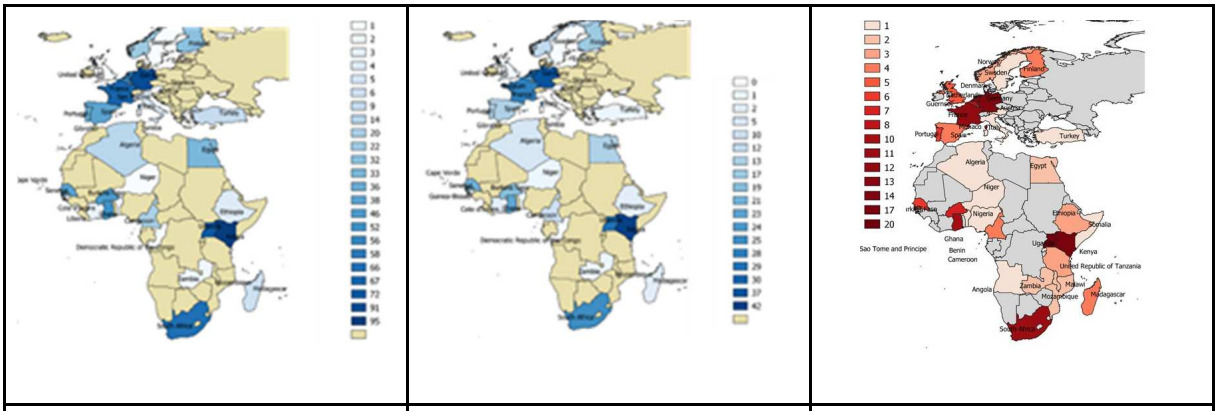


Figure 5: Number of projects per country funded by LEAP-Agri and AURG

All The comparison of the number of pre-proposals with the number of projects selected for funding shows strong competition between teams. However the high numbers of pre-proposals is the proof of a dense network of scientific research in FNSSA working in the two continents. The low rate of funded projects shows a lack of means to carry out the necessary research. If we consider in LEAP-Agri, all the pre-proposals that have passed the threshold of the first round are at a good level, the funding rate (1/3) remains low and can be a source of frustration.

The below maps (Figure 6) visualise the level of participation of different countries according to pre-proposals, final proposals and funded projects. These maps reveal that there are still many countries not participating in FNSSA research projects. Hence, highlighting the need for increasing the efforts to make participation more inclusive.



LEAP-Agri pre-proposals by country	*LEAP-Agri full proposal by country*	*LEAP-Agri+AURG funded projects*

Figure 6: Maps visualizing the level of participation of different countries

More communication is required with left behind countries to gain a better understanding of their needs and to evaluate their interests in participating in future joint calls. Table 10 and table 11 list the eligible partner countries of the calls and were not part of the landscape of analysed projects and

proposals. Thus, they are inactive or have limited activities in the field of bi-continental cooperation in FNSSA.

Table 10: List of eligible African countries that were not participating in the calls

Northern Africa	Eastern Africa	Middle Africa	Western Africa	Southern Africa
Libya	Burundi	Angola	Gambia	Botswana
Morocco	Comoros	Central African	Guinea	Lesotho
Sudan	Djibouti	Republic	Liberia	Namibia
Tunisia	Eritrea	Chad	Mali	
	Malawi	Gabon	Mauritania	
	Mauritius	Sao Tome &	Nigeria	
	Mozambique	Principe	Sierra Leone	
	Rwanda		Togo	
	Seychelles			
	Somalia			
	South Sudan			
	Tanzania			
	Zimbabwe			

Table 11: List of eligible European countries that were not participating in the calls

Western Europe	Eastern Europe
Iceland	Albania
Norway	Bosnia and Herzegovina
Switzerland	North Macedonia
Faroe Islands	Montenegro
	Serbia
	Moldova
	Ukraine
	Georgia
	Armenia

The limited participation of some countries could be due to the absence of a platform for communication and announcements, administrative and organizational burdens, lack of experience, obstacles to get official permits, lack of Knowledge to come up with collaborative research ideas, lack of capacity to prepare idea details and proposals, or technical difficulties in grasping the scope of the call.

To summarise, figures 7a & 7b illustrate the existing relations between partner countries involved in LEAP-Agri and AURG funded projects. The analysis highlights that Algiers and Ankara only have few connections and are weakly represented (4 connections) as compared to Amsterdam, Pretoria and other partners of the LEAP-Agri project (Figure 7a). Using geographic coordinates (plugin Geo layout) of Gephi, Figure 7b illustrates the African European research partnerships within the frame of LEAP-Agri on a world map. The global map is indicating clearly the concentration of African-European partnership in FNSSA. Leading countries are Kenya, Uganda, South-Africa, and Burkina-Faso.

Figure 7a: Partnership networks in LEAP-Agri and AURG projects

Figure 7b: Global map African-European partnership in LEAP-Agri and AURG projects

4.4 Mapping ongoing FNSSA research projects thematically

Three priority areas were identified by the EU-AU High Level Policy Dialogue on Science, Technology and Innovation EU Africa (HLPD), as being of common interest for Europe and for Africa:

1. Sustainable intensification of agriculture (“Sustainable Agriculture (AURG)” /“Sustainable intensification of agriculture (LEAP-Agri)”)
2. Agriculture and food systems for nutrition (“Food and Nutrition (AURG)” / “Agriculture and food systems for nutrition (LEAP-Agri)”)
3. Expansion and Improvement of agricultural markets and trade (“Trade and Market (AURG)” /”Expansion and Improvement of agricultural markets and trade (LEAP-Agri)”)

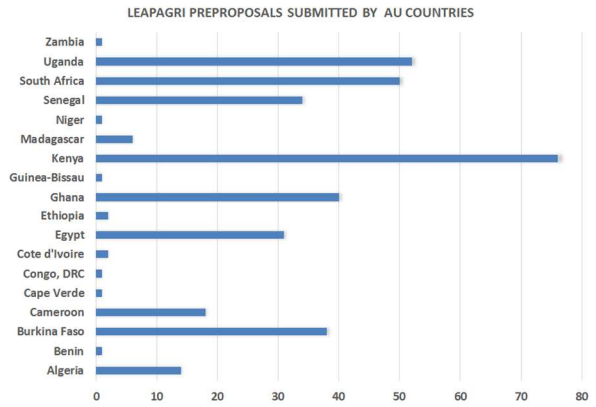
Sustainable intensification of agriculture:

Africa and Europe share the challenge of producing more food for growing populations while reducing the environmental impact of the food production system and their demands on ecosystem services. This theme takes into account R&I proposals on the improvement of the production of food/fibre/biomass and of services (social, economic and environmental); reduction of the

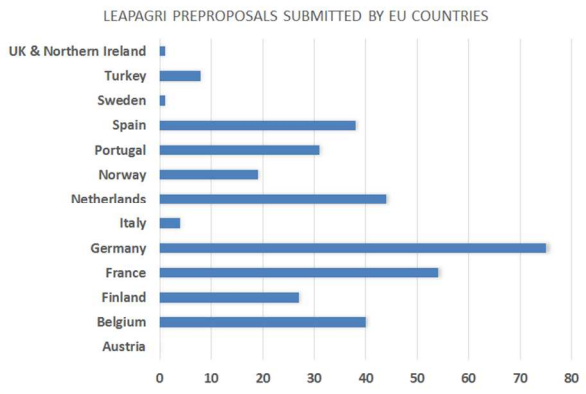
environmental impact of such production and the depletion of natural resources; ecological intensification approaches; breeding of crops and animals; nutrient management; and research on institutional innovations. The subtopics under this theme include:

- Agroforestry systems
- Sustainable water management
- Sustainable food security
- Soil science and remote sensing
- Plant sciences
- Animal sciences

Figure 8 shows the share of each country in the proposals submitted under the Sustainable Agriculture theme. For Africa, Kenya, South Africa, Uganda and Ghana were most frequently collaborating countries and seem to have the highest interest in the topic. For the European countries, Germany, France, Netherlands, Belgium and Spain had the highest shares respectively.



African pre-proposals in the field of sustainable agriculture



European pre-proposals in the field of sustainable agriculture

Figure 8: participation of African and European countries in LEAP-Agri pre-proposals in the field of sustainable agriculture

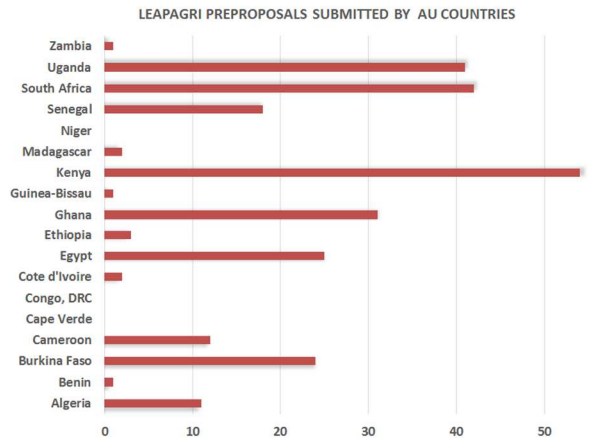
Agriculture and food systems for nutrition:

Dietary inadequacy takes very different forms but all are linked to limitations in the production, availability, access, affordability and consumption of highly nutritious foods and to social behaviour. While the average diets and nutritional conditions of Europeans and Africans may differ, and levels of under-nutrition in Europe are below those in Africa, the regions do have common nutritional challenges. This theme takes into account R&I proposals on: (i) the reduction of food waste (ii) improvement of diets (including through development of aquaculture and coastal fisheries); (iii) solving under-nutrition, obesity and micronutrient deficiency; (iv) the role on diets of urban agriculture and better rural-urban linkages; (v) understanding of consumer behaviour in relation to diets; and (vi) role of regulations, education and incentives. The subtopics under this theme include:

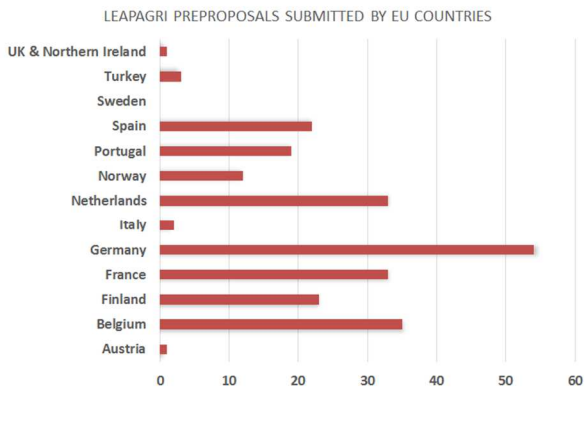
- Nutritious value chain

- Food and nutrition assessment
- Food technology and safety
- Pest and disease control

Figure 9 shows the share of each country in the proposals submitted under the Food and Nutrition theme. For Africa, Kenya, South Africa, Uganda and Ghana were most frequently collaborating countries and seem to have the highest interest in the topic. For the European countries, Germany, Belgium, France, and Netherlands had the highest shares respectively.



African pre-proposals in the field of food & nutrition



European pre-proposals in the field of food & nutrition

Figure 9: Participation of African and European countries in LEAP-AGRI pre-proposals in the field of food & nutrition

Expansion and Improvement of agricultural markets and trade:

If we consider only the funded ongoing projects, figure 10 shows that the main topics of cooperation are in an equal importance "Sustainable intensification of agriculture", "Agriculture and food systems for nutrition" and to a lesser extent "Expansion and Improvement of agricultural markets and trade".

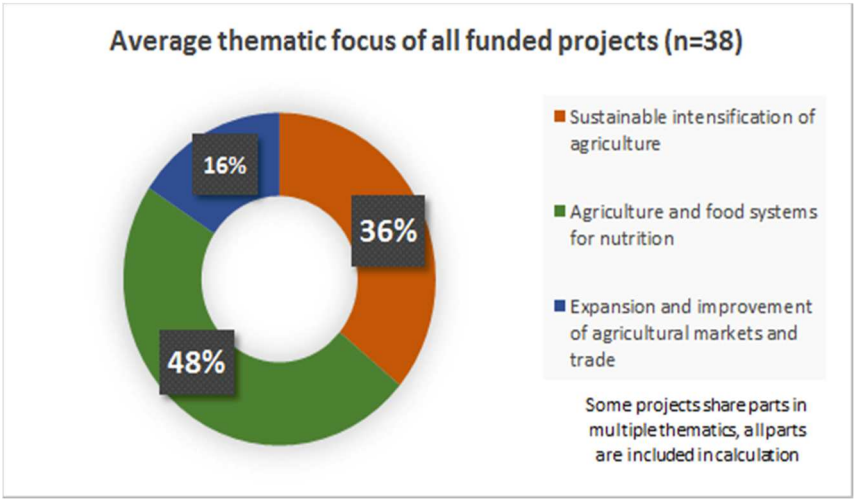


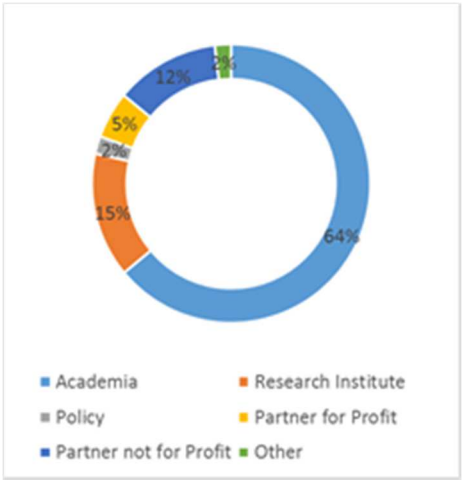
Figure 10: Main topics in the funded projects – LEAP-Agri and AURG

4.5 Mapping ongoing research on type of participating institutions

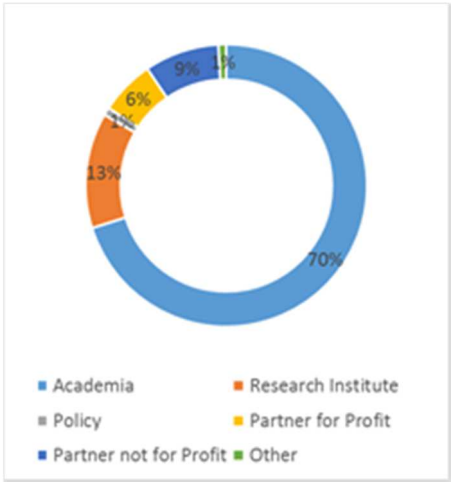
The the 191 LEAP-Agri pre-proposals were carried out by institutions which were classified as follows:

- Academia (Universities, Schools, training...)
- Research institute (National Research Institutes..)
- Policy Maker (Ministries, agencies…)
- Partner for profit (SME, Company…)
- Partners not for profit (NGO, Associations, Civil society…)
- Other

Figure 11 shows similar participation for both Europe and Africa: research institutes had the highest percentage share and partners for profit, such as SMEs participated the least, despite the call text strongly recommending to include entrepreneurs and SMEs. Boosting the participation of SMEs and entrepreneurs is essential if the gap between research and industry is to be closed, and uptake of research outputs scaled to markets through increasing the Technology Readiness Levels (TRLs) of innovations.



Type of Institutions partnering from Africa in LEAP-Agri pre-proposals



Type of Institutions partnering from Europe in LEAP-Agri pre-proposals

Figure 11: Type of institutions partnering in the LEAP-Agri preproposal

Types of institutions partnering in funded projects did not differ from pre-proposals (Figure 12). Despite clear encouragement from the AU and EU Commissions and other donors for greater representation of the private sector and civil society in research projects, funded projects under the AURG and LEAP-Agri umbrella do not appear to strengthen their participation in the different research consortia. However, it is worth noting the greater involvement of the non-academic public sector in AURG projects (34%) as compared to the LEAP-Agri projects (7%).

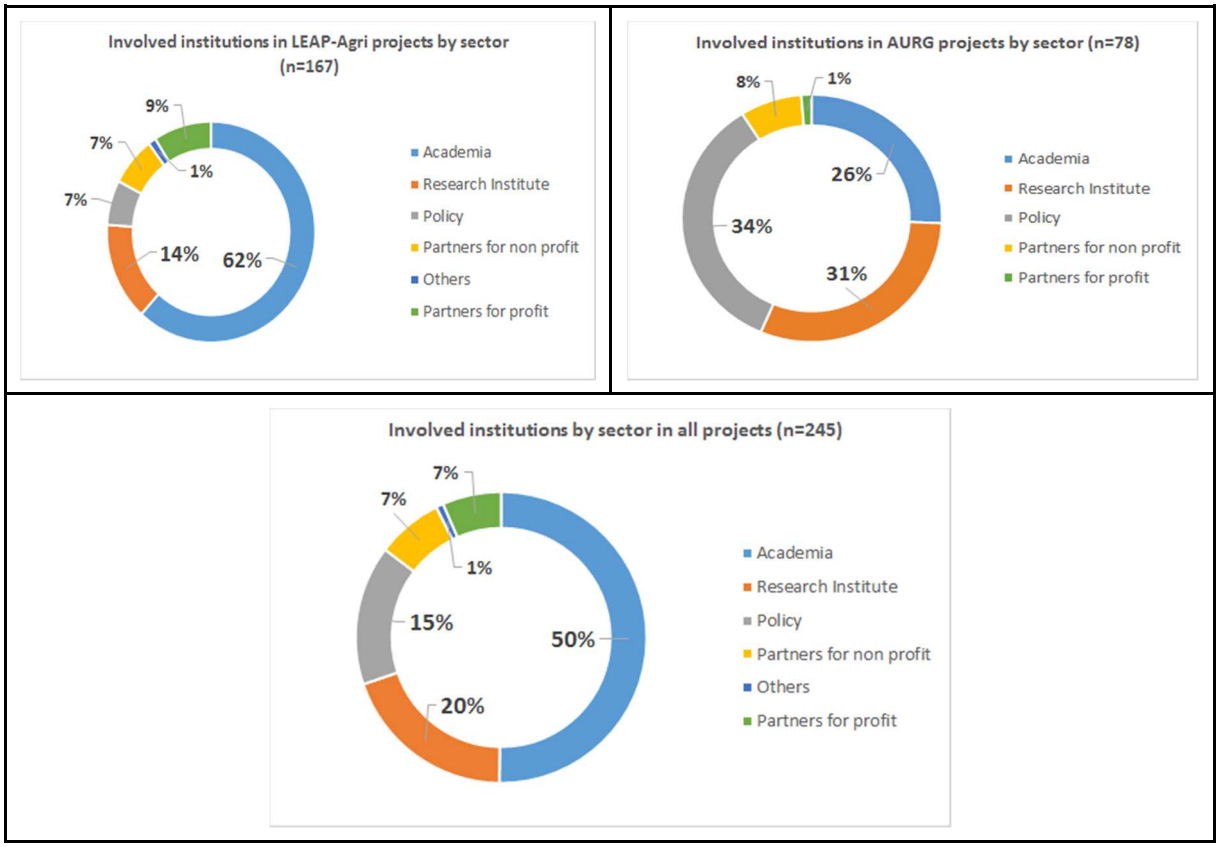
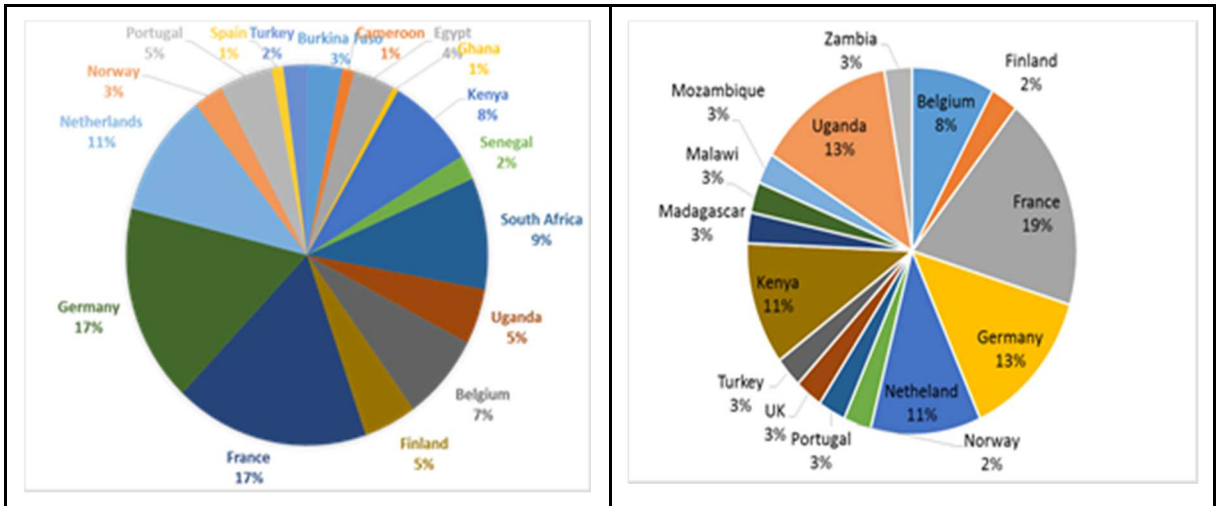


Figure 12: Type of institutions partnering in funded projects (LEAP-Agri & AURG)

With regard to project coordination, it was also found that the majority of European coordinators in the proposals remains the same in the proportion for funded projects. 68% of the 198 proposed consortia at the first LEAP-Agri round were led by a researcher from a European institution and 64% of the 38 funded consortia are led by a researcher from a European institution. Overall, this reveals the unequal distribution of project coordination responsibility among African and European institutions (figure 13).



Coordinators of 198 pre-proposals by country | *Coordinators of 38 funded projects by country*

Figure 13 : Coordinators of pre-proposals and funded projects by country

4.6 Envisioned research and innovation impacts from ongoing research projects in light of the UN Agenda 2030, the AU Agenda 2063 and STISA 2024

1. Agenda 2063: Agenda 2063 "Africa we want" encapsulates Africa's development and transformation priorities for the coming four decades. Central to Agenda 2063 is the sustainable transformation of the continent (human capacities, infrastructures, employment, well-being, good governance). Agenda 2063 is 7 aspirations, 34 priority areas, 20 goals, 174 targets and 200 indicators. The organizational structure is different from Agenda 2030, which is structured around Sustainable Development Goals, targets and indicators. Agenda 2063 is divided into five 10-year implementation periods. The first 10-years implementation plan covers the period 2013-2023 (corresponding to STISA programmes). The different goals are:

1. A high standard of living, quality of life and well-being for all citizens
2. Well educated citizens and skills revolution underpinned by science, technology and innovation
3. Healthy and well-nourished citizens
4. Transformed economies
5. Modern agriculture for increased productivity and production
6. Blue/ocean economy for accelerated economic growth
7. Environmentally sustainable and climate resilient economies and communities
8. A United Africa (Federal or Confederate)
9. Continental financial and monetary institutions established and functional
10. World class infrastructure crises - crosses Africa
11. Democratic values, practices, universal principles of human rights, justice and the rule of law entrenched
12. Capable institutions and transformative leadership in place
13. Peace, security and stability is preserved
14. A stable and peaceful Africa
15. A Fully functional and operational Peaceful and Secure Africa
16. Africain cultural renaissance is pre-eminent
17. Full gender equality in all spheres of life
18. Engaged and empowered youth and children
19. Africa as a major partner in global affairs and peaceful co-existence
20. Africa takes full responsibility for financing her development Goals

2**. Agenda 2030 for Sustainable Development**: The 2030 Agenda is a plan of action for sustainable development representing also Africa's priorities for the post-2015 development agenda. It is therefore not surprising that both Agendas overlap at the level of goals, targets and indicators. SDGs are 17:

1. End poverty in all its forms everywhere in the world
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all

8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

3. Science, Technology and Innovation Strategy for Africa (STISA-2024): The STISA-2024 has been developed when the African Union was formulating the long-term AU Agenda 2063. The STISA-2024 is the first of the ten-year incremental phasing strategies to respond to the demand for science, technology and innovation to impact six critical sectors:

1. Eradicate Hunger and ensure Food and Nutrition Security: Agriculture/Agronomy in terms of cultivation technique, seeds, soil and climate- Industrial chain in terms of conservation and/or transformation and distribution infrastructure and techniques
2. Prevent and Control Diseases and ensure Well-being: Better understanding of endemic diseases – HIV/AIDS, Malaria Hemoglobinopathie- Maternal and Child Health- Traditional Medicine
3. Communication (Physical & Intellectual Mobility): Physical communication in terms of land, air, river and maritime routes equipment and infrastructure and energy- Promoting local materials- Intellectual communications in terms of ICT
4. Protect our Space: Environmental Protection including climate change studies- Biodiversity and Atmospheric Physics- Space technologies, maritime and sub-maritime exploration- Knowledge of the water cycle and river systems as well as river basin management
5. Live Together: Build the Society: Citizenship, History and Shared values- Pan Africanism and Regional integration- Governance and Democracy, City Management, Mobility- Urban Hydrology and Hydraulics- Urban waste management
6. Create Wealth: Education and Human Resource Development- Exploitation and management of mineral resources, forests, aquatics, marines etc- Management of water resources

How do the Goals, Targets and Priority Areas of Agenda 2030 and the Goals and Targets of the Agenda 2063 overlap? A comparison of the 2030 Agenda on Sustainable Development Goals, the Agenda 2063 « Africa we want », including STISA (2014-2024) has been implemented. On the basis of a mapping exercise it appears that the 2030 Agenda shares several similarities with Agenda 2063 they match at 100% in Food and Nutrition Security and Sustainable Agriculture (FNSSA), making this study very relevant in the framework of both programmes AURG and LEAP-Agri and the development of a medium to long-term joint research and innovation agenda.

The synergies regarding FNSSA between the three agendas could be classified according to the SDGs and the Agenda 2063 as follow: (i) Food Security, Food Safety, Nutrition & Poverty Reduction; (ii) Income Generation, (iii) Natural Resources, (iv) Natural Knowledge & Capacity Development, (v) Strategic Alliance. For each of its themes we compared the three agendas (tables 12 to 16) and extracted the keywords and sub-themes referring to them. Each of these tables were analysed by two experts giving their opinion to establish a few indicators for each theme. In the online survey it was proposed to the project coordinators to carry out a self-assessment and to give a score from 1 to 4 for each indicator: (1) the project is not at all in line with the indicator, (4) the project is completely in line with the indicator. An arithmetic mean of scores for each indicator indicates how the programme has an impact on the objective of these agendas and how it can bring a change towards a sustainable development pathway.

Table 12: Comparing 2030 Agenda on SDGs, Agenda 2063 « Africa we want » and STISA, Subtopic1: FIndicators for the subtopic "Income generation" in the 3 agendas: UN Agenda 2030, AU

Subtopic 1: Food Security, Food Safety, Nutrition & Poverty Reduction					
SDG	SDGs targets	Agenda 2063 Goals	STISA-2024 priority areas	relevant Keywords	Make also reference to:
SDG1: End poverty in all its forms everywhere	# 1.4: By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	#1: A high standard of living, quality of life and well-being for all citizens. - Incomes, Jobs and decent work	#1: Eradicate Hunger and ensure Food and Nutrition Security	# poor vulnerable human, #well-being	[equal rights] [access basic services] [new technology] [financial services] [woman] [reduce vulnerability] [climate disaster] [care low income]
	# 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters				
SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	# 2.1: By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	#5 : Modern agriculture for increased productivity and production	#1: Eradicate Hunger and ensure Food and Nutrition Security # Agricultural productivity and production	# end hunger, # food security, #nutrition, # sustainable agriculture, # under-nutrition commodity yields, # climate change and variability,	end hunger] [food security] [sustainable agriculture] [agriculture productivity] [nutritional needs] [genetic diversity] [traditional knowledge] [food production] [water] [sanitation]
	#2.2: By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	#1: A high standard of living, quality of life and well-being for all citizens. - Poverty, inequality and hunger		# stunting in children, # nutritional needs # pregnant, # lactating women, #older persons	

	# 2.5:By 2020, maintain genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, through soundly managed and diversified seed and plant banks at the national, regional levels, and promote access to fair and equitable sharing of benefits arising from the utilization of genetic resources and traditional knowledge		#1: Agriculture Agronomy in terms of cultivation technique, seeds, soil and climate - Industrial chain in terms of conservation and/or transformation and distribution - Infrastructures and techniques	# genetic diversity seeds, animals wild species, #plant banks, #traditional knowledge, #industrial conservation, #industrial transformation, # distribution infrastructures	
SDG3: Ensure healthy lives and promote well-being for all at all ages	# 3.2: By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births	#3: Healthy and well-nourished citizens. - Health and Nutrition	#2: Prevent and Control Diseases and ensure Well-being, # Better understanding of endemic diseases, HIV/AIDS, Malaria Hemoglobinopathie, # Maternal and Child Health, # poor human resources management , # improvements in healthcare delivery., #strengthening local health ecosystems	#access to health services and technologies, #human resources management, #healthcare delivery. # new medicines, diagnostic tools, #traditional medicine #health ecosystems #ethics and research integrity, #public trust in research, #primary health care,	[well-being , 'human development'; 'happiness'; 'quality of life'; 'basic need'; 'income'; 'economic growth'; welfare]; [reduce deaths] [polution] [contamination] [poor access household Mortality]
	# 3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being				
	# 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination				

From this table the two experts identified six indicators to measure the impact of a project related to the objectives of the three agendas in the framework of the theme: "Food Security, Food Safety, Nutrition & Poverty Reduction":

1. Applicability by the target population
2. Increasing the supply of healthy food to the target population
3. Increasing food safety
4. Increasing access of vulnerable groups to healthy food
5. Improving the diet of the target population
6. Reducing hidden hunger and nutritional imbalances

Figure 14 summarizes the scores given by the 38 coordinators of funded projects to each of these indicators. Unsurprisingly, it shows that the two programmes LEAP-Agri and AURG fit well with the objectives of the three agendas, according to funded projects grouped in the subtopic: "Food Security, Food Safety, Nutrition and Poverty Reduction ". The standard deviation analysis indicates that the projects, individually, address more the indicators (1) Applicability by the target population, (2) Increasing the supply of healthy food to the target population (small standard deviation) and less

the other indicators. The biggest difference between the two programmes (LEAP-Agri & AURG) is for indicator (3) Increasing food safety.

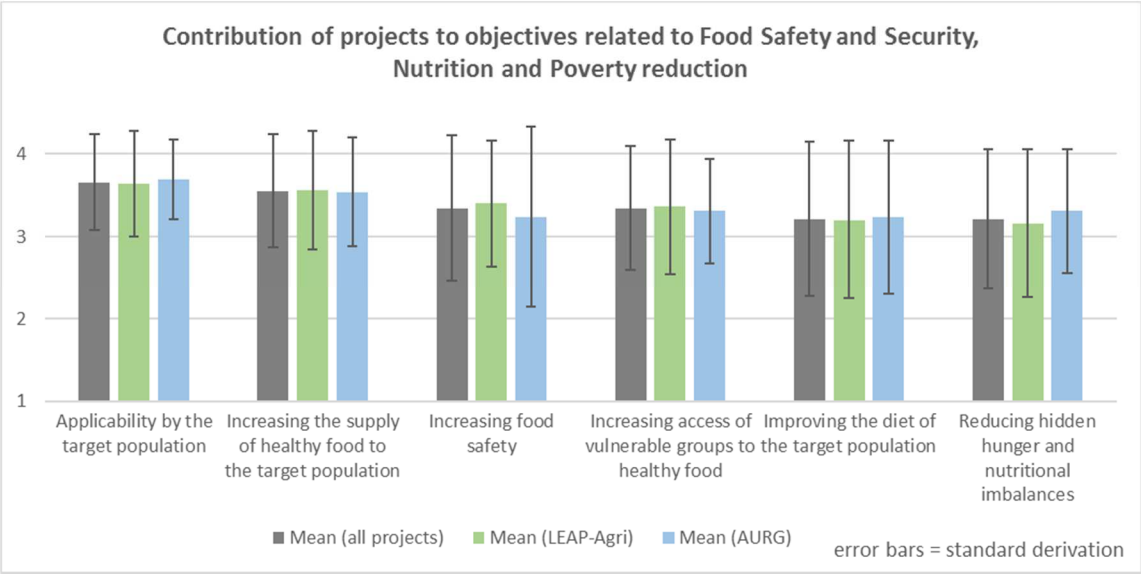


Figure 14: Indicators for the subtopic "food safety and security, nutrition and poverty reduction"

Table 13: Comparing 2030 Agenda on SDGs, Agenda 2063 « Africa we want » and STISA, Subtopic 2: Income Generation

Subtopic 2: Income Generation				
SDG	SDGs targets	Agenda 2063 Goals	STISA-2024 priority areas	Make also reference to:
SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	#2.3: By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	#5: Modern agriculture for increased productivity and production. - Agricultural productivity and production	#1: Eradicate Hunger and ensure Food and Nutrition Security	[protecting environmental services], [increase the food safety], [healthy food] [nutritional imbalances] [food security research] and [food systems] [regional, national and/or global food and nutritional insecurity]
	#2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality		#1: Eradicate Hunger and ensure Food and Nutrition Security	
	#2.c: Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility		#1: Eradicate Hunger and ensure Food and Nutrition Security	
SDG 8: Promote sustained, inclusive and sustainable economic growth, full & productive employment and decent work for all	#8.6: By 2020, substantially reduce the proportion of youth not in employment, education or training	#1: A high standard of living, quality of life and well-being for all citizens. - Social security and protection, including persons with disabilities #4: Transformed Economies - Sustainable and Inclusive economic growth		[decent work] [productive employment] [economic growth]
SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	#9.b: Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities	#4: Transformed Economies - STI driven manufacturing, industrialization and value addition - Economic diversification and resilience		[Social justice, vulnerability, capability approach, value-laden, interdependency] [resilient infrastructure] [industrialisation] [innovation]

	#9.3: Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets			

From this table the two experts defined six indicators to measure the impact of a project related to the objectives of the three agendas in the framework of the subtopic: “Income Generation”:

1. Adaptation of technologies/innovation to local conditions
2. Project results simple to understand and to be implemented
3. Integration of local knowledge innovation and development
4. Improving economic viability of business activities
5. Enhancing productivity and stability
6. Better market integration

Figure 15 summarizes the scores given by the 38 coordinators of funded projects to each of these indicators. It shows that the two programmes LEAP-Agri and AURG fit with the objectives of the three agendas grouped in the subtopic: "Income Generation". Indicators (1) “Adaptation of technologies/innovation to local conditions”, (2) “Project results simple to understand and to be implemented” and (3) “Integration of local knowledge innovation and development” are better scored. The size of the standard deviation shows the difference between projects for the same indicator. The largest differences between projects are for the indicators (4) “Improving economic viability of business activities” and (6) “better market integration”. It is also for these two indicators that the differences are greatest between the AURG and LEAP-Agri projects. AURG projects seem to place less emphasis on improving competitiveness, economic viability and market integration. This difference between the two projects remains small to be statistically significant. However, it may be thought that the closer proximity between research teams and their funding agency in LEAP-Agri has led to projects that are more in line with economic return.

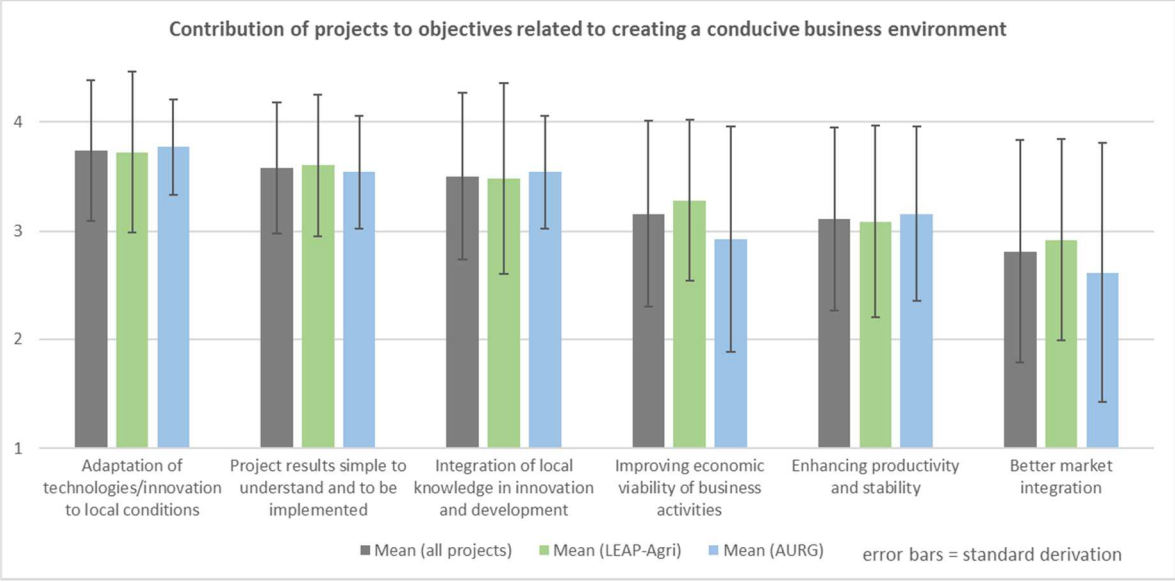


Figure 15: Indicators for the subtopic “income generation”

Table 14: Comparing 2030 Agenda on SDGs, Agenda 2063 « Africa we want » and STISA, Subtopic 3: Natural Resources

Subtopic 3: Natural Resources				
SDG	SDGs targets	Agenda 2063 Goals	STISA-2024 priority areas	Make also reference to:
SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all	#7.3: By 2030, double the global rate of improvement in energy efficiency	G1: A prosperous Africa based on inclusive growth & sustainable development, - G7: Environ-mentally sustainable and climate resilient economies and communities, people have access to affordable and decent housing with all the basic necessities of life such as, water, energy, ICT; - harnessing all African energy resources to ensure modern, efficient, reliable, cost-effective, renewable and environmentally friendly energy	#3: Communication (Physical & Intellectual Mobility), - communication in terms of infrastructure and energy - Promoting local materials	[Solar energy conversion], [photovoltaics and artificial photosynthesis] [Energy storage including batteries], [sustainable synthesis of fuels and chemicals, and molecular/bioinspired catalysis Fuel cells] [storage and distribution],[Carbon capture, storage and utilisation], [biomass conversion] [Capacitive desalination] [thermochemical, piezoelectric and thermoelectric materials and devices] [carbon, care]
SDG 12: Ensure sustainable consumption and production patterns	#12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses			[agricultural policy formulation], [identification of opportunities to improve value chains] [improvement in food security],[monitoring of loss reduction activities]
	#12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil to minimize impacts on human health and the environment		#4 : Protect our Space: Urban waste management	

SDG13: Take urgent action to combat climate change and its impacts	#13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	#1: A high standard of living, quality of life and well-being for all citizens. - Modern, affordable and liveable habitats and quality basic services	#4: Protect our Space - Environmental Protection including climate change studies	[climate change vulnerability] [health issues in the socioeconomic system, food security in the field of agricultural system] [issue of water resource management] [ecological diversity, ecosystem service, water resource management and electric power supply]
SDG15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertificati on, and halt and reverse land degradation and halt biodiversity loss	#15.2: By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	#7 : Sustainable natural resource management and Biodiversity conservation, halt and reverse the process of land degradation and end the loss of biodiversity		[silviculture], [forest management], [forest ecology], [genetics & tree improvement], [harvesting & utilization], [landscape ecology], [soils & hydrology], [wildlife management]
	#15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, and strive to achieve a land degradation-neutral world	#7,13 : Preserve and restore terrestrial ecosystems, making sure to exploit them in a sustainable way, manage forests sustainably, fight against desertification		

Table 14 has made it possible to identify five indicators to measure the impact of a project related to the objectives of the three agendas in the framework of the subtopic: “Natural Resources”:

1. Better resilience and adaptive capacity to climate disasters
2. Reduction of foo losses
3. Achieving environmentally management of chemical and wastes
4. Restauration f degrade land and soil
5. Implementation of sustainable management of forests.

Figure 16 summarizes the scores given by the 38 coordinators of funded projects to each of these indicators. According to the online survey, the first concern of projects in the two programmes (LEAP-Agri & AURG) is increasing resilience and adaptation to climate disasters followed by the reduction of food losses. Restoration of degraded land and soil, and implementation of sustainable management of forests are themes less present in the projects of the two programmes (LEAP-Agri & AURG). **This fact is to be noticed and surely to be corrected in future calls for projects on FNSSA**! These two

themes, although in different applications, are important for the two continents and can be the subject of experience sharing.

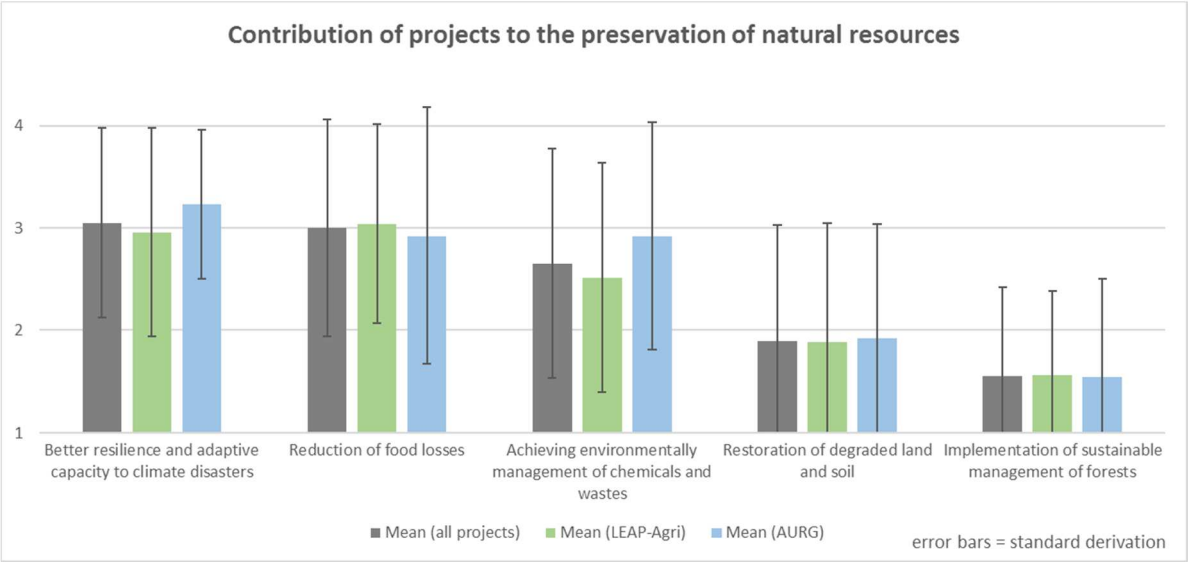


Figure 16: Indicators for the subtopic "natural resources"

Table 15: Comparing 2030 Agenda on SDGs, Agenda 2063 « Africa we want » and STISA, Subtopic 4: Natural Knowledge & Capacity Development

Subtopic 4: Natural Knowledge & Capacity Development				
SDG	SDGs targets	Agenda 2063 Goals	STISA-2024 priority areas	Makes also reference to :
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	#4.4: By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	#2: Well educated citizens and skills revolution underpinned by science, technology and innovation. - Education and science, technology and innovation (STI) driven skills revolution	#2: Prevent and Control Diseases and ensure Well-being - Traditional Medecine #6: Create Wealth: Education and Human Resource Development	[increase youth and adults skills] [employment decent jobs] [knowledge skills] [human rights] [gender equality] [end discrimination] [empower women, girls] [vocational training] [capacity on climate change] [lifelong learning] [cooperation and capacity in water] [cooperation and capacity in agriculture] [cooperation and capacity in nutrition] [dissimination of technologies] [teach, university, research] [curriculum, school, support] [network]
	#4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and			

	appreciation of cultural diversity and of culture's contribution to sustainable development			[responsibility, challenge, ethic], [think big]
	#4.8: By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries			
SDG 5: Achieve gender equality and empower all women and girls	#5.1: End all forms of discrimination against all women and girls everywhere	#17: Full gender equality in all spheres of life - Women and girls empowerment		[women and men members community]
SDG 6: Ensure availability and sustainable management of water and sanitation for all	#6.a: By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies		#4: Protect our Space - Knowledge of the water cycle and river systems as well as river basin management #6: Create Wealth: - Management of water resources	[development, transfer, dissimination, diffusion technologies water] [capacity water treatment] [health water]
SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	#9.c: Significantly increase access to ICT and strive to provide universal and affordable access to the Internet in least developed countries by 2020	#10 : World class infrastructure cross - Africa Communication and infrastructure connectivity Communications and infrastructure connectivity.		[resilient infrastructure] [sustainable industrialization] [production aptterns]

SDG 12: Ensure sustainable consumption and production patterns	#12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	#12 Capable institutions and transformative leadership in place		[improve institutions and tackle corruption].
SDG 13: Take urgent action to combat climate change and its impacts	#13.3: Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning		#4: Protect our Space: - Environmental Protection including climate change studies	[‘climat* chang*’ OR ‘global warm*’ OR ‘carbon emission*’ OR ‘CO(2) emission*’ OR ‘energy consumption’; (4) mitigation OR decarboni*ation OR (emission* NEAR/3 reduction*)]

Table 15 has made it possible to identify seven indicators to measure the impact of a project related to the objectives of the three agendas in the framework of the subtopic: “Natural Knowledge & Capacity Development”:

1. Strengthening scientific and institutional capacity
2. Acquisition of knowledge and skills needed to promote sustainable development
3. Increase the number of youth and adults who have relevant skills for jobs implement
4. Ensure the relevant information and awareness for people and sustainable development
5. Expanding the number of scholars
6. Increasing access to information and communications technology
7. Ending all forms of discriminations

Figure 17 summarizes the scores given by the 38 coordinators of funded projects to each of these indicators. According to the online survey, the first concern of projects in the two programmes (LEAP-Agri & AURG) is “Strengthening scientific and institutional capacity”. Depending on the project, the following five indicators have the same importance. In both programmes, funded projects were less concerned by: “Ending all forms of discriminations”.

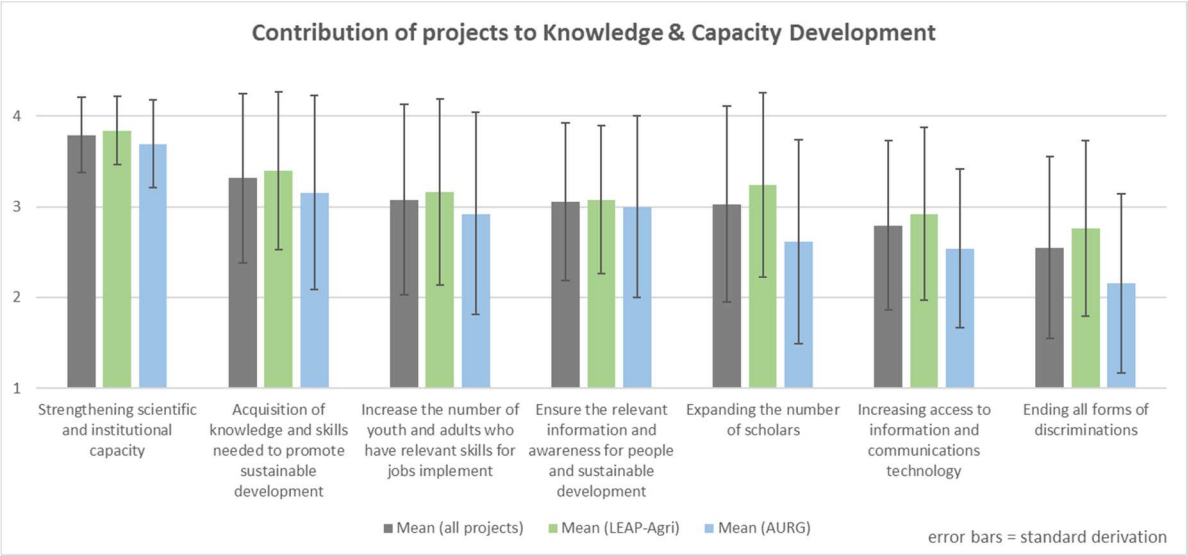


Figure 17: Indicators for the subtopic "Natural Knowledge & Capacity Development"

Table 16: Comparing 2030 Agenda on SDGs, Agenda 2063 « Africa we want » and STISA, Subtopic 5: Strategic Alliance

Subtopic 5: Strategic Alliance				
SDG	SDGs targets	Agenda 2063 Goals	STISA-2024 priority areas	Make also reference to:
SDG 12: Ensure sustainable consumption and production patterns	#12.a: Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production			[circular economy and sustainability]
SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development	#17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed	#19: Africa as a mojor partner in global affairs and peacefull co-existence - Africa's place in global affairs - Partnerships	#Partnership	[partnership] [cooperation] [share infrastructures] [technology transfer] [Financial resources]
	#17.15: Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development			
	#17.16: Enhance the global partnership for sustainable	#20: Africa takes full responsibility for financing her		[statistical capacity]

	development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries	development Goals. - African capital markets - Fiscal systems and public sector revenue - Development assistance		
	#17.19: By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries			

Table 16 has made it possible to identify five indicators to measure the impact of a project related to the objectives of the three agendas in the framework of the subtopic: “Strategic Alliance”:

1. Involve key local stakeholders throughout the research process
2. Enhance institutional partnerships
3. Build on already existing results considering lessons learnt
4. Realistic assumptions with social, economic and environmental circumstances
5. Plan adequate activities and mechanisms to translate research results into policies and practices

Figure 18 summarizes the scores given by the 38 coordinators of funded projects to each of these indicators. According to the online survey, and as could be expected the two programmes LEAP-agri and AURG are building a strategic alliance between the AU and the EU and the five indicators show strong scores. Higher scores are for the two first indicators: (1) Involve key local stakeholders throughout the research process and (2) Enhance institutional partnerships.

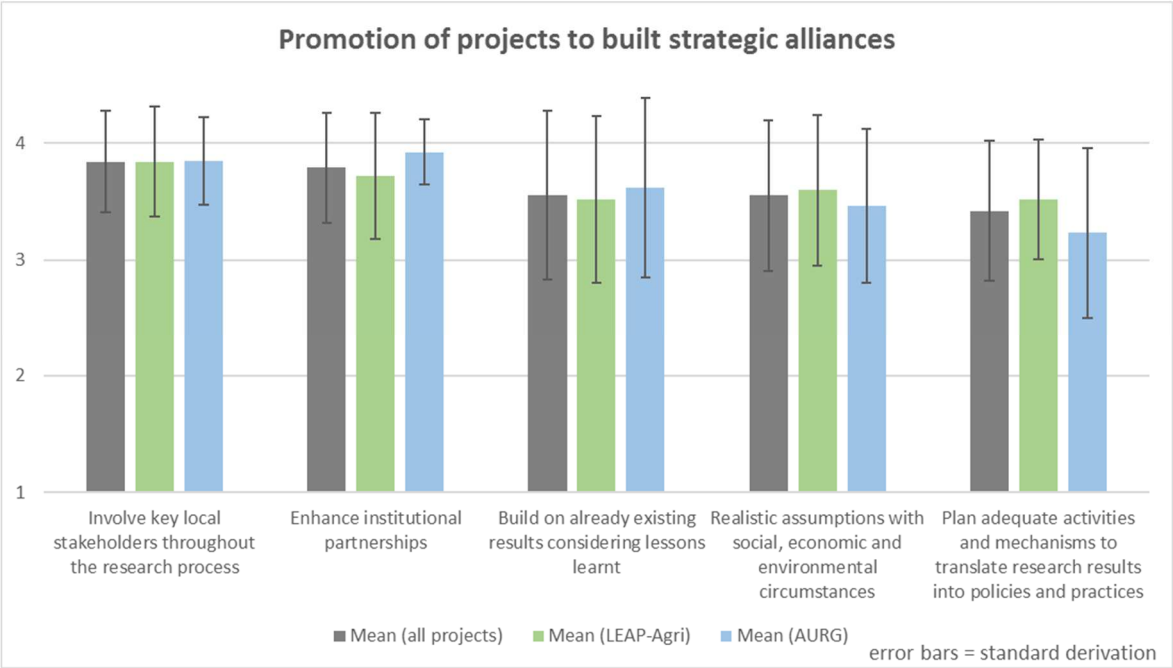


Figure 18: Indicators for the subtopic "Strategic Alliance"

Figure 19 shows for each project its impact on the five subtopics defined from the UN 2030, AU 2063 & STISA 2024 agendas. The projects have been ranked from left to right according to the average score obtained on all indicators. The projects generally show high scores for the subtopic "Food Security, Food Safety, Nutrition & Poverty Reduction" and lower scores for the subtopic "Natural Resources" There is concern about environmental sustainability of the results of projects that show high scores high the subtopics "Food Security, Food Safety, Nutrition & Poverty Reduction" and "Income generation" and low scores on the subtopic "Natural resources".

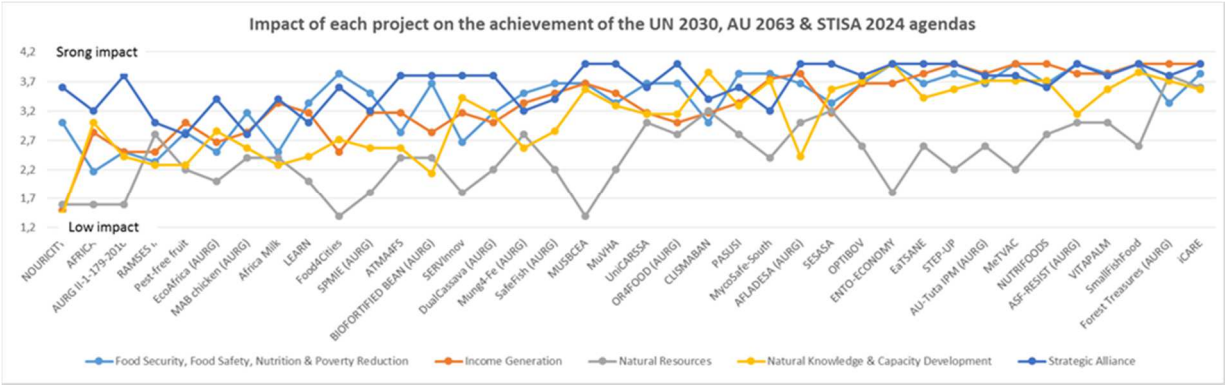


Figure 19: Impact of individual project on the five subtopics defined from the UN 2030, AU 2063 & STISA 2024 agendas

4.7 Collaboration challenges

A series of partly closed and partly open-ended questions allowed the 38 coordinators to give their opinion on the opportunities, constraints and challenges of the partnership in FNSSA. While all are committed to the partnership and without exception will volunteer to participate in a new project should the opportunity arise, they point out important constraints.

Challenges related to proposal writing

In the online survey, LEAP-Agri and AURG project coordinators found, in the same proportion, more difficulties in putting together a proposal due to lack of financial means or difficulties in understanding the administrative requirements than in identifying consortium partners or understanding the terms of reference (figure 20).

Figure 20: Difficulties to overcome in setting up an AU-EU joint research & innovation proposal

Three AURG interviewed coordinators confirmed historical relationships between African and European researchers in the field of FNSSA, finding a partner was not a problem. However they regret that they always work with similar consortia that do not renew themselves much.

These interviews confirmed the bibliographic and the proposal analysis that in Africa there is a significant divide between Anglophone and Francophone countries, very few consortia brought together partners from both Francophone and Anglophone Africa. North Africa, which has privileged relations as a Mediterranean third country of the EU, was very rarely found in these consortia. Partners from Central Africa the less represented in consortium proposals. Conflict-prone areas such as Sudan and the Democratic Republic of Congo were hardly covered.

On the European side, there tends to be little engagement from Eastern European countries. However, as these countries also face challenges related to food safety and quality, EU market access/penetration, poor infrastructure, and poor policy instruments, they could certainly benefit from more actively collaborating with African counterparts dealing with similar challenges. Yet, countries such as Bulgaria, Latvia and Poland were hardly represented in AU-EU FNSSA projects, as compared to Western European countries, such as France, Germany, the Netherlands and the United Kingdom. While there are historical causes for the perpetuation of partnership relations, which can hardly be reversed overnight, this should not discourage ever-increasing efforts to increase the participation of AU and EU member states not currently involved in the projects, to bring fresh ideas to the fore and to address shared challenges together.

Despite the modern and almost free means of communication and distance working, it seemed difficult for a consortium to put together a proposal with any chance of success without at least one face-to-face meeting and a field or laboratory visit. Successful proposals were often the result of visits that have taken place, in most cases at the initiative of the European partner. It was suggested that pre-proposals selected for the second round should receive funding for a consortium meeting. This should even be broadened to provide funding to jointly develop the proposal including initial fieldwork to properly establish relations with the target group and relevant stakeholders. This can make sure that relevant problems will be addressed by the project.

While it is the responsibility of applicants to put together the proposal from a scientific and technical point of view, they do not always have the skills to put together the increasingly complex administrative, financial and legal parts required by donors. As attested by a coordinator, very few consortia can offer the service of private offices for the setting up of their proposals in the administrative, financial and legal form requested by the donors. The research support services in Universities and Research Institutions in Africa could be more associated to receive information on European or African programmes and benefit from permanent training. When in an African country there is one or several National Contact Points for Horizon 2020, they are scientists and not very concerned by the administrative and financial aspects of the calls.

Many coordinators (LEAP-Agri and AURG) noticed the short time between the call for proposals and the deadline for the submission of the concept note and then between the concept note and the entire proposal. These short delays appear to be a difficulty that may cause some to give up. The calls agendas (LEAP-Agri and AURG) seemed more suitable for donors with their disbursement requirements than for the consortia. It seems reasonable to adapt the agendas to the needs of those who receive the funds rather than those who give them.

Language also appeared to be a difficulty with the obligation to write proposals in English.

Challenges related to start and to implement a project

Almost half (44%) of the responding project coordinators faced challenges related to the mobilisation of funds held by several funding agencies whose agendas did not coincide. The difficulty in recovering the funds from the funding agencies came far ahead of challenges such as signing the consortium agreement (26%), mobilising partners (18%) or holding the kick-off meeting (12%) (Figure 21).

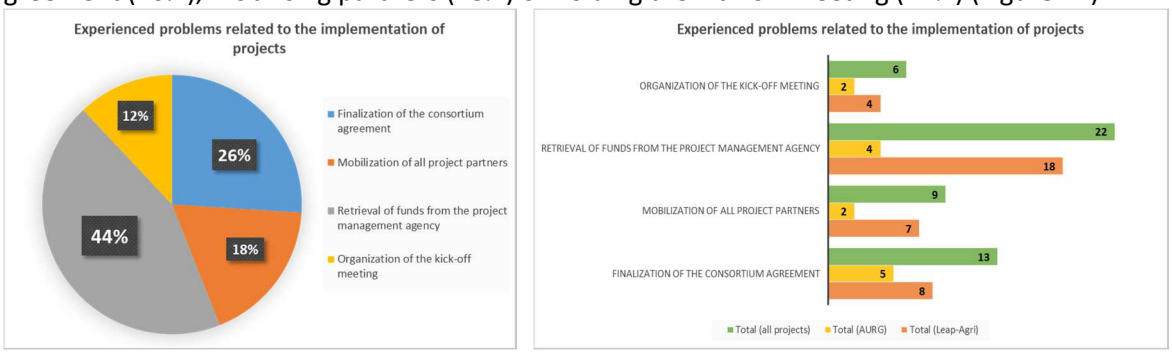


Figure 21: Challenges related to start and to implement a project

The difference in perception between the LEAP-Agri and AURG coordinators on the recovery of funds shows that the partnerships are more surmountable when the funds are concentrated with one funder (AURG). In their comments, the coordinators also mentioned that funding was too weak and too crumbled in relation to the level of demand for research and innovation. The small number of finally selected proposals was also mentioned as a factor of discouragement.

The results show the need to improve joint funding mechanisms. Building equal partnerships requires also to rethink hegemonic modes of funding and to develop funding instruments that are capable of catering for diverse contexts and flexibility.

Research projects designed around the concept of equal partnership as applied not only to input but also to benefits would ensure a two-way flow of information and value-addition alike, allowing both Africa and Europe to gain from the collaboration in equal measure.

When identifying challenges related to partnerships, the AURG program had little response to the online survey. For both programs, the primary reasons for partnership dysfunction are (1) “Unbalanced equipment with resources by North and South partners” (2) “Unbalanced role of partners in the research”. Competition for results and the sharing of intellectual property do not appear to be major challenges (Figure 22). In the comments, the delay by some funding agencies is noted as a problem to cooperation. A request for resources for team-building training appears. The problems of punctuality in the delivery of reports (financial as well as technical) and the maintenance of team spirit were mentioned in a few comments.

Figure 22: Challenges related to partnerships

Perceived benefits and constraints to developing long-lasting research partnerships

In the online survey an open-ended question on the benefits and constraints of bi-regional projects was filled out extensively. Among the first benefits reported was that these programmes show how the AU-EU collaboration is increasingly becoming more reflective of the political aspiration towards co-ownership and equal partnership for mutual interest and mutual benefit. Focussing on areas of common interest, and sharing common values are key ingredients of co-owning projects; and these are areas where AURG and LEAP-Agri have achieved significant improvements. The AURG programme, although still dependent on EU funding, is seen as gradually building African institutional capacity to manage pan-African research programmes. Such programmes, eventually fully funded and owned by African countries, would expand the space for cooperation with international partners, including the EU, and would provide a much richer and diverse basis for bi-regional cooperation. The following two quotes provide a representative insight into the general opinions of the 36 LEAP-Agri and AURG project coordinators about the important benefits of bi-regional AU-EU cooperation projects:

“The bi-regional AU-EU cooperation is advantageous in that it fosters sharing of North-South expertise for addressing food and nutrition security and sustainable agriculture challenges in the AU member countries. This expertise is in the areas of academia, industry and laboratory infrastructure, all of which are instrumental for the capacity development in the AU. On the other hand, the EU benefits in capacity development through involvement of the young academia who will train for their PhD and Masters under this arrangement. This partnership also creates a window for business opportunities where SME from the EU can partner with local investors to promote innovations for solving pertinent

challenges in this area. Another important advantage of this cooperation is the engagement of the AU member countries to fund researchers. AU countries having lagging on this for long."[50]

"The projects will promote collaboration between European and African scientists through addressing questions of joint interest. Sustainable improvement of disease control measures and agricultural development will improve income generation, enhance the economic cooperation between EU and African countries and will promote the competitiveness of agricultural markets. Promote the training and upgrading of scientists as well as target populations such as farmers. Stimulate and promote research activities in participating countries, to develop research strategies to promote uptake of the technology, and to coordinate the sharing of results and best practice. Enhance the capacity of local institutions and assessment of region specific risk factors. Human and animal welfare will be improved by providing training and methodology that will enhance the capabilities of scientists/policy-makers to formulate national control policies. This will meet the goals of food security, food safety, alleviation of poverty, improving animal welfare and promoting environmental sustainability."[51]

Besides the recognized benefits of bi-regional cooperation, respondents highlighted a range of constraints. All LEAP-Agri project coordinators question the principle of ERANET-COFUND projects according to which each team is funded by its national funding agency according to national rules. This implies many constraints that AURG projects have not experienced. The first of these constraints was the failure of a particular funding agency to provide the funds to their national research teams and hence, blocking all partners while putting the unfunded partner in a difficult position. "The major constraint to this bi-regional cooperation has been the poor or inadequate commitment on the part of AU member countries to release their Co-funding as agreed upon. This has caused a lot of challenges as other consortium partners especially from the EU released their funding early in the implementation of the project but the AU partners have either lagged behind or not at all released their funds. In light of this, the agreed upon activities cannot proceed since they are synchronized"[52] .

Despite the challenges for some national teams to retrieve the funds, most affected projects developed solidarity procedures and the projects were able to start either by rearranging the project agenda or by other partners advancing their own funds. "The project was challenged due to a late start in Uganda. We are grateful to have experienced a well-functioning cooperation between funders and researchers, which has enabled the project to address unforeseen needs and strengthen its performance in those fields promising"[53].

Another constraint of this funding method was the difference in the amount of funds allocated by each agency, which puts the less funded partners in second place whatever the needs of the project in terms of that partner's skills. Eligible expenditure differs between funding agencies and some have been singled out for their share of overheads. "I would strongly opt against further procedures for project set-up and evaluation: the funding in these projects is already small and to get a good output all needs to be put into the actual activities of the project and overhead should be reduced."[54]

The AURG projects whose funding was fully provided by the African Commission did not report these funding constraints, other than to say that the total funding was not commensurate with the ambition requested by the evaluators for these projects. Visa regulation was a constraint in staff exchange necessary to the bi-regional FNSSA cooperation. The unbalanced access to resources as well as to human and infrastructural capacity was also a constraint for this cooperation.

[50] An African project coordinator
[51] An European project coordinator
[52] An African project coordinator
[53] An European project coordinator
[54] An European project coordinator

Perception on ways to improve collaboration

An open-ended question in the online survey collected views on how to improve cooperation between funding agencies and research teams to jointly address relevant problems related to FNSSA.

The major idea raises the fact that future projects must be built between funders and researchers. This requirement implies a working cooperation, institutional support and a partnership based on collaboration, equity and mutual interest and respect from each involved party and a climate of trust. All these characteristics depend on an active and open communication from each actor. On the one hand, some coordinators regret the lack of exchanges, discussions and listening from funding agencies; this situation leads to a misunderstanding between actors and some tensions could occur. On the other hand, coordinators suggested a simple solution to resolve this problem: a joint decision on some points (agenda, potential problems, information flow, guidelines, administrative procedures, etc.) for effective cooperation and comprehension. To support this idea, some coordinators suggested annual meetings with funders and researchers (or an occasional presence on the field) to identify gaps, shortcomings and problems, share knowledge and lessons learned. The objective should be to improve project management, increase performance in projects and ensure transparency in this communication.

The other point – mentioned by the majority of coordinators – were problems in relation with funds. Indeed, coordinators pointed the finger at funding agencies for many reasons: lack of funding, delays to unlock funds, different payment strategies and the rigidity for allocation and use of funds in projects. These problems led to delays in projects' activities (or rushed experiments to respect timelines) and a lack of reliable results. All these problems have negative impacts on projects and actors. However and fortunately, some solutions were available like these mentioned above and, for coordinators, a harmonized payment strategy, more flexibility in allocation and use of funds and a complete agreement on these points are keys. A long-term partnership cannot be efficient without a long-term funding.

The last point mentioned by coordinators was about "time". This point deals with timing for the release of funds, for monitoring and evaluations, to fill in gaps and resolve problems. For this, researchers recommended extending the duration of projects. Extra time could permit researchers to plan properly their experiments, have reliable results and respond to real needs and expectations of funded projects.

The last two points (time and funds) are highly interdependent. Indeed, many problems in the field can be solved through good communication and a clear policy of funding with defined timelines. This strategy must be jointly defined with all involved actors in funded projects.

An effective long-term partnership between Africa and Europe might be based on good management in terms of time and funding, an equal involvement of parties (funders, researchers) and a complete and joint agreement between different actors for some points (agenda, funding, guidelines etc.). These requirements can lead to a local, regional and global promotion of research in Africa.

Two ways to improve collaboration have been proposed in the online survey. The first one was to improve the partnership in adopting the Research Fairness Initiative discussed and adapted to the bi-regional STI cooperation by the CAAST-Net+ project[55]. The second one was the establishment of a

[55] Botti, Lauranne (et al.) 2018 Equality in Health Research Cooperation Between Africa and Europe: The Potential of the Research Fairness Initiative. in Africa-Europe Research and Innovation Cooperation, Global Challenges, Bi-regional Responses. Editors: Andrew Cherry, James Haselip, Gerard Ralphs, Isabella E. Wagner. Copyright: 2018. Publisher. Palgrave Macmillan. Basingstoke. pp 99-119.

procedure recognized by the HLPD to evaluate projects, define new calls and monitor the project, set-up help bi-regional cooperation on FNSSA. This procedure was developed by the LEAP-Agri project (Cf §6.3: The Programme and Innovation Management Cycle (PIMC)[56]), but already engaged during CAAST-Net + project with the KMCS Initiative[57] (Knowledge Management and Communication System Initiative).

The scientific community is today faced with two major, often contradictory, challenges that can lead individuals or teams to failures in research integrity or ethics. On the one hand, the complexity and diversity of the objects and processes studied lead to the development of increasingly important partnerships, often international and sometimes between STI organisations of different levels in their development. On the other hand, researchers and research teams and their institutions are subject to fierce competition for both funding and results. As a result, scientific discourse, based on real facts and logic, is threatened by "alternative facts".

In this context, COHRED has developed with other partners a "Research Fairness Initiative"[58], now known as the "RFI" (Research Fairness Initiative), in the form of written reports, which aim to promote transparency in institutional partnerships and thus fair and ethical cooperation. This initiative, which initially focused on the health sciences, has been extended to the whole field of science and in particular to partnerships between organizations in advanced and developing countries. The extension of the RFI was carried out in the framework of the European project CAAST NET (Advancing SSA-EU cooperation in research and innovation for global challenges)[59] with the participation of some partners, today in LEAP-Agri.

Research partnerships (or formalized research collaborations) are an essential element of development in low- and middle-income countries and are recognized as one of the targets of sustainable development goal number 17 (UN Agenda 2030). Such research collaborations and networks are also considered essential for developing a strategy to address global or local challenges and for building national capacities of research systems (Nordling, 2015[60], GSDR 2019[61]).

The partners (especially from low-income countries) should not only benefit from access to the research product or final technology, but also participate in building the capacity of research systems and in the development of economic activities. The institutional partnership in research and innovation should not be limited to co-publication, but should also include job creation, increased social capital, more reliable local finances and communication and data storage facilities, sharing of intellectual property rights and the benefits derived from them, etc.

Most, if not all, research stakeholders are well aware of these facts, and many are working to improve the way partnerships are created and maintained and how benefits (and costs) are shared more equitably. The volume of co-publications, guidelines, practical tools and even international legal instruments, such as the Nagoya Protocol (United Nations, 2010) is increasing.

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[56] LEAP-AGRI (2020) The Programme and Innovation Management Cycle (PIMC) - A Model for long-term programming activities in the scope of the AU-EU Partnership on Science, Technology and Innovation (STI)

[57] CAAST-NET+ (2017) A KMCS initiative blueprint by the CAAST-Net Plus project

[58] https://rfi.cohred.org/

[59] Cherry A. (dir.), Ralphs G. (dir.), Haselip J. (dir.), Wagner I.E. (dir.), Albergel Jean (dir. trad.). (2018). Coopération Afrique-Europe en matière de recherche et innovation : défis mondiaux, réponses bi-régionales. Paris (FRA) ; Marseille : EAC ; IRD, 133 p. ISBN 978-2-7099-2652-2

[60] Nordling, L. (2015) Research: Africa's fight for equality. https://www.nature.com/news/research-africa-s-fight-for-equality-1.17486

[61] https://sustainabledevelopment.un.org/gsdr2019

Within this framework, RFI does not invent new standards. It is a reporting tool that leading research and/or innovation organizations can use to describe how they behave and expect their partners to behave in joint research programs. These organisations produce this report in the form of an activity report with a chosen periodicity and request certification. RFI Reporting Organisations (RFI) answer questions on 15 key aspects of equity and efficiency in research partnerships, divided into the three phases of collaboration: equal opportunities and co-construction (pre-project), fair process (during) and equitable sharing of benefits, costs and results (after). The RFI does not request reports on each contract or partnership but focuses on the conditions, policies and practices that RROs put in place to optimize the R&I partnerships in which they are or will be involved.

On the subject of RFI, 58% of the project coordinators of the two programmes (LEAP-Agri & AURG) were of the opinion that they would collaborate more confidently with an organisation that would be RFI certified, 5% do not see the point of this certification and 37% have no opinion (Figure 23).

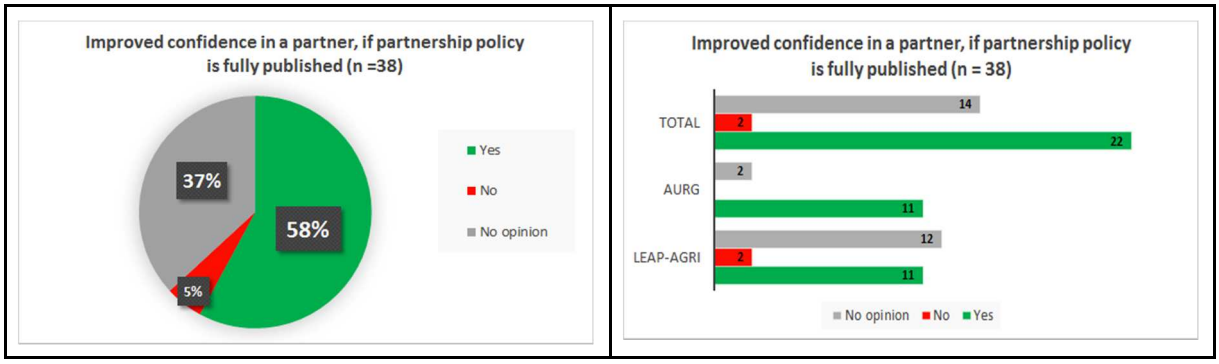

Figure 23: RFI as bi-regional partnership cooperation policy

The RFI should be recommended by the HLPD as an element encouraging bi-regional partnership cooperation for a mid & long term cooperation in STI for FNSSA.

With regard to a new procedure recognized by the HLPD to evaluate projects, define new calls and monitor the project, set-up help bi-regional cooperation on FNSSA, the online survey proposed to the coordinators of the LEAP-Agri and AURG projects to use a cursor on a scale of 0 to 100 to rate the level of support or constraint, the adoption of such a model by donors and decision-makers can bring to a medium - long-term joint research and innovation agenda in FNSSA. Out of the 36 responses, 18 (50%) coordinators are of the opinion that this adoption could be an encouragement to cooperation and would add logic and value to successive calls for projects, 8 (22%) are in favour but think that this model would bring constraints, 3 (8%) are not in favour and think that the model would bring more constraints than facilitations, finally 7 (20%) are against it, either finding it complicated to implement or too constraining. This favourable opinion led LEAP-Agri to propose a model which is developed in the paragraphs below.

5 MEDIUM, LONG-TERM PROGRAMMING ACTIVITIES IN THE SCOPE OF THE AU-EU PARTNERSHIP ON FNSSA

5.1 The Challenge

Multi-institution and collaborative Research and Innovation (R&I) programmes and efforts for capacity building within a certain thematic domain often lack a common identity and 'language', including a common understanding of terms and concepts. Rarely, collaborations have been able to seize the opportunity to secure a common understanding and to formalize partnership structures. Accelerated by the short duration of externally funded projects and the excessive use of competitive calls for proposals, many collaborations for R&I and capacity building have remained fragmented. The project-based nature of collaborations, including local research projects as well as multi-national and trans-continental funder partnerships, can lead to repetition of methods and sub-optimal spending of funds. Additionally, research outputs, outcomes and the lessons learned from R&I and capacity building programmes are not always evaluated jointly by different stakeholder groups. Furthermore, the gained knowledge is not always handed over to succeeding investments in R&I collaborations. Likewise, the transfer of research results into practice and to agencies for up-scaling and capacity building is not vigorous enough and additionally challenged when important linkages within innovation systems, such as the Agricultural Knowledge and Innovation Systems (AKIS) are not sufficiently structured.

Overall, in this 'projectified world'[62]R&I programmes are typically not systematically followed-up and assessed within a vision of long-term institutionalized learning, leading to a lack of reflexive and impact-oriented steering of allocating resources. These shortcomings are particularly challenging for the development of the bi-continental AU-EU R&I Partnership on STI, and the thematic area of FNSSA because of:

1. the large number and different interests of R&I institutions and stakeholders involved across Europe and Africa,
2. the high diversity of contexts and perceived challenges across and within the two continents,
3. the diversity of visions about the role of R&I in addressing various challenges, and
4. the insufficient and unequal access to relevant information on the activities by the different stakeholders on the two continents in the field of FNSSA.

This highlights the need for AU-EU Partnership stakeholders to invest in a more systematic overarching and long-term coordination process, with feedback mechanisms and learning loops, which at the same time can effectively drive systemic societal changes that are desired on both continents.

5.2 Theory of Change and Impact Pathways - Making the Logic of Interventions Explicit and Facilitating Monitoring and Evaluation (M&E)

A key instrument to successfully institutionalize learning is applying the Theories of Change and Impact Pathway (TCIP) approach for designing and evaluating interventions in complex problem-situations. A Theory of Change is a conceptual model of how change has happened due to a particular intervention, programme or project in the past or how future change is expected to happen. Impact Pathways describe the sequence of activities, outputs and outcomes, which have to occur in order to reach a certain long-term goal or impact. The assumptions and hypotheses about how a project should achieve impact are made explicit. Multiple and sometimes mutually exclusive pathways leading to a long-term goal may exist. The TCIP approach helps to navigate along and between different impact pathways.

[62] The term is borrowed from "Ison, R. 2010. Systems Practice: How to Act in a Climate-Change World. Springer, London

Typically, developing a TCIP is a participatory process, in which stakeholders first jointly analyse a specific situation. Based on this analysis, they co-design R&I and capacity building agendas and define impact pathways including expected outputs, outcomes and impact goals. Alongside, indicators for a long-term M&E process are specified. This process elucidates underlying assumptions and generates a common understanding on how impact may be achieved through the implementation of a certain intervention.

As R&I activities typically face uncertainties, successful innovation processes also require flexibility. The reflection on the TCIP helps stakeholders to take action when a change to the direction of implementing activities is needed, as to still achieve the desired impact. The approach likewise supports funders to make more effective and needs-based funding decisions. By decomposing and jointly reflecting on the logic of an intervention, the approach helps to strategize and harmonize different agendas. Therefore, the application of the TCIP approach supports collaboration management on project-, programme-, and intercontinental partnership-level and facilitates M&E processes. This fosters reflexivity and learning, while better utilizing resources and synergies.

In the case of the two programmes LEAP-Agri and AUG, nine groups of stakeholders have been identified. In the online questionnaire each funded project coordinator was asked to rate on a scale from 1 to 4 (1 very low, 4 very high) the level at which different stakeholder groups could be impacted by the project results (Figure 25). Considering the theory of change, this shows that all major actor-groups involved along the value chain and food systems should be equally impacted by the AURG programme and the LEAP-Agri programme. The changes envisioned by the projects fall into three categories:

1. Important changes for small farmers, farmers, local communities and research,
2. Medium changes for policy makers and local government
3. Less change in food processing, food trade and investors.

The high standard deviation in the rating by the 38 projects shows the variety of targeted stakeholders groups following the projects. Very few projects are targeting a large number of different stakeholders in a holistic approach across the value chain.

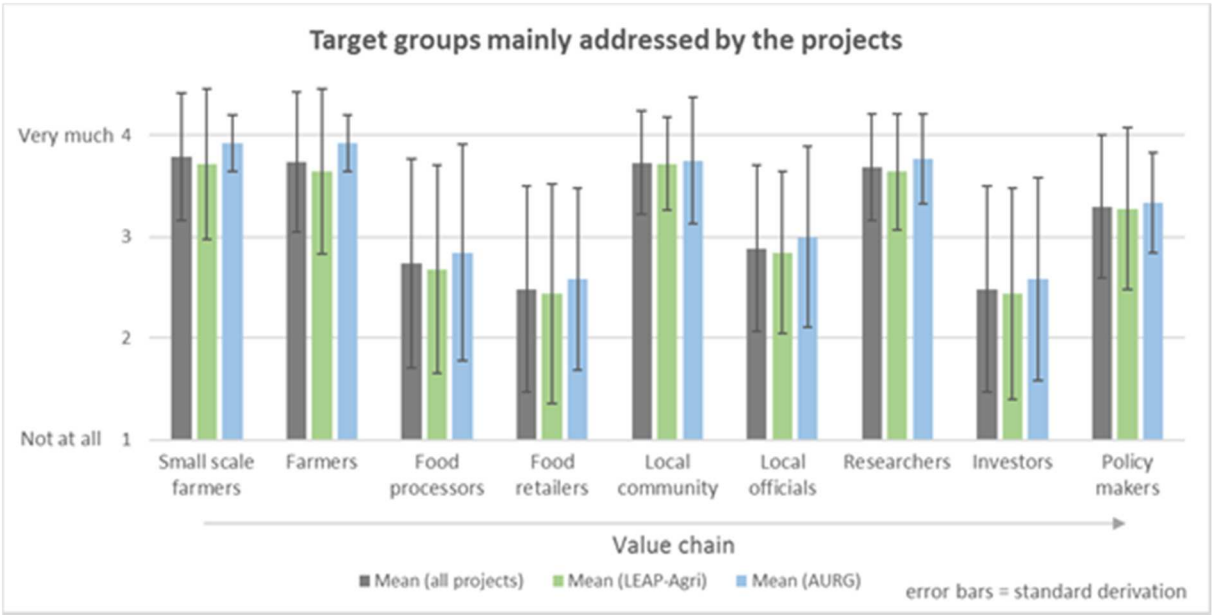

Figure 24: Importance of change according to stakeholders groups

5.3 The Programme and Innovation Management Cycle (PIMC) - A Systematic Model of an Overarching Coordination Processes

The Programme and Innovation Management Cycle (PIMC) is a strategic and systematic model that describes how efficient investments into R&I, capacity building and continuous learning at different levels and scales can be fostered. By highlighting the importance of linking different processes, which are necessary for network building, agenda setting, effective research uptake towards innovations and the institutionalisation of learning, the PIMC provides orientation within complex collaboration contexts, such as in the case of the EU-AU R&I Partnership on FNSSA. It helps to initiate and maintain a coherent an inclusive network of partners in R&I and capacity building. The PIMC provides a reference point for different activities and actor arrangements within multiple learning cycles. However, the model only partly provides suggestions about the particular actor group(s) and/or organizational structures for implementing the different phases. The agreement on the respective governance remains upon the particular setting. In the case of establishing the EU-AU R&I Partnership on FNSSA, participation of representatives from both continents in all stages is a prerequisite for success.

The PIMC is an inclusive and a circular model (Figure 25), which is flexible in its thematic focus, in the inclusion of interested stakeholders and the modes of organization for different activities and functions. It builds on a simple management principle: Plan-Do-Check-Act. In the following text, the different functions and activities needed for the systematic overarching and long-term coordination process to evolve are described, while specific strategies of operationalizing these are not provided. In general, several PIMCs could be initiated and implemented in parallel, e.g. in different regions, on different political levels or on different thematic fields. In each case, the PIMC creates the anchor for long-term learning and investment into R&I and capacity building collaboration and ensures that relevant information for stakeholders' decision-making will be provided throughout the entire process. It is estimated that one cooperation cycle of a PIMC may take between 9 and 14 years. Cycles will then continue and follow each other.

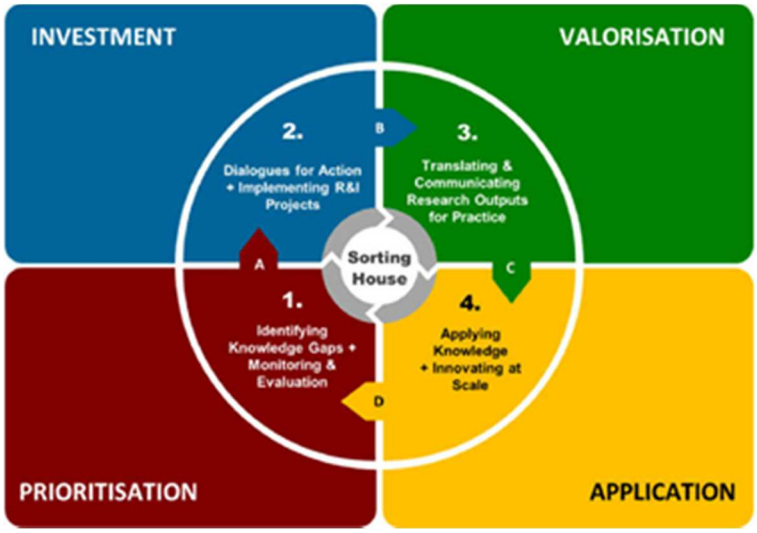

Figure 25: The stylised PIMC model with its four phases

Phase 1: Prioritisation: Identifying Knowledge Gaps and Monitoring & Evaluation – The Sorting House Mechanism

In the initial phase 1. **Prioritisation**, a particular problematic situation or system of interest together with already available knowledge is assessed. While developing a General-TCIP for a PIMC, the envisioned goals and desired impacts from collaborative R&I and capacity building interventions are

defined. This phase relates also to clarifying the purpose of engaging in the process of transforming parts of a system or problem-situation, such as improving food systems in a given local region or from a global perspective. It needs clarification of how different parts should interconnect to achieve desirable outcomes and functioning systems. Moreover, as R&I and capacity building collaborations do not emerge from a vacuum but relate to a legacy of networks, programmes and projects, future activities need to build on the lessons learned from these.

During phase 1. **Prioritisation**, guided by the Sorting House Mechanism, a group of experts with diverse backgrounds, skills and knowledge will make sure that relevant knowledge is pooled and evaluated in light of the identified problematic area and the envisioned collaboration goals. According to a specific situation in which a PIMC will be applied, for example in the context of an EU-Africa R&I Partnership on FNSSA, experts from the AU and the EU will jointly identify knowledge gaps in light of African and European societal systems, development strategies and collaboration needs. Hence, facilitated through the Sorting House Mechanism, the General-TCIP will be developed.

The elaboration of the General-TCIP sets out with an analysis of the current state, the identification of constraints and research investment opportunities as well as the definition of R&I and capacity building agendas, generating shared benefits for Africa and Europe. Thereafter, the assumed impact pathways comprising expected outputs, outcomes and impacts of the envisaged activities are explicated and an M&E concept is developed. Generally, this TCIP should be designed in a way that it enables the provision of diverse research portfolios while capturing local demands.

The Sorting House Mechanism

To make sure that a solid knowledge base for collaboration and effective R&I investments is established, the Sorting House Mechanism is suggested. In general, the Sorting House Mechanism facilitates the collection, analysis, integration and 'translation' of various research outputs and scientific advice that has been generated through different research projects to be utilized in the different fields of practice. It is an ongoing supporting process to ensure the inclusion of relevant knowledge into the activities of the whole PIMC. However, within the entire PIMC its contributions are most critical during phase 1. **Prioritisation** and phase 3. **Valorisation**. The mechanism supports knowledge exchange and integration between research, practice and policy-making. It ensures awareness of designing inclusive processes, which may build on existing methods. It also points out to integrate the specific needs of particular target groups in the approaches from the beginning and to make sure that the knowledge produced is relevant for their situation. However, the formal and organizational form of the Sorting House needs to be elaborated within the specific context. For example, it may be institutionalized as a scientific or a multi-stakeholder advisory board to a permanent group of funders, established as a standing committee to high-level policy-makers or it could be an independent AU-EU organization.

The General-TCIP needs to include a concept for mobilizing and securing funding for the envisioned R&I activities and serves the following dialogues in phase 2. INVESTMENT. Depending on the institutional type of the Sorting House, the latter is particularly critical if potential funders have not been already involved in this General-TCIP development in phase 1. PRIORITISATION. The Sorting House is crucial to bridge the gap between R&I stakeholders, including researchers, innovators, farmers, consumers, entrepreneurs and decision-makers and to ensure bi-directional information flow, i.e. research outputs are available to policymaking and vice versa, R&I and capacity building agendas are legitimised and reflect emerging policy needs. Therefore, General-TCIP development is ideally done already together with decision-makers and funders or within a formalized process of interaction between actors from the Sorting House and legitimized funding agencies.

Phase 2: Investment: Dialogues for Action and Implementation of R&I and Capacity Building Projects

In this phase, the envisioned activities according to the previously elaborated General-TCIP have to be defined in detail and implemented. This may start by mobilizing a network of decision-makers, funding agencies, researchers and innovators as well as representatives from the target groups to engage in dialogues towards programming and implementing mutually designed and funded R&I and capacity building projects, which eventually feed into the overarching suggested General-TCIP from phase 1. Prioritisation. Mobilization aims at creating new funding networks, e.g. a Funder-Alliance or in case of a succeeding PIMC-cycle, at reassuring effective collaborative action among partners of already established funding networks. The goal of these dialogues is to motivate funders to take up and contribute towards realizing the impact pathways that were developed through the Sorting House Mechanism in the previous phase 1. Prioritisation.

In this phase of 2. **Investment**, modes for investment of resources, in-kind and cash, have to be negotiated among the funding institutions. In addition, guidelines for collaboration have to be defined or re-emphasized from previous cooperation. The particular funder networks may themselves establish a Sub- TCIP, i.e. Sub-TCIP of a particular Funder-Alliance/ funder network, of how they assume their particular engagement and investment will lead to desired outcomes and contribute to the envisioned impacts and the General-TCIP that was developed during phase 1. PRIORITISATION. The specific funder network and the R&I projects need to be managed and reflected in light of the established General-TCIP and the Sub-TCIP.

Within this phase of the PIMC, calls for research will jointly be designed and selected R&I projects implemented. Funds need ideally be provided that support practice-oriented and transdisciplinary research approaches. Researches will also be required to develop individual Project-TCIPs[63] These also have to include communication strategies of their scientific outputs to motivate changes in next-level and the intended end-users. Capacity building activities may also be considered already in the R&I projects. Ideally, these R&I Project-TCIPs will align with the General-TCIP that was defined during prioritisation as well as with the Sub-TCIP of a particular funder network. The implemented research will generate various outputs, including scientific publications and knowledge, different products for capacity development and research-based policy recommendations for improvements of the problematic area.

Phase 3. Valorisation: Translating and Communicating Diverse Research Outputs for Practice – The Sorting House Mechanism

The R&I and capacity building projects implemented during the previous phase 2. Investment produced various outputs, for example specific manuals or successful approaches to communicate generated knowledge with multiple end-users. These different research outputs and lessons on related outcomes have to be collected, jointly assessed and integrated with other relevant knowledge. This is important to enable cross-fertilization of outputs and outcomes between various projects and to track achieving desired impact.

This joint assessment is facilitated by the reference to the General-TCIP, which is above the level of individual project TCIPs, from the phase 1. **Prioritisation** and, if applicable, in light of the Sub-TCIP of a particular funder network. This assessment is supported by stakeholders form the Sorting House. These may be the same group of actors from phase 1. **Prioritisation**. They may map and cluster R&I projects and their Project-TCIPs to establish best practices and create linkages between projects.

[63] In this scenario three levels of TCIP may exist: an overarching meta-level General-TCIP established by the Sorting House during phase 1. **Prioritisation**, the Sub-TCIP of a particular Funders-Alliance, and the Project-TCIP for individual research projects

The research outputs generated through multiple funding networks will be evaluated with regard to the General-TCIP as well as towards their contribution to the SDGs as well as other emerging policy shaping agendas and issues. The Sorting House ensures that evidence-based research outputs and the outcomes generated within the context of a specific project can likewise enable desired changes in a different context and/or at higher policy-levels. Relevant knowledge products are pooled from different sources and tailored to the needs of particular target groups. Research results are reformatted, translated and summarised in ways that facilitate their use by multiple actors from practice, innovation, policy, development and upscaling.

The Sorting House Mechanism is designed for cross-fertilization of outputs and outcomes, amplifying the dissemination of knowledge and facilitating the communication between end-users such as entrepreneurs of different scales, researchers and policy-makers. The Sorting House Mechanism is not promoting a top-down dissemination process of research results by only a few experts from the Sorting House.

Phase 4. Application: Systems Improvement through Innovations at Scale

After the research outputs have been gathered, compared, cross-analysed and possibly also reformatted, the generated knowledge needs to be applied in practice and research-based recommendations implemented at scale. This will generate outcomes and impact of a larger magnitude as compared to those obtained by the many individual R&I projects. To achieve this goal, a viable link between actors and activities during phase 3. **Valorisation** and actors from implementation needs to be maintained. Based on the research and innovation outputs produced and the outcomes generated, new entrepreneurial activities along the value chains can effectively be supported, for instance through new market mechanisms or new public policies, contributing to systemic change and development. Again, these processes need to be accompanied by actors from the Sorting House with the purpose of M&E and following up on the logic of the initially established General-TCIP during 1. PRIORITISATION of the first cycle of the PIMC. The achievements in terms of improving the problematic situation as identified in the beginning need to be documented and arising knowledge gaps identified. An impact analysis as an element of the M&E concept of the General-TCIP may facilitate this identification. This latter activity bridges to a new cycle of the PIMC in order to fill the identified gaps and to foster learning and development.

Restarting and maintaining PIMC

After some years and the utilisation of research outputs in practice, the group of experts in the Sorting House reflects on the experiences made within the PIMC and the lessons from the M&E activities to close the first PIMC. In consultation with the funder network(s), the lessons learned during the first PIMC will be summarised and analysed and fed back into policy and investment decision-making. The result of this reflection process will be formulated in a subsequent new General-TCIP for another PIMC to begin.

An evolving sequence of PIMCs creates a long-term Knowledge Management and Communication Framework (KMCF). Thereby, various activities, methods and technologies related to the collection and the exchange of knowledge on a particular problematic issue or system will systematically be build up. It frames the maintenance of existing and newly created databases, science based advisory systems and institutionalized partner dialogues. Supported by the Sorting House Mechanism, which ensures integration of knowledge and lessons learned not only from the research conducted within the PIMC but also from other scientific sources and innovation initiatives, a truly relevant knowledge framework can be created. In turn, this will reduce the repetition of activities and inefficient spending of funds.

Gained knowledge and experiences are systematically handed-over and linked to actors for up-scaling. It fosters long-term institutionalized learning and impact-oriented steering of allocating resources.

Institutionalizing the PIMC model as a concerted set of practice and reference to actions, it will help i) to institutionalize learning and communication within a multi-sectoral network of partners, ii) to implement commonly agreed long-term collaboration methods and tools and iii) to expand and maintain funder networks. The PIMC, including the TCIP approach may serve as a strategic and systematic implementation model for different EU-AU HLPD thematic roadmaps as well as their improvement, such as the "Roadmap towards a jointly funded EU-AU Research & Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture".

The PIMC model promotes more coordinated and needs-oriented multilateral investments of resources for R&I and capacity building, and likewise frames the exchange and the use of knowledge on different societal levels. It encourages feedback mechanisms and conceptualises the processes needed to account for the results and experiences of previous interventions to avoid replication, increase linkages between existing initiatives and to encourage the adoption of results. The model emphasises communication and exchange between different stakeholders from research, policy, implementation and innovation about the valorisation and application of research outputs. It facilitates making local research and capacity building activities in different contexts more visible to societal and public actors.

6 CONSOLIDATING THE NETWORK AND BUILDING A VISION FOR FUTURE COLLABORATION

6.1 Institutionalising the PIMC Model

The PIMC model emphasizes knowledge management and the model explains how generated outputs from research and experiences made of R&I and capacity building collaborations should systematically be linked, so that R&I investments can effectively build on each other. Particularly the Sorting House Mechanism and the processes of knowledge management and communication implied by it are crucial for learning and maintaining viable linkages for innovation systems to function. By funders committing to the proposed processes, i.e. investing into R&I and capacity building based on the suggestions and activities of the Sorting House Mechanism, a long-term funder network may implicitly be created.

The PIMC model as such does not shed light on its concrete operationalization and on the possibilities to sustain long-term collaboration of a particular funder network, e.g. funding agencies and research institutions already involved in AU-EU projects. The PIMC model lacks explanations of the details of the mechanisms to secure long-term funding of PIMC processes for the KMCF to be established. To overcome this problem, a more formal commitment to sustain the PIMC cycles and to secure funding of R&I projects might be required. The ways of institutionalizing the PIMC model within a more formal funder network, partnership or alliance need to be elaborated successively by interested stakeholders. Further elaborating and jointly developing the PIMC approach is vital, for example in the domain of FNSSA. The AU-EU HLPD on STI with its Senior Officials Meetings (SOM) and the HLPD Bureau could be the appropriate platform for discussing the relevance of the PIMC model and eventually broadly adopting and implementing it, since all member states of the AU and the EU are involved here. Successful institutionalization involves joint learning by the institutions involved in AU-EU R&I collaborations on the added value of the PIMC in comparison to other R&I programming approaches already implemented.

6.2 Improving partnerships in AU-EU R&I activities

Partnerships should be based on trust, collaboration and mutual interest. The changes in the landscape of AU-EU cooperation in R&I must tend towards supporting more balanced partnerships and co-

financing (academic and private). The creation of just thematic collaborative networks and bridge the scientific gap on a global scale, which will directly impact capacity building for low-income and middle-income economies.

Collaborations must also be designed taking into account the regional dimension on the scale of Africa; by integrating priorities that may be different between West Africa and Southern Africa for example. Taking this regional diversity into account should make it possible to strengthen south-south and north-south cooperation around joint projects and give more funding opportunities, in particular through the National Research Councils.

The keys to effective cooperation between donors and researchers are a joint definition of priority areas and expected improvements as well as transparent administrative procedures and open communication. This can result in the identification of real needs, validating existing potential solutions, mobilizing forces, and filling important gaps. This rational approach will allow a classification of the actions to be carried out according to the state of advancement of the individual fields (e.g. market gardening, livestock farming, food security, etc.), the geographical areas and resources that can be mobilized. General conditions of use of European grants for external actions should be adapted/simplified to ease the management process of STI projects. This can allow for greater flexibility and adaptation in order to adjust research activities according to local needs and capacities.

The open-ended questions in the online questionnaire and the interviews show the need for research capacity building in Africa. Research institutes/researchers should be supported by their governments and that these governments should commit to the long-term project by providing funding. Additional budgets have to be allocated for cooperation activities and the human and material means be made available to project managers for smooth running of the work. Transparent management of project funds must be ensured.

An accent needs to be put on capacity building and institutional support by organizing general skills improvement training events such as project management, finance reporting and project partnerships.

Project coordinators feel the need to improve and institutionalize interactions between research teams and funding agencies by maintaining active communication to identify potential problems such as those on finance, compliance and reporting. There is a need for a planned reporting/interaction schedule between the funders and the researchers, instead of unscheduled ad-hoc interactions. The domiciliation of projects must be in close collaboration with the funders. Following points have been proposed by the coordinators:

- Stakeholder meetings attended by government officials should be stimulated.
- Flexibility in using funds and release of additional funds during project progress.
- Funders to participate in project annual meetings to bring accountability as well as identify the gaps and shortcomings.
- Transparency: Funders should be on what they want to be done and how. They should be forthright with information.
- Having a joint and equal funding procedure for all partners instead of administration by multiple, national funding agencies.
- Regular meetings between the researchers and funders for updates and consideration for more funding opportunities as regard to new research areas from the initiated projects.
- Most of the projects that are being funded to address FNSSA problems have a short time frame ~ 3 years. With this time frame, some projects may close without reaching their targeted outputs. There is therefore need for the funders to work out a mechanism to continue funding some projects for the medium to long term. This will ensure that valuable project outputs are not missed due to the short term design of the projects.

- The need for the funders to help projects in direct procurement of certain items as long as value for money as respected. This will in turn reduce the length of the procurement process and ultimately delivery of timely project outputs.
- The funding arrangement should be flexible enough to allow the researchers to address important any unforeseen and unplanned issues that almost always arise in the implementation of multi-institutional and cross-border of-course without deviating too much from the project goals and objectives.

6.3 Supporting innovation processes, up taking research outputs to scale, impacting the communities

There is a need to effectively translate research outputs into tangible outcomes useful to society. To this end, project coordinators recommend a one-stop centre (e.g. website) for Q and A to guide researchers as well as funding agencies to respond to their challenges; and to update on available funds to allow commercialization of the innovations or outputs. They would also like more follow-up between projects, and allow the option to extend the current projects to new countries and to perform more research based on the results obtained from the first partnership program. The pooling of research questions, research infrastructures, talents, funders, in the North and South, must aim to avoid the dispersion of public funds so that they really benefit research projects.

Translation of research results into market products or services should be promoted so that these results benefit populations and businesses and are capable of impacting African and European economies. It should be also possible to consider upscaling of the developed technologies from grantees to other countries and wider adoptions.

In the design phase of projects, giving more space to farmers and to other stakeholders in the design of the research should lead mainly in identifying the problem to be solved. During the project implementation, taking into account the set-up conditions for the sustainability of the application of the results and more tangible outputs may attract the private sector.

Finally, dissemination of knowledge should be implemented by organizing annual grantee meetings for lesson learning and sharing of knowledge and cooperation; establishing adequate pathways to pass information on requirement with a transparent and prompt information flow.

7 CONCLUSION

Global food and nutrition security is key to sustainable development. Embedded in the Joint Africa-EU Strategy (JAES), the AU-EU High Level Policy Dialogue (HLPD) on Science, Technology and Innovation frames intensified cooperation between Africa and Europe on common priorities for joint research and innovation in the field of food and nutrition security and sustainable agriculture (FNSSA). In 2016, the HLPD Senior Officials Meeting adopted a Roadmap supporting the EU-Africa R&I Partnership on FNSSA, which is structured around four main pillars: (i) Sustainable intensification, (ii) Agriculture and food systems for nutrition, (iii) Expansion and improvement of agricultural markets and trade and (iv) Cross-cutting issues. In the same year, the LEAP-Agri ERANet CoFund project was launched to support the development of the AU-EU R&I Partnership on FNSSA. Besides jointly funding R&I projects on FNSSA, LEAP-Agri also aims to provide inputs to the development of a medium to long-term joint research and innovation agenda on FNSSA grounding the long-term AU-EU Partnership on FNSSA.

This deliverable provides important insights into the current situation of R&I collaborations and the multiple existing challenges. These need to be addressed when advancing the joint medium to long-term research and innovation agenda on FNSSA. Besides this agenda framing research priorities, a

partnership mechanism is likewise required to effectively facilitate implementation of collaborative research and guide AU-EU cooperation initiatives. The current COVID-19 pandemic profoundly illustrates how different systems are closely interrelated. In turn, highlighting the need to create an enabling policy environment that ensures future AU-EU FNSSA research can address joint challenges in a systemic way, including aspects of health, climate change, energy use and gender equality to contribute to sustainable and resilient transformation of food systems feeding into global development.

This deliverable shows how current research partnerships between the two continents are still unbalanced with regard to both countries and actor groups. Hence, conditions need to be created that allow for research collaborations to become more diverse and coordinated. Emphasis needs to be put on identifying and reducing barriers for participation. Respective capacities need to be created and innovation processes be fostered, for example by strengthening African scientific and institutional capacities.

Sustainable transformations need co-development and inclusive innovation processes. Hence, attention needs to be paid to both, including vulnerable actor groups as well as particularly encouraging the participation of private sector actors. In turn, frameworks for funding need to facilitate research collaborations addressing relevant challenges and producing practice-oriented results.

Our inputs for the development of a joint medium to long-term AU-EU R&I agenda shall provide guidance on R&I initiatives in the field of FNSSA. On principle, the topics covered by international collaboration need to be more systematically linked with the SDGs while being coherent with national, European and Pan-African development agendas. However, flexibility is required to continuously evaluate the priorities and mutual benefits of bi-regional research partnerships for FNSSA.

The implementation of LEAP-Agri and the feedback gathered from the research projects highlights the limits of the ERANet co-funding instrument and the need to go beyond this way of doing things together. Alternative instruments of funding need to be supported based on the experiences gained and best practices. Further investigations will be made in the frame of the coming Deliverable 6.2 of this Work package 6. Future funding instruments need to be coherent with a long-term vision and be made more conducive to ensure equal participation of countries and institutions. Therefore, funding agencies and research programming actors need to be mobilized to create formal structures that ensure long-term and reliable funding to food systems' transforming research collaborations.

To reach the goal of better coordination and to overcome fragmentation of the FNSSA research landscape, an open partnership platform needs to be created. The Platform needs to be open to the entire research innovation chain. The different initiatives on FNSSA need to be tied together and activities embedded in the HLPD policy process. Such a long-term knowledge management, communication and governance mechanism has been under development in the frame of LEAP4FNSSA. An opened and shared data repository including information on funding initiatives along with better ways to measure output and impact need to be established within the frame of the platform. The PIMC is proposed to be adopted by the HLPD as a tool for the design of a long-term sustainable platform for the FNSSA partnership. To improve partnerships, HLPD could further promote the Research Fairness Initiative (RFI) as an instrument for systematically improving research cooperation involving collaborators from developing and advanced countries.

Appendix I: List of figures

Appendix II: List of Tables

Appendix III: List of acronyms

ACP group of states: African, Caribbean and Pacific group of states
AIDS: Acquired Immune Deficiency Syndrome
AKIS: Agricultural Knowledge and Innovation Systems
AMCOST: African Ministerial Council on Science and Technology
ANR: Agence Nationale de la Recherche
ASARECA: Association for Strengthening Agricultural Research in Eastern and Central Africa
AU: African Union
AUC: African Union Commission
AUHCRST: African Union High Commissioner for Human Resources for Science and Technology
AURG: African Union Research Grant
CAADP: Comprehensive Africa Agriculture Development Programme
CAAST-Net Plus: Advancing SSA-EU cooperation in research and innovation for global challenges
CCARDESA: Centre for Coordination of Agricultural Research and Development for Southern Africa
CGIAR: Consultative Group on International Agricultural Research
CIRAD: Centre de coopération Internationale en Recherche Agricole pour le Développement
COHRED: Council On Health Research for Development
COVID-19: Coronavirus disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), December 2019
CSA: Coordination and Support Action
EC: European Commission
EU: European Union
FAFS: Framework programme for Food Security in Africa
FNSSA: Food and Nutrition Security and Sustainable Agriculture
FAO: Food and Agriculture Organization of the United Nations
FARA: Forum for Agricultural Research in Africa
GSDR: Global Sustainable Development Report
HIV: Human Immunodeficiency Virus
HLPD: High-Level Policy Dialogue
HLPE: High-Level Panel of Experts
IARC: International Agency for Research on Cancer
IRD: Institut de Recherche pour le Développement
IRP: Independent Review Panel
JAES: Joint AU-EU Strategy
KCMSI: Knowledge Management and Communication System Initiative
KMCF: Knowledge Management and Communication Framework
LEAP-Agri: A Long-term EU-Africa research and innovation Partnership on food and nutrition security and sustainable Agricultre
LEAP4FNSSA: Long-term EU-AU research and innovation Partnership for Food and Nutrition Security and Sustainable Agriculture
M&E: Monitoring and Evaluation
NARES: National Agriculture Research and Education Systems
NEPAD: New Partnership for Africa's Development agency
NGOs: Non-Governmental Organizations
PIDA: Programme for Infrastructure Development in Africa
PIMC: Programme and Innovation Management Cycle
RECs: Regional Economic Communities
RFI: Research Fairness Initiative
RINEA: Research and Innovation Network for Europe and Africa
R&I: Research and Innovation
SDGs: Sustainable Development Goals
SMEs: Small and Medium Enterprises
SROs: Agriculture Sub-Regional Organisations
STC: Specialised Technical Committees
STI: Science, Technology and Innovation
STISA: Science, Technology and Innovation Strategy for Africa
S3A: Science Agenda for Agriculture in Africa
TCIP: Theories of Change and impact Pathway
TRLs: Technology Readiness Levels
UN: United Nations
WECARD: West and central african Council for Agricultural Research and Development
WFP: World Food Programme
WHO: World Health Organization
WoS: Web of Science
WP: Work Package

Appendix IV: List of LEAP-Agri and AURG funded projects

Project number (LEAP-Agri)	Project acronym	Research and Innovation foci			Coordinator	Involved countries									
		SI	AFSN	EIMT		1	2	3	4	5	6	7	8	9	10
57	WAGRINNOVA	x			Gomez-MacPherson H.	Burkina Faso	Ghana	Netherlands	Senegal	Spain					
65	MUSBCEA Project	x			Erume J.	Germany	Kenya	Spain	Uganda						
77	PASUSI	x			Sumelius J.	Finland	Ghana	Norway	Uganda						
99	Pest-free fruit	x			Brevault T.	Belgium	Finland	France	Kenya	Senegal					
114	EaTSANE		x		Cadisch G.	Germany	Kenya	Netherlands	Uganda						
127	SPEAR	x	x	x	Ottaviani Aalmo G.	Ghana	Kenya	Norway	Senegal	Spain					
146	Project AFRICA	x	x		Hessel V.	Ghana	Netherlands	Portugal	South Africa	Uganda					
159	STEP-UP	x	x		Sieber S.	Germany	Kenya	Netherlands	Uganda						
168	VITAPALM	x	x		Arondel V.	Cameroon	France	Germany	Ghana						
208	AFRICA-MILK	x			Vall E.	Burkina Faso	France	Kenya	Madagascar	Netherlands	Senegal				
215	RAMSESII	x			Seghieri J.	Burkina Faso	France	Netherlands	Senegal						
220	MeTVAC	x	x		Karagenc T.	Algeria	Egypt	Portugal	Turkey	UK					
222	LEARN	x			Kortekaas J.	Cameroon	Germany	Netherlands	South Africa						
229	CLISMABAN	x			Gheysen G.	Belgium	Kenya	Spain	Uganda						
259	NOURICITY		x	x	von Braun J.	Ghana	South Africa	Uganda							
271	UniCARSSA	x	x		Otinga A.	Kenya	Netherlands	Portugal	Uganda						
273	SERVInnov	x	x		Mathe S.	Burkina Faso	Cameroon	France	Germany	Madagascar					
281	Food4Cities	x	x	x	Verburg P.	Belgium	Netherlands	South Africa	Uganda						
282	SmallFishFood	x	x	x	Kolding J.	Germany	Ghana	Kenya	Netherlands	Norway	Uganda				
288	CASSANDRA	x	x		Vanderschuren H.	Belgium	France	Kenya	South Africa						
326	OPTIBOV	x			Croojmans R.	Egypt	Finland	Netherlands	Portugal	South Africa	Uganda				
345	MuHVA	x			Vachiery N.	Benin	Burkina Faso	France	Niger	Portugal	South Africa				
350	ATMA4FS			x	Brümmer B.	Belgium	Germany	Ghana	Netherlands	Senegal	South Africa				
360	Ento-Economy		x		Kinyuru J.	Belgium	Germany	Kenya	Uganda						
400	NUTRIFOODS		x		Byaruhanga Y.	Finland	Kenya	Netherlands	South Africa	Uganda					
465	SESASA	x			Fürst C.	Burkina Faso	France	Germany	Ghana						
483	MycoSafe-South		x		Croubels S.	Austria	Belgium	Ethiopia	Kenya	Norway	South Africa				

LEAP-Agri Projects

Year	Project acronym	Research and Innovation foci			Coordinator	Involved countries									
		SI	AFSN	EIMT		1	2	3	4	5	6	7	8	9	10
2016	EcoRodMan	x			Massawe A.	Tanzania	UK	South Africa	Ethiopia	Uganda	Belgium				
	DualCassava		x		Maruthi M. N. G.	UK	Tanzania	Tanzania	Malawi						
	SSCALERS				Salack S.										
	EcoAfrica	x			Vololoniaina L.	Madagascar	Madagascar	Madagascar	Madagascar	Mozambique	South Africa	South Africa	France	France	Belgium
	SPMIE		x		Fandika I. R.	Malawi	Zambia	Malawi	Zambia	Malawi	Malawi	Malawi	Malawi	Malawi	Malawi
	ICPICS (BIORI)	x			Chemuliti J.	Kenya	Kenya	Somaliland	Kenya	Kenya	Somaliland				
	ASF-RESIST		x		Masembe C.	Uganda	Nigeria	UK	Kenya	Sweden	Uganda	Nigeria			
	WACCI Project	x			Yirenkyi Danquah E.	Ghana	Burkina Faso	Nigeria							
	Forest Treasures		x		Madureira M.	Portugal	S. Tomé e Principe	S. Tomé e Principe	Angola	Angola					
2018	Mung4-Fe		x		Mbeyagala K. E.	Uganda	Kenya	Tanzania	Tanzania						
	AU-*Tuta* IPM		x		Khamis F.	Kenya	Kenya	Tanzania	Uganda	Kenya					
	SafeFish		x		Nakavuma J.	Uganda	Ghana	Ghana	Ghana	Ghana	UK	Uganda			
	IITA	x			Liavoga A.	Nigeria	Cameroon	Gabon							
	BIOFORTIFIED BEAN	x	x		Paparu P.	Uganda	Uganda	Rwanda	Italy						
	MAB - Chicken		x		Dos Anjos F.	Mozambique	Uganda	Uganda	Uganda	Mozambique	Mozambique	Uganda			
	MACOWECA				Zoro Bi I. A.										
	IOFSP				Moumouni Moussa I.										
	OR4FOOD		x		Médoc J-M.	France	Senegal	Senegal	Senegal	Ethiopia	France				
	AFLADESA		x		Mutiti Mweetwa A.	Zambia	Ethiopia	Uganda	Uganda						

AURG Projec

SI	**Sustainable Intensification**
AFSN	**Agriculture for Food Systems and Nutrition**
EMT	**Expansion of Markets and Trade**