Eradicating Hunger and Achieving Food and Nutrition Security in Africa

RUFORUM Implementation Plan for Priority One of the Science, Technology and Innovation Strategy for Africa (STISA- 2024)

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FOREWORD

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Since its inception in 2004, the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM, see www.ruforum.org) has steadily grown to become an important player in Agricultural and Higher Education landscape in Africa. Created by Vice Chancellors of 10 universities in Eastern and Southern Africa, RUFORUM has expanded its membership to now 55 universities in 22 countries in Africa. A core function of RUFORUM is to foster integration of African Universities in national innovation process to support Africa's development. A key component of this effort is working collaboratively amongst the member universities and with other actors in and outside Africa to ensure Africa has the required human and institutional capacity to drive Africa's development agenda, especially of ensuring Food and Nutrition security.

In recognition of RUFORUM's role to mobilise African Universities to support Africa's development agenda, especially the Comprehensive African Agricultural Development Programme (CAADP), the African Union Commission in July 2014 mandated RUFORUM to lead the development of Implementation Plan for the Science, Technology and Innovation Strategy (STISA-2024) Priority One on Eradication of Hunger and Attainment of Food and Nutrition Security in Africa. Subsequently, RUFORUM conducted a series of consultative meetings with various stakeholders to derive this RUFORUM Implementation Plan for STISA Priority One. The Plan presents an analysis of the essential role of STI in transforming African agriculture. This transformation is a central component for reaching the desired outcomes in 2024. To make Africa hunger free, and food and nutrition secure, the Plan provides a practical and effective roadmap to achieving the Africa Accelerated Agriculture Growth and Transformation (3AGT) goals for shared prosperity and improved livelihoods. It also provides a blue print concerning STI contribution towards 3AGT and Africa's transition to an innovation-led, knowledge-based economy. Given the interdependence of various agriculture, and food and nutrition security stakeholders in the implementation of this Plan, RUFORUM pleads for full ownership, responsibility, and accountability to the African people by concerned parties in order to wipe out hunger and food and food insecurity from the face of mother Africa for ever.

ACRONYMS AND ABBREVIATIONS

3AGT	Africa's Accelerated Agricultural Growth and Transformation
AAAST	African Academy of Agricultural Science and Technology
AAIS	Africa Agricultural Innovation System
AAIN	Africa Agribusiness Incubator Network
AAS	African Academy of Sciences
AAU	Association of African Universities
ACE	African Centres of Excellence
ACP	Africa, Caribbean and Pacific (Nations)
AESIF	Agricultural Education and Skills Improvement Framework
AET	Agricultural Education and Training
AFAAS	African Forum for Agricultural Advisory Services
AfDB	African Development Bank
AfSDGs	African SDGs
AFTA	Africa Free Trade Area
AGRA	Alliance for a Green Revolution in Africa
AIDA	Accelerated Industrial Development of Africa (Action Plan for)
AHECE	African Higher Education Centres of Excellence
AMCOST	African Ministerial Council on Science and Technology
ANAFE	African Network for Agriculture, Agroforestry and Natural Resources Education
AOSTI	African Observatory for Science Technology and Innovation
ASATI	Africa Science for Agricultural Transformation Initiative
ASRIC	African Scientific, Research and Innovation Council
ASTI	Agricultural Science and Technology Indicators
ASTII	African Science, Technology and Innovation Indicators
ATPS	African Technology Policy Studies Network
AR&D	Agricultural Research and Development
AR4D	Agricultural Research for Development
ARIs	Advanced Research Institutes
ARIPO	African Regional Intellectual Property Organisation
ASATF	African Science for Agriculture Transformation Fund
AU	African Union
AUC	African Union Commission
°C	Degrees Celicius
CAADP	Comprehensive Africa's Agricultural Development Programme
CAADP-PP	CAADP Partnership Platform
CAP	Common African Position
CARP	Coalition for Africa Rice Production
CGIAR	Consultative Group for International Agricultural Research
CoP	Communities of Practice
CoSHEAR	Common Space for Higher Education and Agricultural Research
CPA	Consolidated Plan of Action (for Science and Technology in Africa)
CSO	Civil Society Organisation
CGIAR	Consultative Group on International Agricultural Research
CHEA	Conference on Higher Education in Agriculture
DFIs	Development Finance Institutions
DREA	Department of Rural Economy and Agriculture (of AUC)
DTAs	Designated Technical Agencies
EDF	European Development Fund

EIS	European Innovation Scoreboard
EU	European Union
FAAP	Framework for African Agricultural Productivity
FAO	Food and Agricultural Organization
FARA:	Forum for Agricultural Research in Africa
GDP	Gross Domestic Product
GDPRD	Global Donor Platform for Rural Development
GFAR	Global Forum for Agricultural Research
GNP	Gross National Product
HDI	Human Development Index
HIEL	Higher Institutes of Education and Learning
HRST	Human Resources, Science and Technology (Dept. of AUC)
IAR4D	Integrated Agricultural Research for Development
IBSE	Inquiry Based Science Education
ICSU-ROA	International Council for Science – Africa Regional Office
ICTs	Information Communication Technologies
IFPRI	International Food Policy Research Institute
IFAD	International Fund for Agricultural Development
IPR	Intellectual Property Rights
IPTA	Innovation Platform for Technology Adoption
IS&P	Implementation Strategy and Plan
IS&R	Implementation Strategy and Roadmap
K4D	Knowledge for Development
LDCs	Least Developed Countries
MDGs	Millennium Development Goals
M&E	Monitoring and Evaluation
NAFSIPs	National Agricultural and Food Security Investment Plans
NAIPs	National Agricultural Investment Plans
NARIs	National Agricultural Research Institutions
NARS	National Agricultural Research System
NASTIS	National Agricultural Science, Technology and Innovation Systems
NEPAD	New Partnership for Africa's Development
NIMES	National Integrated Monitoring and Evaluation System
NPCA	NEPAD Planning and Coordinating Agency
NSA	Non State Actors
NSTIH	NEPAD Science, Technology and Innovation Hub
OECD	Organisation for Economic Cooperation and Development
PAIPO	Pan African Intellectual Property Organisation
PAU	Pan African University
PMPA	Pharmaceutical Manufacturing Plan for Africa
R&D	Research and Development
RAIPs	Regional Agricultural Investment Plans
RASTIS	Regional Agricultural Science, Technology and Innovation Systems
RDI	Research, Development and Innovation
RECs	Regional Economic Communities
ReSAKSS	Regional Strategic Analysis and Knowledge Support System
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
S3A	Science Agenda for Agriculture in Africa
SAAs	Strategic Action Areas
SDGs	Sustainable Development Goals
SETDEV	Science Ethics and Technological Responsibilities in Developing and Emerging Countries (project under the auspices of European VII Framework programme)
SROs	Sub-Regional Agricultural Research Organizations
SSA	Sub-Saharan Africa

S&T	Science and Technology
STEM	Science, Technology, Engineering and Mathematics (Education)
STC	Specialised Technical Committee
STC-ARDWE	STC on Agriculture, Rural Development, Water and Environment
STC-EST	STC on Education, Science and Technology
STI	Science, Technology and Innovations
STISA	Science, Technology and Innovations Strategy for Africa
STISA-P1	STISA Priority One
TEAM	Tertiary Education for Agricultural Mechanism
TFP	Total Factor Productivity
TIMSS	Trends in International Mathematics and Science Study
ToC	Theory of Change
ULP	User Led Process
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UniBRAIN	Universities, Business and Research in Agricultural Innovation
UNICEF	United Nations Children's Fund (originally United Nations International Children's Emergency Fund up to 1953)
WEF	World Economic Forum
YPP	Young Professionals Programme

EXECUTIVE SUMMARY

The RUFORUM implementation plan for STISA-Priority One elaborates the baseline situation and factors either impeding or enabling the use of STI in agriculture as well as the desired future to 2024. It outlines 9 strategic action areas aligned to the 5 strategic objectives of STISA. These in turn are broken down into a set of 36 sub-action areas with implementation milestones for the remaining 3 phases of STISA 2024 implementation. It spells out the specific actions required to develop agricultural STI capabilities and the supporting instruments that are critical for responding to Africa's transformative agenda. The plan is meant to guide making of choices in terms of the required sets of actions to delivering expected results and impact, based on strengthened systemic implementation capacities of various actors. The strategic action areas are:

- SAA 1.1: Set priorities, develop and implement prioritised multidisciplinary flagship programmes supported by efficient management to meet the needs of society within context of the Science Agenda for Agriculture in Africa
- SAA 2.1: Support building, upgrading and/or enhancing quality of agricultural R&D and AET infrastructural assets core for scientific and technological developments to support Africa's agricultural growth and transformation, including access to their use by researchers
- SAA 2.2: Develop and connect human and institutional capacities – enhancing technical and professional competencies, response capacities and capabilities to manage and govern the advancement of STI, integrate and co-create new knowledge to drive Africa's agricultural transformative agenda
- SAA 2.3: Build systems for data collection and analysis, as well as sharing of information on progress towards major goals and implementation of activities
- SAA 3.1: Develop National and Regional innovation and knowledge systems that add value to and ensure optimal returns from investments in STI
- SAA 3.2: Foster value addition, agribusiness and entrepreneurship to address and respond to African socio-economic challenges
- SAA 4.1: Transform and strengthen Africa's agricultural STI environment into an effective innovation system to meet Africa's socio-economic needs
- SAA 5.1: Through effective policy practice provide an enabling policy and institutional environment for the sustainable application and performance of science - integrating STI in strategies, plans and programs at national and regional levels
- SAA 5.2: Establish funds and financing mechanisms that promote national, regional and continental solidarity in agricultural STI.

Implementation of the plan is to be effected through effective coordination mechanisms for both state and non-state actors and stakeholders at the continental, regional and national levels. Countries will provide leadership to garner active participation and contribution of public, private, education and research, societal and funding sector stakeholders to design and implement various flagship programs and initiatives. RECs and designated Technical and Professional Agencies will coordinate with the AUC and NPCA in implementing the broad STI Framework and submitting implementation status reports. RUFORUM will provide catalytic support functions, including advocacy through continental and international platforms, facilitating linkages to continental and regional strategies and plans, and contributing to the strengthening of systemic capacities at national levels and rebuilding the sharing, collaborative and learning capabilities of participating institutions.

1. INTRODUCTION

This is the RUFORUM Implementation Plan for Priority One (Eradication of hunger and achieving food and nutrition security) of the 10-year Science, Technology and Innovation Strategy for Africa (STISA-2024) that was adopted by the African Union (AU) Assembly of Heads of State and Government in June 2014. The implementation of STISA is integral to achieving the AU Agenda 2063, based on the continental aspirations for inclusive growth, sustainable development and social integration, drawing upon the potential of African people, especially women and youth, for its delivery. The Common African Position (CAP) on the post-2015 global development agenda defined in the Sustainable Development Goals (SDGs) clusters Africa's development priorities into six pillars, with a strong emphasis on the importance of science, technology and innovation (STI) through enhancing technological capacities for realising Africa's transformative agenda, building an enabling environment for innovation, increasing support for research and development, and ensuring optimal utilisation of space and geospatial technologies.

The plan elaborates the baseline situation and factors either impeding or enabling the use of STI in agriculture as well as the desired future to 2024. It provides guidance to determine the appropriate sets of actions to translate the Africa Accelerated Agriculture Growth and Transformation (3AGT) goals for shared prosperity and improved livelihoods and charts the action-pathway for positioning STI to contribute towards 3AGT and Africa's transition to an innovation-led, knowledge-based economy (STISA 2024 Mission). More importantly, it articulates the Theory of Change (ToC) and linkages to existing initiatives related to STISA Priority One (STISA-P1); a clear roadmap with timeframe for implementation; and recommendations for linkages with the other five priorities and prerequisite actions of STISA 2024. It spells out the specific actions required to develop agricultural STI capabilities and the supporting instruments that are critical for responding to Africa's transformative agenda. These actions, with buy-in from both State and non-State actors, will help (i) develop the pillars for building national agricultural STI systems (NASTIS) and improving STI readiness in terms of infrastructure, professional and technical competence, and entrepreneurial capacity; (ii) draw upon synergies among the NASTIS actors through setting priorities and implementing specific policies and flagship programmes supported by efficient management, to foster regional agricultural STI systems (RASTIS), and (iii) utilise the NASTIS and RASTIS in delivering on Priority One to address societal needs in a holistic and sustainable way, thus effectively responding to the AU Vision and Agenda 2063.

The RUFORUM plan is meant to guide making of choices in terms of the required sets of actions to delivering expected results and impact, based on strengthened systemic implementation capacity as set out in the Malabo Commitments and CAADP Results Framework. The plan provides a roadmap to stimulate and guide impact on: institutional execution capacity linked to a set of factors including organisation effectiveness and efficiency in resource use, management skills, decision-making system, learning and adapting; enabling policy practice (aligned to implementation), and alliances and partnerships for implementation. The plan also addresses challenges such as: misalignment in organizational strategies and roles; discrepancy between continental commitments and national-level follow-up actions; and lack of clarity and coherence in translation of political vision into action and deliverables.

2. ISSUES IN AFRICA's AGRICULTURE, SCIENCE, TECHNOLOGY AND INNOVATION SYSTEMS

2.1 African Agriculture: Potential and Challenges

The 2014 Africa Progress Report states emphatically that *"to accelerate Africa's transformation, then we have to significantly boost our agriculture and fisheries"*. At the present time, 60 - 70% of the population of Africa is directly involved in agriculture. The African Development Bank (AfDB) estimates that agricultural production generates up to 25% of Africa's GDP; agribusiness (inputs supply, processing, marketing, and retailing) contributes an additional 20%. The agribusiness component (in Africa, south of the Sahara) is expanding rapidly and is projected to be worth over US$1 trillion by 2030, up from US$313 billion in 2010[1].

In terms of natural resources, the continent has considerable potential; the World Bank estimates that Africa has more than 50% of the world's fertile and unused land. Sub-Saharan Africa has some 24% of the world's land with rain-fed crop potential. The continent uses only 2% of its renewable water resources against a global average of 5%. With Africa having both water and land in abundance, the region has the potential to provide sustained response to rising global prices of agricultural commodities due to increasing demand and declining supply. Declining supply has been due largely to factors such as land degradation and water scarcity in many countries, especially in Asia. Despite the contributions of the Green Revolution to Asian agriculture, poverty and malnutrition remain an entrenched problem. The expanding populations of Asia provide a ready market for competitively produced and marketed African agricultural commodities. Within Africa, a growing population and the rapid urbanisation of the continent is expanding local demand for food.

The CAADP, endorsed in July 2003, has had a very significant impact on Africa's agriculture through providing a clear vision for agricultural transformation. Of the 54 countries on the continent, some 40 have signed CAADP Compacts; 13 countries have surpassed the CAADP 10% target investment of their national budgets in agriculture in any single year[2]. Burkina Faso, Ethiopia, Guinea, Malawi, Mali, Niger, and Senegal have surpassed the target in most years. Nigeria's agricultural transformation agenda targets food security and creation of 3.5 million jobs by 2015. Ghana has made a significant dent on poverty by boosting cocoa faming. Malawi undertook a successful seed and fertilizer subsidy program and turned its food deficit into a 1.3 million tonnes surplus within a period of two years. Through increases in agriculture budget from 1.6% in 2008 to 7.7% in 2009, Sierra Leone raised output of rice up to 784,000 tonnes well above the domestic requirement of 550,000 tonnes. The role of STISA-P1 is to build on this foundation to broaden and sustain the gains made under CAADP.

The challenges to enhancing African agriculture are well rehearsed. Productivity in agriculture is well below potential. Food and nutrition insecurity is still an enormous challenge to many countries. Sub-Saharan Africa (SSA) has the highest prevalence of undernourishment, with around one in four people in the region being undernourished. Available evidence shows that in Africa the existing systems of food production are incompatible with the ever-increasing demand for food.

[1] Growing Africa: Unlocking the Potential of Agribusiness, IBRD: Washington DC

[2] Burkina Faso, Burundi, Ethiopia, Ghana, Guinea, Madagascar, Malawi, Mali, Niger, Republic of Congo, Senegal, Zambia, and Zimbabwe

Climate change is a major threat to agriculture in Africa, altering temperatures, affecting rain patterns, and reducing household and farmers' access to water. Recent predictions by the World Bank indicate that with a 2°C increase in temperature, all crop yields across sub-Saharan Africa will decrease by 10% by the 2050s. Higher increases in temperature could cause crop yields to decrease by 15% to 20% and present-day cropping areas for maize, millet and sorghum will become unsuitable for these crops. The Sahel region from Senegal to Chad and the Horn of Africa, particularly Djibouti, Ethiopia, Kenya and Somalia, have all been severely affected. Changed rainfall patterns could profoundly damage the 95% of Africa's agriculture that is rain-fed. On a broader scale, climate change is destroying biodiversity and ecosystems on which agriculture depends.

Government has a critical strategic role in the early stage of development especially in remote areas because it is unlikely that private traders will deliver research, extension and credit services to smallholders, especially to those in remote areas. The public sector role is to create an enabling environment for business development which includes providing macro-economic stability, investment-friendly policies and infrastructure development. One of the major obstacles faced by the poor in the developing world is lack of access to information and to financial services. The widespread growth of mobile phone use, spurred by low cost handsets and competitive service provision, has opened new options to the rural poor. They can explore commodity and input prices easily. New services, such as the mobile money transfer system, allow simple, reliable, and cheap payments to be made by those previously excluded from the banking system. M-PESA, for example, launched in 2007 by Safaricom, Kenya's largest mobile-network operator, is now used by over 17m Kenyans, equivalent to more than two-thirds of the adult population; around 25% of the country's gross national product (GNP) flows through it. M-PESA lets people transfer cash using their phones, and is by far the most successful scheme of its type on earth, now operating in six other African countries as well as in Asia and Eastern Europe. M-PESA was originally designed as a system to allow microfinance-loan repayments to be made by phone, reducing the costs associated with handling cash and thus making possible lower interest rates. But after pilot testing it was broadened to become a general money-transfer scheme.

2.2 The STI Agenda for African Agriculture

In the new global development agenda, 8 out of the 17 SDGs are directly dependent on performance of the agricultural sector as follows: Goal 1- End poverty in all its forms everywhere; Goal 2- End hunger, achieve food security and improved nutrition, and promote sustainable agriculture; Goal 5- Achieve gender equality and empower all women and girls; Goal 8- Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; Goal 10- Reduce inequality within and among countries; Goal 12- Ensure sustainable consumption and production patterns; Goal 13- Take urgent action to combat climate change and its impacts; Goal 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.

The remainder of the SDGs (9 of 17) are for Africa all indirectly linked to agriculture as follows: Goal 3- Ensure healthy lives and promote well-being for all at all ages; Goal 4- Ensure inclusive and equitable quality education and promote life-long learning opportunities for all; Goal 6- Ensure availability and sustainable management of water and sanitation for all; Goal 7- Ensure access to affordable, reliable, sustainable, and modern energy for all; Goal 9- Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; Goal 11- Make cities and

human settlements inclusive, safe, resilient and sustainable; Goal 14- Conserve and sustainably use the oceans, seas and marine resources for sustainable development; Goal 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; Goal 17- Strengthen the means of implementation and revitalize the global partnership for sustainable development.

SDG 2 on ending hunger, achieving food security and improving nutrition, and promoting sustainable agriculture specifies the following targets:

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

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

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

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

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and ensure access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

2.b Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

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

SDG 17 strongly comes out on strengthening global partnership for technology transfer and technological capabilities by:

a) Enhancing regional and international cooperation for science, technology, and innovation and solutions-oriented research, and enhancing knowledge sharing, including through North-South, South-South and triangular cooperation;

b) Promoting transfer and dissemination of clean and environmentally sound technologies to developing countries;

c) Fully operationalizing the Technology Bank and STI Capacity Building Mechanism for LDCs;

d) Strengthening institutions and building capacities in developing countries to undertake research, development and adaptation of technologies, including clean and environmentally sound technologies; and,

e) Supporting fully research and development of vaccines and medicines for the common diseases of developing countries, notably LDCs.

The STISA is about – Science, Technology and Innovation. The word science comes from the Latin *"scientia,"* meaning knowledge. *Science* is defined as "knowledge attained through study or practice," or "knowledge covering general truths of the operation of general laws, esp. as obtained and tested through scientific method [and] concerned with the physical world." Science refers to a system of acquiring knowledge, using observation and experimentation to describe and explain natural phenomena. The term science also refers to the organized body of knowledge people have gained using that system. Less formally, the word science often describes any systematic field of study or the knowledge gained from it. Doing research that – besides technical breakthroughs – also actively seeks for institutional and infrastructural breakthroughs is part of the STI approach that should bring farmers, producers, and rural entrepreneurs closer to science, as the processes of science become more appealing to rural society. It is then the role of leadership to continually translate the body of science and technology work into different work-streams as follows:

• *Problem solving and adaptive research:* science that seeks farm-level, or production, processing, and marketing solutions that improve productivity, profitability and competitiveness of produce/products or services as well those than enhance resilience; this category of science is needs-driven and closest to producers and entrepreneurs; often requires more multi-stakeholder and inter-disciplinary collaboration; solutions may require combinations of technical, institutional and infrastructural innovations.

• *Strategic, subject matter and disciplinary research:* science that seeks higher order technical solutions, methods or knowledge that can be applied across several needs. This is research often carried out in laboratories as well as on controlled experiments in laboratories and field conditions. Strategic knowledge is for wider application across say a cropping or livestock system, farming system, or challenges shared across such, and so on.

• *Basic and fundamental research:* science that seeks deeper knowledge on principles of basic sciences and constitute building blocks of disciplinary and subject matter knowledge such as in biology, biochemistry, physics, economics, psychology and so on.

Technology, from Greek words "*techne"* and *"logia"* is defined as the collection of techniques, methods or processes used in the production of goods or services or in the accomplishment of objectives. Technology can be the knowledge of techniques, processes, etc. or it can be embedded in machines, devices and other inventions. It is the purposeful application of information in the

design, production, and utilization of goods and services, and in the organization of human activities. Technology is generally divided into the *tangible* (blueprints, models, operating manuals, prototypes) and intangible (consultancy, problem-solving, and training methods). It is highly associated with the rise of the notion of efficiency in terms of human productivity, and applied to machines relates to levels of automation - entirely or almost entirely automated and intelligent technology; semi-automated partially intelligent technology; and, labour-intensive technology.

Innovation is defined as "the process of bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behaviour and performance by a network of organizations, enterprises, and individuals". The innovation systems concept embraces not only the science suppliers but the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways. The essential elements of an innovation system include (a) a knowledge (research) and education domain, (b) a business and enterprise domain comprising the set of value chain actors and activities that both use outputs from the knowledge and education domain, and innovate independently, and (c) bridging institutions that link the two domains - extension services, political channels, and stakeholder platforms - that facilitate the transfer of knowledge and information between the domains.

The innovation system also includes the frame conditions that foster or impede innovation, including public policies on innovation and agriculture; informal institutions that establish the rules, norms, and cultural attributes of a society; and the behaviours, practices, and attitudes that condition the ways in which individuals and organizations within each domain act and interact. Implicit throughout the system are farmers - both as consumers and producers of knowledge and information, as producers and consumers of agricultural goods and services, as bridging institutions between various components, and as value chain actors. Beyond the borders of the system, though nonetheless important, are influencing factors such as linkages to other sectors of the economy (manufacturing and services); general science and technology policy; international actors, sources of knowledge, and markets; and the political system.

Many of the challenges of ensuring global food and nutrition security cannot be adequately addressed without the participation of the research community and the application of science. Development theory now requires equal attention on improving productivity, reducing the negative environmental impacts of production (including reducing emissions of greenhouse gasses), reducing waste at all stages in the food chain, and in helping citizens eat more healthily. Thus, it is of paramount importance to take a "food systems" view within the broader context of the bio-economy, i.e. the production, transformation and utilisation of bio-based resources and materials in addressing STISA-P1. To address these broad challenges both new knowledge and enhanced movement of knowledge into use is needed. Strategic interventions should be informed by a range of horizon scanning, foresight and research prioritisation exercises, not in order to predict the future, but to look at plausible futures as a guide to developing either strategies for planning or finding solutions that "fit most scenarios".

The breadth of the intellectual challenge requires greater interdisciplinary thinking than has hitherto been the norm, and requires significant cooperation across the African continent (and beyond) as no single country can invest sufficiently to fully address the challenge. Africa needs to encourage more strategic approaches to building interdisciplinary research programmes, and

aligning national and international efforts. As much as interdisciplinary research is needed, it is also important to encourage innovation to bring a better balance between the production of food (and its economic potential), its impact on and competition for water resources, and the sustainability of ecosystem services that are public goods. This will require greater sophistication in the regulatory and policy environment.

Finding ways to identify common research priorities on a continental scale is important to avoid competition with other countries globally, or wasted effort by not aligning similar investments or missing strategically important knowledge gaps on the assumption that "some other country is doing that". Scientific research creates the most societal benefit when the knowledge is used. Across the world, governments grapple with the "valley of death" between research undertaken and its uptake into innovation and use. Facilitating the green innovation economy requires building bridges across this valley. This requires greater linkage between stakeholders who are end-users and research providers. Such linkage needs to be encouraged throughout the research process (including in the co-design of research programmes, and participation in steering research which can help provide "pull" for the use of the knowledge). Although in stimulating knowledge-into use stakeholders are primarily identified as associated with industry, with the driver being economic growth arising from using research, civil society also has a stake that may be non-financial, and may be associated with the development of social rather than technological innovation. A recurrent challenge to the research and innovation system is stimulating two-way knowledge flow, allowing practitioners to access knowledge for implementing the "best practice" and allowing researchers to understand and address practitioners' needs.

New research is not always needed as what we already know can be a platform for innovation if the knowledge is easily available and accessible. Africa needs to enhance knowledge structures and systems that allow data to be comprehensively shared, from which decision tools can be developed, and information accessed by end-users. This may include developing "honest knowledge brokers" or "trusted intermediaries" to ensure end-user trust in the information. It may also include enhanced efforts for user-involved research, such as developing networks of farmers involved in on-farm research and innovation and aiding them in the role of knowledge champions for peer-to-peer learning and application of science. STI covers a broad range of academic and applied issues, and demystifying and promoting understanding of science would lead to positive societal outcomes. The challenges in meeting food and nutrition security involve societal choices about pathways to achieve goals and many of these choices require social innovation and attitudinal change across society. This, in turn, needs greater public understanding of the issues around agricultural science, technology and innovation.

Most African farming systems are complex mixtures of enterprises. A dominant staple (often maize, rice, yams or banana) will incorporate significant areas of other crops - pulses, oil seeds, cotton, sorghum and millet, with beans, other legumes, and cassava often planted as intercrops. Cattle, goats, poultry are important components; cattle play a major role in supplying draft power and small ruminants are often used for distress sales. Diversity declines as farm size decreases (especially in mono-modal rainfall areas). Importantly in most of the major farming systems on the continent, smallholders are dominant.

The most significant routes out of poverty in the system are diversification (up to 30%), intensification (around 25%), and leaving the land (20%); numbers vary from country to country but these provide the broad picture. Remittances play a major role in African farming systems. The

able-bodied youth and males flock to towns in search of employment, with the effect that many farms are managed by elderly female-headed households – which accounts for the widespread food insecurity and poverty. Africa has a huge population of poor people who need cheap food. Intensification that relies on the inefficient use of expensive inputs is not a sustainable option. For example, it is widely recorded that African farmers use a fraction of the fertiliser that their counterparts on other continents utilise. Fertiliser is, and will remain, an expensive input for African farmers into the foreseeable future.

The objective of STISA-P1 agenda is that by 2030 each and every African country is food and nutrition secure. Today the continent's population is about 1.1 billion people, 60% of whom live below the poverty line of US$1.25 per day and of whom more than 200 million are chronically hungry. Successful implementation of the STI agenda will mean that all Africans will have access to and be able to afford nutritious food and poverty and hunger will be eliminated. This goal is consistent with that set out in the agriculture-related (CAADP) goal for sustainable development in Africa. This ambitious, but achievable, objective will be dependent upon a quantum and broad-based increase in agricultural productivity on the continent led by a strong human capital base. The numbers are challenging. Productivity will need to double every five years starting from 2015. This will need to be matched with investments in services, infrastructure, skills development, and entrepreneurship. The STI agenda will need to observe critical intervention points:

- *Improving the efficiency of input use:* options include innovative maize-legume systems that have been shown to improve fertiliser use efficiency as much as ten times, and blending of fertilisers at national or regional level to provide fertilisers targeted for specific crops or areas (Kenya and Zimbabwe provide practical examples of this practice)
- *Further development of national or regional seed systems:* this involves further developing main staple crop varieties targeted at specific areas or conditions. In addition there is a real need for improved seed of other species (especially legumes). In Uganda, a local seed company has developed into a significant regional business through contracting with smallholders to produce legume and vegetable seeds which previously were expensive, difficult to obtain, and often of poor quality.
- *Addressing labour bottlenecks:* this is a serious constraint on all African farming systems productivity for which there are no particularly good answers. Options include various forms of minimum tillage, conservation agriculture, herbicide use, and labour and equipment contracting. There are significant issues with respect to each of these.
- *Making efficient use of water resources:* at present, only about 3% of Africa's arable land is irrigated compared to 47% in Asia. Africa uses less than 3% of its water resources for agriculture. It is estimated that to irrigate 20 million hectares of African farmland will require US$37 billion with an additional US$31 billion in operating costs through 2015.
- *Market and other infrastructure development:* creating and maintaining transport infrastructure, building world class agricultural research institutes and universities which focus on agricultural innovations.

The transformation of Africa's agriculture needs sustained intense interventions in science, technology and innovations linked to a well-defined, coherent, and evidence based strategies and policies which provides the foundation for improved approaches and practices, and creates and sustains core institutions and actors.

The *STISA 2024* is a ten-year strategy approved by African Heads of States in 2014 to enhance the use of Science, Technology and Innovation (STI) to underpin social and economic development in Africa. The strategy contributes directly to the African Union Agenda 2063 *("the Future we want")* and represents the first of six 10-year strategies for building science and innovation capacity in Africa. STISA 2024 builds on the Consolidated Plan of Action (CPA) for Science and Technology in Africa adopted in January 2007, including lessons from its implementation, such as 1) the importance of attracting government financial support, 2) enhancing strategic planning to enhance capacity for S&T on the continent; 3) enhancing the linkages between the CPA and other continental frameworks and strategies and 4) ensuring ownership by the relevant stakeholders. Earlier attempts by the African governments to turn around their development fortunes through efforts to mainstream STI in Africa's development policies and actions include: the Monrovia Strategy (1979); the Lagos Plan of Action, (1980) and the Abuja Treaty (1991). The African Manifesto for Science, Technology and Innovation released in 2010 by the African Technology Policy Studies Network (ATPS) in collaboration with African, Indian and European Partners and Stakeholders, under the auspices of an European VII Framework programme project, Science Ethics and Technological Responsibilities in Developing and Emerging Countries (SETDEV) envisioned a new renaissance in Africa, a new world order in which there is self-rule and democratic governance of STI in Africa for African development. It set out three core actions required to achieve this vision: 1) Restoration of confidence in African STI and African experts by Africans; 2) Concerted public and private investments in building sustainable STI infrastructures; and, 3) Adoption of proactive policies to fully embed African STI in African societies.

The STISA 2024 is designed for implementation through six priority areas viz. 1) eradication of hunger and achieving food and nutrition security; 2) prevention and control of diseases; 3) communication (physical and intellectual mobility); 4) protection of our space; 5) live together-build the society; and 6) wealth creation. Within the context of the CAADP Results Framework, Priority One of STISA focuses on elements by which agriculture will contribute to ending hunger, essentially through (a) making food available and (b) on the access side, opening up increased economic opportunities for people (i.e. jobs and income).

The STISA implementation framework has specified five strategic objectives that are intended to give impetus to achieving the Mission to "accelerate Africa's transition to an innovation-led, knowledge based economy". These strategic objectives are:

1) *Enhance effectiveness of Science, Technology and Innovation (STI) in addressing/implementing priority areas* – the need for a stronger STI system central to transforming the continent's socio-economic landscape through STI policy development and reforms that recognise and position research and development, including the requisite infrastructure, as a driver for socio-economic change.
2) *Improve technical competencies and institutional capacity for STI development* – STI system is only as strong as the endogenous technical and institutional capacity. Interventions to develop this capacity, at national, regional and continental levels, will be critical for developing Africa's intellectual capital that effectively responds to its manifold challenges.
3) *Promote economic competitiveness through fostering innovation, value addition, industrial development and entrepreneurship in synergy with existing and/or new instruments* – the need for strengthening Africa's innovation value chain as a precursor for translating research and development outputs for commercialisation and use in the broader African

and global society. Such innovation support will help strengthen Africa's economic competitiveness and improve the quality of life of its citizens.

4) *Protect knowledge production (including inventions, and indigenous knowledge) by strengthening Intellectual Property Rights (IPR) and regulatory regimes at all levels* – the need for protecting the STI landscape by ensuring that the intellectual capital is protected for Africa's use. In addition, existing and new regulatory regimes must support the mobility and use of ideas, knowledge exchange and technology transfer that is critical for translating intellectual capital to knowledge products and services.

5) *Facilitate STI policy reforms, harmonization, science diplomacy and resource mobilization*– the STI sector does not operate in isolation, but draws down from other sectors and transitions into the commercial market and society. Hence, harmonized policies ensure seamless integration of the STI interest in the pre- and post-phases of the innovation value chain and also key segments within the innovation value chain.

The *Science Agenda for Agriculture in Africa (S3A)* constitutes strategies for implementing the agriculture component of STISA 2024 and represents decisive efforts to build and strengthen capacity that is required to put science, technology and innovations to work for agriculture in Africa. The S3A provides the framework for transforming Africa's agriculture through the building and strengthening of capacity for the production, uptake, utilization, financing and sustained partnering in support of agricultural research and innovation. The S3A has three core thrusts: *integrating* sciences more effectively at national and regional levels; *connecting* science to end-users with greater impact especially for CAADP at national and regional levels; and, s*trengthening* the sciences and their application to agriculture at national and regional levels.

The main strategic goal of the S3A is to increase public and private sector investment into agriculture R&D and at least double the volume of investment by 2020. Moreover Africa should be significantly reducing its dependence on donor funding for research during the same period. Important activities under S3A include building capacity at the national level to critical mass and ensuring investment in higher agriculture education; promoting solidarity among African countries in building shared science capacities; growing some national centres into regional Centres of Excellence; sharing technologies across countries and regions including sharing information, facilities and staff; mainstreaming the visibility of science at the community level; and, improving the working capacity of young researchers.

2.3 African Higher Agricultural Education and the Challenge of STI

The development of science, technology and innovations (STI) capacity is pivotal for the transformation of Africa's agriculture. A strengthened Science, technology and innovation sector in Africa will require two important features at the national and subsequently regional level: *a) Strong research focused institutions that produce contextually relevant research results that can be utilized at local levels; b) highly skilled cadre of professionals that are able to support the grounding of science, technology and innovation locally for development.* African Universities, in particular, have a critical but often unfulfilled role to play in the development process. *Universities can help develop African expertise; they can enhance the analysis of African problems; strengthen domestic institutions; serve as a model environment for the practice of good science, and enable African academics to play an active part in the global community of scholars.*

The transformation of agriculture in Africa will require African professionals of the highest quality working across the relevant scientific disciplines and within the private and public sectors. Context specific knowledge and technology generation and its use will be critical for the competitiveness of African states. A higher education system that addresses effectively the development challenges of the continent must be put in place today to create the innovators of tomorrow. Today the demand for higher education on the continent far exceeds current capacity of the sector to train. The postgraduate sector is particularly weak, with too few universities producing the talent required to support knowledge generation and research. There is a shortage of suitably qualified and experienced teachers which impinges on both the quality of courses offered and the availability of mentoring for young graduates. Many of the most talented African professionals leave for overseas institutions, frustrated by the lack of resources and support at home.

Universities have a central role in building an enabling environment for Africa's transformation. In a continent where resources are short and skills are scarce, the careful shepherding of African's top talent into prestigious African research institutes, universities, and think tanks is an essential strategy. Young people can be attracted to such institutes to work with the best professionals and to build their own skills, experience, and competences.

African countries need to invest in science and technology and the development of innovations systems in the agricultural sector. STI has an important role to play in the attainment of Africa's sustainable agricultural development objectives. Yet, it has received the most inadequate support on the continent. Africa's continued low investment in science and technology is manifest in the declining quality of science education at all levels of the educational system. Institutions of higher learning, particularly universities and technical colleges, are in urgent need of renewal and link to the needs of the agricultural sector. There is a tenuous link between STI institutions and industry, a mismatch between R&D activities and national agricultural and industrial development strategies and priorities. As a result, research findings from public research institutions are not adequately accessed and used by local industries and particularly small and medium-sized agricultural enterprises.

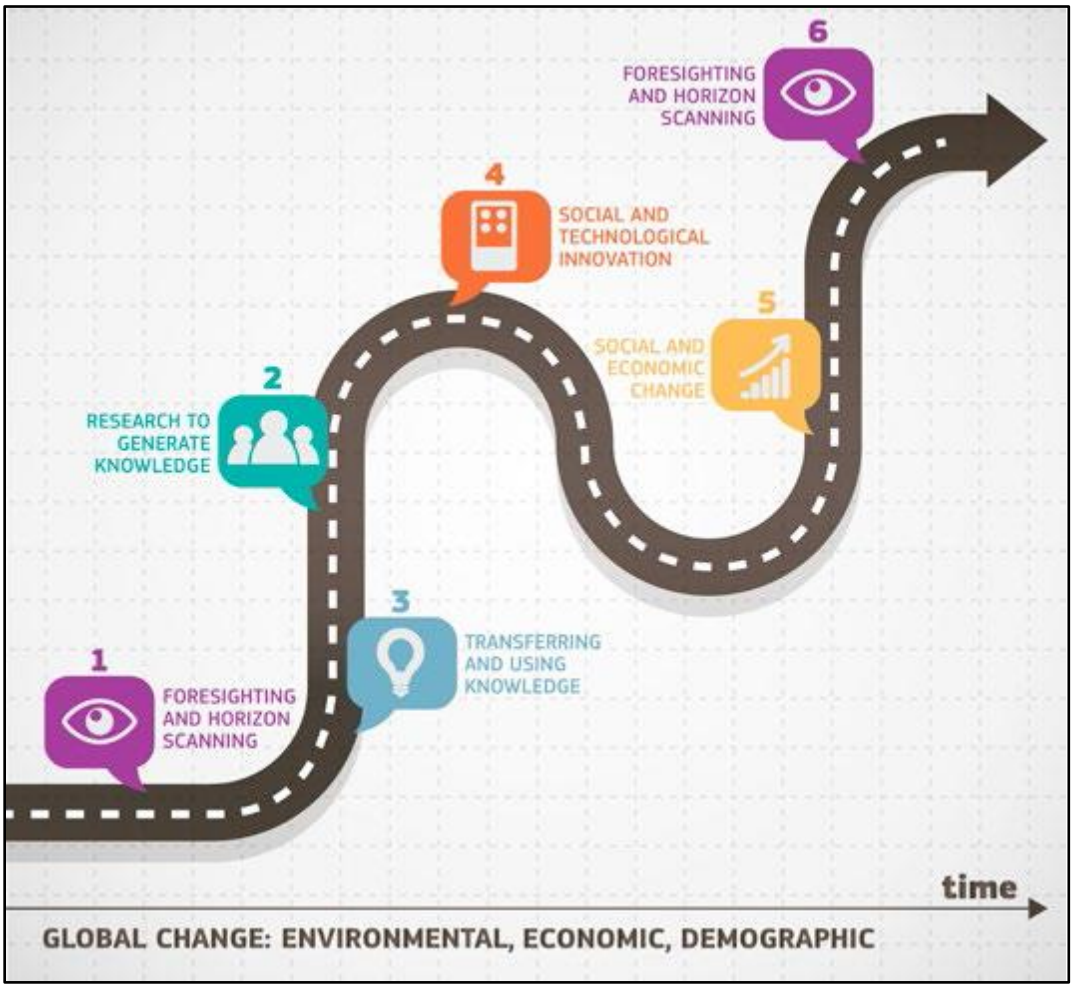
Technological applications and innovations are created through knowledge derived from investment in agricultural R&D. The transfer of science and technological knowledge is often an issue that is not well addressed by African countries and regional research institutions. The continent has continued to register limited increase in R&D expenditure, attract only a small number of R&D projects, and record low growth in patent applications and trademarks granted. Although investments in AR&D in Africa rose by more than 20% between 2001 and 2008, most of this growth occurred in only a few countries while it stagnated or even fell in many others. In many countries, infrastructure for R&D is neglected, inadequate or decaying. There are a number of cross-cutting structural issues to enhance the utility of knowledge-generation within Africa. These issues are characterised as being interlinked to make a virtuous spiral.

As illustrated in Figure 1[3], initially, strategic analysis of the future (foresighting) sets the research needs. Research is then undertaken to generate knowledge. This research needs to address the triple "bottom lines" for economic, public and environmental health, and therefore has to be interdisciplinary and undertaken within a systems approach. Research effort across different countries should be better aligned to ensure complementarity of efforts. The knowledge generated

[3] Source: European Union (2015): The Role of Research in Global Food and Nutrition Security. Expo 2015 EU Scientific Steering Committee *Discussion paper* EUR 27123 EN (ISBN 978-92-79-45830-9; ISSN 1831-9424; doi: 10.2788/521449)

then should be utilised by creating technological and social innovation (in part through education and communication). Innovation then, in turn, creates social and economic change. This coupled with global development and environmental change happening through time, then requires the forecasting to be updated.

Figure 1: Structural issues for enhancing the utility of knowledge-generation



In 2010, the Government of Uganda and RUFORUM, with support of national, regional and international partners hosted a regional meeting[4] of African Ministers, Members of Parliament, senior officials responsible for education, agriculture, science and technology, finance and planning, private sector, civil society, and farmer representatives, to discuss strengthening higher education in agriculture, so that African universities and other education institutions can contribute more effectively to the CAADP processes. The conference aimed to consolidate recent developments by strengthening high level partnerships and policy support for re-engineering African higher education in agriculture and science.
The government leaders committed to:

[4] Conference on Higher Education in Agriculture (CHEA Conference)

1) A renewed and vigorous emphasis by African governments on restoring the quality of higher education in agriculture, necessary for properly preparing the increased intakes of diplomas, undergraduates and postgraduates for their responsibilities to achieve CAADP targets. This would require special focus on higher degree training to produce the required capacity for delivering high quality teaching and learning experiences at African universities and colleges.

2) Increased investment in higher education in agriculture in Africa and to be included as an integral agricultural development investment in CAADP Country Compacts and Medium Term Agricultural Productivity Programmes guided by structured foresighting.

3) Take urgent actions to develop an Africa-wide action and investment plan for implementing the AUC and NPCA strategies for strengthening capacity development in agriculture, designed to support CAADP.

4) Ensure that Ministries responsible for higher education, education institutions and other relevant actors create conducive and friendly environments for women and girls education and career advancement at all levels.

5) Advocate for increased support and engagement of the African higher education networks in policy making and programme implementation for agricultural training and research by the AUC, RECs, NPCA and FARA.

6) Support local and international partnerships which address critical capacity needs for sustainable agricultural development, including partnerships amongst universities and engagement with communities, private sector and the African diaspora.

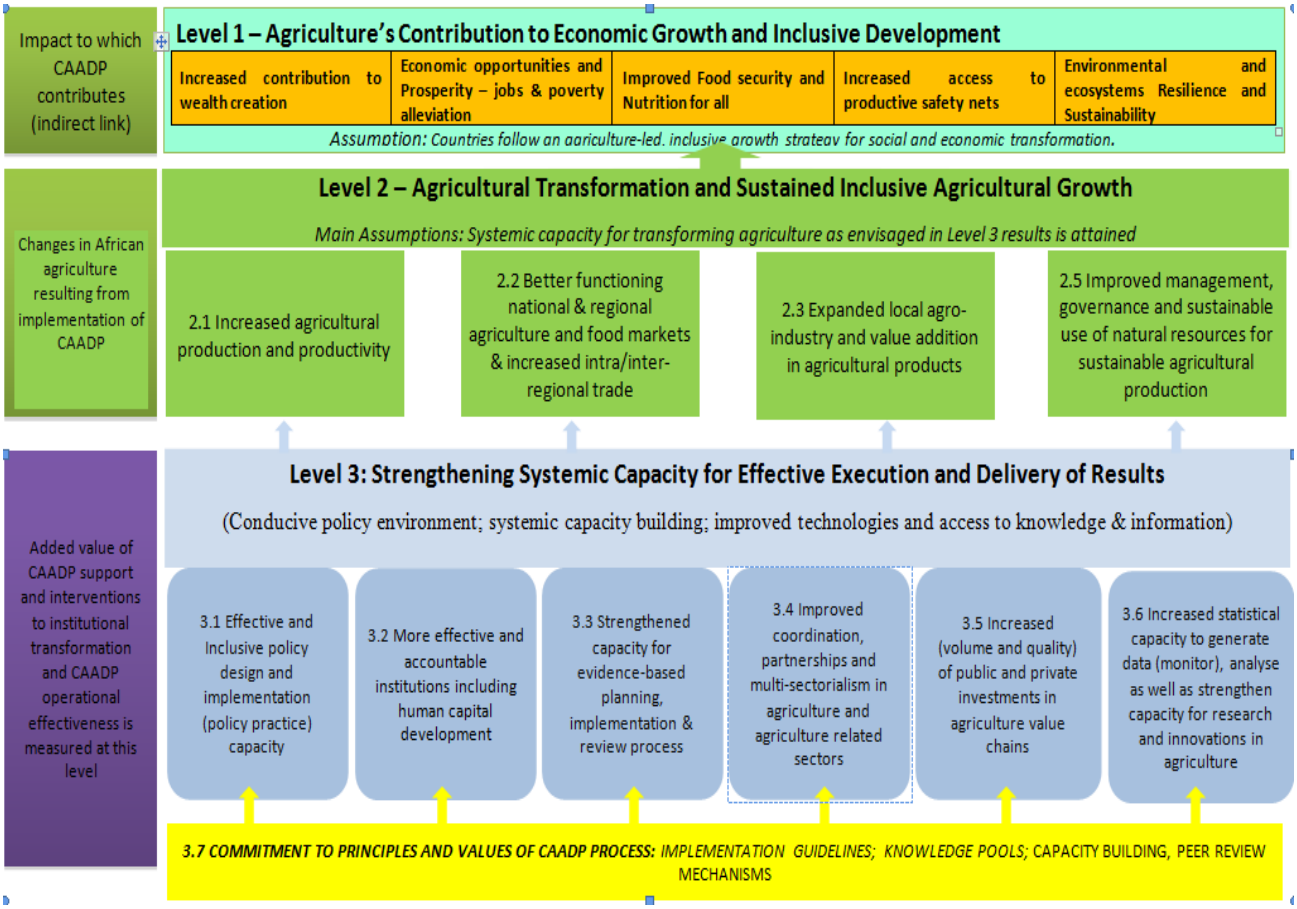
The TEAM Africa[5] Initiative was a key outcome of the CHEA Conference which was later integrated into NEPAD. TEAM Africa supported the development of the *Agricultural Education and Skills Improvement Framework (AESIF), 2015 – 2025* which envisions transforming Africa's Agriculture Education and Training (AET) in order to leverage the quality and quantity of skilled workforce required for the advancement of agricultural growth and the achievement of targets set in the CAADP Malabo Declaration. The AESIF's mission is to stimulate and guide policy and institutional reforms to strengthen AET capacity to produce the desired skilled work-force with entrepreneurial competencies. The main strategic goal is to strengthen and transform the AET system across all training levels, including the non-formal training , the formal vocational and technical training components, as well as the higher education component (at undergraduate and postgraduate levels) and guide capacity building to continuously replenish the skilled human capital much needed to drive the agriculture transformation agenda in Africa, particularly leveraging the potential of women and youth, and entrepreneurship. Other complementary strategic goals include: 1) providing a common agenda in leveraging multi-consortia private-public partnerships on agriculture education and skills development to drive innovation and wealth creation; 2) offering practical guidelines and tools for sharing of experiences and learning; and, 3) ensuring coherence among initiatives and alignment between actors, and integration of all processes into a common agenda mainstreamed within the CAADP process.

[5] The Tertiary Education for Agricultural Mechanism (TEAM) was created by RUFORUM, ANAFE, FARA and the World Bank to bring together African partners with the support of partners in and outside Africa to promote reforms at higher education institutions.

2.4 Strategic Action Areas for CAADP Implementation

The *Comprehensive Africa Agricultural Development Programme (CAADP)*, as a strategic policy framework for the agriculture sector, offers the African continent and countries the required strategic direction for eradicating hunger and achieving food and nutrition security. The CAADP identifies three outcomes at different levels of 1) transformational change as a result of CAADP by creating conducive environments and systemic capacity; 2) sustained inclusive agricultural growth through agriculture, jobs and poverty reduction; and 3) contributing to Africa's social economic development (wealth creation, resilience, improved and nutrition security) (Figure 2)[6].

Figure 2: CAADP Results Framework



A set of 11 strategic action areas (SAAs) have been specified to facilitate and guide, but not prescribe, options for practical actions which will deliver results and impact in support of the sustaining CAADP Momentum 2025 vision and goals. The SAAs are divided into two groups (Table 1): four SAAs focus on thematic options that will directly bring about agricultural transformation and sustained growth (Objective 1) and the remaining seven SSAs will strengthen systemic capacity to enable that transformation and growth to occur (Objective 2). To complement the 11 SSAs, the CAADP implementation strategy and roadmap (IS&R) is also based on a set of crosscutting principles: accountability, evidence-based, transparency, inclusiveness, local ownership and

[6] AUC/NPCA (2015): The CAADP Results Framework 2015-2025 - "Going for results and impacts", "Sustaining CAADP momentum"

leadership, subsidiarity, sustainability and commercial orientation with a deliberate effort to nurture the domestic private sector.

Table 1: SAAs for CAADP Implementation

Strategic Action Area	*Table 1* ***Sub-action areas***
IS&R Objective 1: Transformed agriculture and sustained inclusive growth	
1) *SAA 1a*: Adopt measures to increase sustainable agricultural production and productivity in an inclusive manner	• Establish agricultural R&D and advisory and extension services for the development, dissemination and adoption of technologies and innovations which are appropriate for local contexts
	• Invest in the production, accessibility and utilisation of appropriate and cost-effective and quality agricultural inputs (for crops, livestock, fisheries and aquaculture), irrigation and farm implements/machinery – with emphasis on local production
	• Facilitate the development or adaptation, promotion and application of post-harvest loss management technologies and natural resource management practices appropriate for African agricultural commodities and context
2) *SAA 1b*: Market infrastructure, regional trade and integration, and value chains development	• Develop and implement policies and incentives - especially for youth and women to enter agricultural value chains - and invest in infrastructure to promote the development of regional value chains and strategic food and agricultural commodities
	• Harmonise trade regimes, measures and standards, and remove non-tariff barriers within and across regional trade blocs (RECs), and domesticate and implement regional and continental trade agreements at national level
	• Develop/review and implement comprehensive plans and budgets to up-scale market and structured-trade infrastructure and facilities at national and regional levels along regional corridors for agricultural goods and services.
3) *SAA 1c*: Increase resilience of livelihoods and production systems to climate variability and change and other shocks	• Develop and implement policies and strategies that support livelihood diversification, disaster risk reduction and coping strategies that better buffer populations against shocks (e.g. safety nets, insurance, and nutrition interventions)
	• Implement resilience-based policies and programs for farm (e.g. climate smart agriculture), and landscape management, including ecosystem based approaches to support ecosystem service provision and restoration
	• Promote agro-biodiversity for improved nutrition and climate change adaptation, including the use and conservation of genetic stocks (crops, livestock and fisheries), that can diversity available nutritious foods for local consumption and also adapt to harsh and changing climate.
4) *SAA 1d*: Strengthen governance of land, water and other natural resources	• Stimulate and facilitate increased public awareness and access to land policy and land administration information
	• Build expert capacity to appraise and continually align existing land and water governance to changing needs and circumstances, including targeted access that have greatest transformational potential but without disenfranchising African citizenry and compromising sustainability
	• Strengthen community-level structures to engage effectively in policy formulation, implementation and monitoring of land and water governance and use.
IS&R Objective 2: Strengthened systemic capacity to implement and deliver results	

Strategic Action Area	*Table 1* *Sub-action areas*
1) *SAA 2a:* Build and strengthen capacity for evidence-based planning, implementation, review and dialogue	• Review national and regional agricultural investment plans for compliance with, or integration of, the Malabo Declaration goals, targets and actions
	• Build capacity for policy analysis to support evidence-based decision making and program design and implementation
	• Establish and strengthen platforms for regular review and dialogue on implementation of agricultural investments plans.
2) *SAA 2b:* Review and implement policy and institutional reforms that strengthen leadership, management and technical capacity in agriculture	• Undertake institutional and organizational reviews and mapping to align mandate, human capacity and institutional structures and arrangements for effective implementation.
	• Design and implement training programs that enhance capacity for implementation and accountability.
	• Undertake systematic and periodic policy reviews, design and implement reforms that are evidence-based, transparent and inclusive of all stakeholders.
3) *SAA 2c:* Strengthen local ownership and leadership to champion agriculture and CAADP agenda, align coordination and implementation partnerships	• Identify, train and provide on-going mentorship for a cadre of leaders in and for key institutions charged with coordination and partnership responsibilities at all levels
	• Strengthen inter-ministerial coordination through awareness creation and capacity development targeting holders of the most critical leadership positions in relevant government ministries and departments (e.g. directors, permanent or principal secretaries, heads of units/programmes) to champion 'partnership mind-set and practice' incorporating collective planning and implementation of agriculture programmes across government ministries, departments and agencies
	• Support and strengthen non-state actors' capacity to participate in and influence agricultural policies and programs.
4) *SAA 2d:* Enhance skills, knowledge and agricultural education	• Strengthen capacity for knowledge generation, packaging and dissemination • Develop innovative ways and incentives to increase youth enrolment in agricultural disciplines in vocational and tertiary education – e.g. through exciting agribusiness training programs • Equip value chain actors with entrepreneurship skills through targeted capacity building programs
5) *SAA 2e:* Strengthen data and statistics for evidence-based planning, implementation, monitoring and evaluation, and review processes	• Strengthen capacity to design data collection instruments and collect and manage data, particularly on indicators directly relevant for measuring performance in implementing the Malabo Declaration.
	• Strengthen capacity to analyse data and generate credible statistics on agriculture and rural development.
	• Promote data sharing and strengthen data-sharing protocols across different ministries and agencies responsible for, and involved in, agriculture and rural development.
6) *SAA 2f:* Establish and institutionalize mutual accountability mechanisms with regular peer reviews and strong dialogue platforms	• Strengthen agricultural M&E systems, including enhancing data generation and analytical capacities and improving agriculture statistics.
	• Establish and strengthen multi-stakeholder platforms for review, dialogue and debate at country, regional and continental levels.
	• Foster alignment and harmonization of policies and strategies on statistics and data across the relevant sectors.

Strategic Action Area	*Table 1* *Sub-action areas*
7) *SAA 2g:* Identify and enhance innovative financing models for increased public and private sector finance for agriculture investments along the value chain	• Implement public expenditure reviews to attract additional public resources to agriculture consistent with the 10% Maputo commitment
	• Identify, stimulate and support innovative finance models and products through tapping into non-traditional financing sources such as development-based financial institutions to increase public expenditure to agriculture
	• Mobilise and create innovative private-private partnerships to leverage private sector finance in agriculture value chains.

2.5 STISA 2024 Strategic Action Areas

The STISA implementation framework has specified five strategic objectives, with the associated strategic action areas (Table 2), that are intended to give impetus to achieving the Mission to "accelerate Africa's transition to an innovation-led, knowledge based economy". These strategic objectives are:

1) *Enhance effectiveness of Science, Technology and Innovation (STI) in addressing/implementing priority areas* – the need for a stronger STI system central to transforming the continent's socio-economic landscape through STI policy development and reforms that recognise and position research and development, including the requisite infrastructure, as a driver for socio-economic change.

2) *Improve technical competencies and institutional capacity for STI development* – STI system is only as strong as the endogenous technical and institutional capacity. Interventions to develop this capacity, at national, regional and continental levels, will be critical for developing Africa's intellectual capital that effectively responds to its manifold challenges.

3) *Promote economic competitiveness through fostering innovation, value addition, industrial development and entrepreneurship in synergy with existing and/or new instruments* – the need for strengthening Africa's innovation value chain as a precursor for translating research and development outputs for commercialisation and use in the broader African and global society. Such innovation support will help strengthen Africa's economic competitiveness and improve the quality of life of its citizens.

4) *Protect knowledge production (including inventions, and indigenous knowledge) by strengthening Intellectual Property Rights (IPR) and regulatory regimes at all levels* – the need for protecting the STI landscape by ensuring that the intellectual capital is protected for Africa's use. In addition, existing and new regulatory regimes must support the mobility and use of ideas, knowledge exchange and technology transfer that is critical for translating intellectual capital to knowledge products and services.

5) *Facilitate STI policy reforms, harmonization, science diplomacy and resource mobilization*– the STI sector does not operate in isolation, but draws down from other sectors and transitions into the commercial market and society. Hence, harmonized policies ensure seamless integration of the STI interest in the pre- and post-phases of the innovation value chain and also key segments within the innovation value chain.

Table 2: SAAs for STISA Implementation

Strategic Objective	Strategic Action Area	*Table 2* Sub-action areas
Strategic objective 1: Enhance effectiveness of STI in addressing/ implementing priority areas	*Strategic Action 1*: Develop multidisciplinary Flagship Programmes to address the priority areas aligned with relevant continental frameworks	1. Conducting longitudinal baseline and foresight studies of STI status/outlook in Member States. 2. Establishing institutional organization/research teams or networks. 3. Mapping of Research Institutions and Centres. 4. Establishment of a Registration/Accreditation system at the National, Regional and Continental levels. 5. Developing and elaborating RDI programmes to address the priority areas. 6. Mobilising resources for implementation of the Flagship Programmes and projects. 7. M&E of the implementation of Flagship Programmes
Strategic objective 2: Improve technical competencies and institutional capacity for STI development	*Strategic Action 2*: Develop STI infrastructure that is core for scientific and technological developments to support socio-economic growth.	1. Leveraging physical and digital infrastructure projects to build engineering capacity. 2. Introducing measures to increase national and regional content of labour and materials. 3. Building and upgrading tools for scientific discovery. 4. Establishing and strengthening linkages with continental and global scientific and engineering communities. 5. Embracing green approaches in infrastructure design and development. 6. Sharing research facilities within regions and in the continent, as well as linking regions with transport infrastructure to enhance mobility. 7. Increasing accessibility of scientific infrastructure for maximal use. 8. Establishing Science Parks as platforms to promote RDI underpinned by public private partnerships.
	Strategic Action 3: Increase STI human and institutional capacity to drive Africa's transformative agenda	1. Expand education & training programmes in STEM. 2. Establish/upgrade research-intensive universities, research centres & vocational institutions and digital libraries. 3. Establish National and Regional multi-institutional Centres of Excellence. 4. Establish competitive grant schemes, bursaries and scholarships for emerging and experienced researchers. 5. Establish STI Chairs. 6. Incentivise high profile STI diaspora members to contribute, lead and help build capacity.
Strategic objective 3: Promote economic competitiveness through fostering innovation, value addition, industrial development and entrepreneurship in synergy with other instruments (e.g. AIDA, PMPA, UniBRAIN)	*Strategic Action 4*: Develop National and Regional innovation and entrepreneurship systems that address and respond to African socio-economic challenges	1. Establish technology transfer and commercialisation programmes for actors within an innovation system. 2. Facilitate stakeholder collaborations and strategic research public, private partnerships. 3. Encourage the establishment & expansion of financing instruments (e.g. Seed Capital and Early Stage Venture funds). 4. Support the use of enabling technologies (e.g. ICT and nanotechnology). 5. Support the establishment and sustainability of innovation infrastructure. 6. Improve the measurement of innovation.

Strategic Objective	Strategic Action Area	*Table 2* Sub-action areas
Strategic objective 4: Protect knowledge production (including inventions, and indigenous knowledge) by strengthening IPR and regulatory regimes at all levels	*Strategic Action 5*: Transform and strengthen Africa's STI environment into an effective innovation system to meet Africa's socio-economic needs	1. Support Member States and RECs to develop, implement and coordinate STI strategic plans and programmes. 2. Promote STI policy evaluation, reforms and harmonisation. 3. Strengthen IP and regulatory systems. 4. Expand incentives, rewards and recognition programmes. 5. Engage academies for review and advice. 6. Mobilise resources for STI-led development. 7. Improve gender balance. 8. Establish ASRIC. 9. Build public understanding and participation in STI.
Strategic objective 5: Facilitate STI policy reforms, harmonization, science diplomacy and resource mobilization		

3. STISA-P1 IMPLEMENTATION PLAN

3.1 STISA-P1 Strategic Action Areas

The STISA-P1 implementation plan is based on a conceptual hierarchy of objectives (Figure 3) that clarifies the targets for ensuring that STISA 2024 is able to achieve its long term vision of achieving food and nutrition security and eradication of hunger in Africa. The plan clarifies for potential partners how they can engage and how they will be linked to other initiatives such as the implementation phase of Comprehensive African Agricultural Development Program (CAADP), the wish of African Heads of State and Government outlined in the Malabo Declaration on sustaining CAADP, the Science Agenda for Agriculture in Africa (S3A), the Agricultural Education and Skills Improvement Framework (AESIF) and other priority areas of STISA 2024. The plan also presents some of the emerging elements as well as flagship programs.

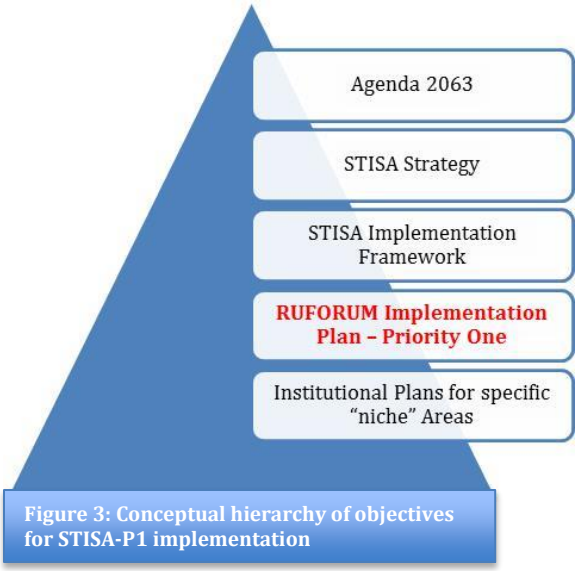


Figure 3: Conceptual hierarchy of objectives for STISA-P1 implementation

Table 3 below summarizes the seminal elements of the RUFORUM Implementation Plan for STISA-P1 - Eradicating Hunger and Achieving Food and Nutrition Security.

Table 3: STISA-P1 – Strategic Elements for Implementation

STISA Strategic Objective	STISA-P1 Strategic Action Area	*Table 3* STISA-P1 Sub-action areas
Strategic objective 1: Enhance effectiveness of STI in addressing/ implementing priority areas *[for STISA-P1 by aligning with and implementation to advance the CAADP targets and the 3AGT agenda]*	*Strategic Action 1.1*: Set priorities, develop and implement prioritised multidisciplinary flagship programmes supported by efficient management to meet the needs of society within context of the Science Agenda for Agriculture in Africa	***SAA 1.1.1:*** Adopt the S3A as the principal vehicle and framework for operationalizing the AR4D components of *Sustaining the CAADP Momentum* and STISA 2024 ***SAA 1.1.2:*** Support and strengthen science and technology interventions for CAADP NAIPs implementation ***SAA 1.1.3:*** Identify broad areas of science and set continental, regional and national agricultural science priorities and themes connected with the needs and opportunities in Africa's agriculture. ***SAA 1.1.4:*** Develop instruments for aligning complex research challenges across multiple societal needs and across space (within and between member states and beyond). ***SAA 1.1.5:*** Facilitate the necessary transformation and sustenance of basic science and technology capacity at national level and ability to leverage knowledge and new technologies from the regional and global stocks of knowledge and partnerships ***SAA 1.1.6:*** Establish functional innovation partnerships, platforms and collaboration for deepening STI in agriculture, promoting an inclusive innovation culture and adoption of IAR4D, innovation and entrepreneurship, leveraging existing relationships with relevant partners within and outside Africa to deal with emerging challenges ***SAA 1.1.7:*** Mainstream the visibility of science at national, supra-national and at community level ***SAA 1.1.8:*** Production of scientific outputs – generate knowledge, appropriate technologies, policies and institutional innovations for promoting generation and uptake of technologies and agribusiness for enhancing food security, jobs and wealth creation
Strategic objective 2: Improve technical competencies and institutional capacity for STI development *[for STISA-P1 – build and improve systemic capabilities at national level to a sufficient critical mass - human capital, technical competencies, infrastructure, enabling environment, innovation and entrepreneurial mindset and institutional capacity]*	*Strategic Action 2.1*: Support building, upgrading and/or enhancing quality of agricultural R&D and AET infrastructural assets core for scientific and technological developments to support Africa's agricultural growth and transformation, including access to their use by researchers	***SAA 2.1.1:*** Promote solidarity among African countries in building shared science and educational capacities, sharing technologies across countries and regions including sharing information, facilities and staff ***SAA 2.1.2:*** Establish National and Regional multi-institutional Hubs/Centres of Excellence – research centres, research-intensive universities, vocational institutions, digital libraries
	Strategic Action 2.2: Develop and connect human and institutional capacities – enhancing technical and professional competencies, response	***SAA 2.2.1:*** Adopt AESIF as the instrument for a transformed Africa's agricultural education system for the needed human capital to achieve CAADP and Malabo Declaration objectives on agriculture-led development in Africa

STISA Strategic Objective	STISA-P1 Strategic Action Area	*Table 3* STISA-P1 Sub-action areas
	capacities and capabilities to manage and govern the advancement of STI, integrate and co-create new knowledge to drive Africa's agricultural transformative agenda	***SAA 2.2.2:*** Strengthen Regional research and training nodes and centres of excellence as the instrument for developing high level STI capacity for STISA-P1 and other Priority Areas ***SAA 2.2.3:*** Undertake institutional and organizational reviews and mapping to align mandate and human capacity for effective implementation ***SAA 2.2.4:*** Provide support to countries and RECs that enhances implementation and institutional learning, including training and education programs that respond to country and regionally identified capacity building needs. ***SAA 2.2.5:*** Improve planning, governance and implementation of Agriculture Education and Training (AET) and other STI technical areas at country, regional and continental levels ***SAA 2.2.6:*** Review and update relevant curricula and design and implement training programmes that, in addition to strengthening the instruction in traditional agricultural science disciplines, enhance capacity for implementation and accountability and impart practical and entrepreneurial skills ***SAA 2.2.7:*** Strengthen Africa-wide "Academic/ Scientific Mobility Programs", including mobilising diaspora through national and regional initiatives ***SAA 2.2.8:*** Strengthen ongoing training, retention of trained academics, agricultural scientists and researchers and establish/support agricultural research and training networks, institutions twinning, collaborative research, etc.
	Strategic Action 2.3: Build systems for data collection and analysis, as well as sharing of information on progress towards major goals and implementation of activities	***SAA 2.3.1:*** Develop/strengthen M&E systems – improving baseline data and statistics, enhancing data generation and analytical capacities, working with partners at multiple scales for harmonized data collection, analysis and dissemination. ***SAA 2.3.2:*** Facilitate the launch of new and improve existing systems, strengthen capacity for knowledge management and improve communication and knowledge exchange that is inclusive and respectful of cultural complexity and informs policy and other forms of decision making. ***SAA 2.3.3:*** Establish and implement a framework for tracking investment and human capital development in African Universities and other Tertiary institutions
Strategic objective 3: Promote economic competitiveness through fostering innovation, value addition, industrial/ agribusiness development and entrepreneurship in synergy with other	*Strategic Action 3.1*: Develop National and Regional innovation and knowledge systems that add value to and ensure optimal returns from investments in STI	***SAA 3.1.1:*** Support and promote science & technology commercialization and agribusiness innovations ***SAA 3.1.2:*** Support tertiary educational institutions to offer trans-disciplinary scholarship to produce "liberally educated, scientifically literate and professionally prepared students", developing human resources capable of creating and sustaining globalised and knowledge-based societies.

STISA Strategic Objective	STISA-P1 Strategic Action Area	*Table 3* STISA-P1 Sub-action areas
instruments (e.g. AIDA, CARP, PMPA, UniBRAIN)		***SAA 3.1.3:*** Support development and delivery of agribusiness management training programmes backed by appropriate contextual research.
	Strategic Action 3.2: Foster value addition, agribusiness and entrepreneurship to address and respond to African socio-economic challenges	***SAA 3.2.1:*** Support Networks to lead Agribusiness transformation in Africa. ***SAA 3.2.2:*** Strengthen outreach and community engagement programmes (of Universities, research institutions, HIEL) to foster value addition in food production and processing. ***SAA 3.2.3:*** Develop incubation centres and industry linkage programmes for transfer of technology and creation of PPP to assist in agribusiness financing
Strategic objective 4: Protect knowledge production (including inventions, and indigenous knowledge) by strengthening IPR and regulatory regimes at all levels	*Strategic Action 4.1*: Transform and strengthen Africa's agricultural STI environment into an effective innovation system to meet Africa's socio-economic needs	***SAA 4.1.1:*** Facilitate development of models of governance for ensuring agricultural STI is integrated in strategies, plans and programs at national and regional levels; connected to end-users at national level; is appropriately applied to agriculture at national and regional levels ***SAA 4.1.2:*** Facilitate the development and application of harmonised mechanisms for identification, inventory and protection of technologies (including patenting of indigenous innovations and technologies) ***SAA 4.1.3:*** Establish policies, quality assurance, registration, accreditation and qualifications frameworks at national and regional levels for the achievement of greater compatibility and comparability, increasing the international competitiveness, ensuring operational autonomy of higher education and research systems.
Strategic objective 5: Facilitate STI policy reforms, harmonization, science diplomacy and resource mobilization	*Strategic Action 5.1:* Through effective policy practice provide an enabling policy and institutional environment for the sustainable application and performance of science - integrating STI in strategies, plans and programs at national and regional levels	***SAA 5.1.1:*** Facilitate the analysis and review of existing policies, support policy development and formulation, design and implementation of institutional reforms that are evidence-based, transparent and inclusive of all stakeholders ***SAA 5.1.2:*** Facilitate the provision and sharing of tools, including incentives to support the adoption and implementation of effective STI policies at the country and regional scales. ***SAA 5.1.3:*** Establish and strengthen/foster effective partnerships (both horizontal and vertical) and multi-stakeholder platforms for coordination, review, dialogue and debate among partners and stakeholders at country, regional and continental levels

STISA Strategic Objective	STISA-P1 Strategic Action Area	*Table 3* STISA-P1 Sub-action areas
	Strategic Action 5.2: Establish funds and financing mechanisms that promote national, regional and continental solidarity in agricultural STI.	***SAA 5.2.1:*** Identify and enhance innovative financing models for increased public and private sector finance and strengthening the contribution of STI to 3AGT ***SAA 5.2.2:*** Provide evidence and guidance to countries on financing principles and strategic investments in STI for accelerated increases in agricultural productivity, equitable development and sustainably productive environments ***SAA 5.2.3:*** Provide incentives for sustainable financing of STI through increased investment into agricultural R&D and education by domestic public and private sector, African philanthropy, international private foundations, bilateral donors, multilateral programs of donors, and development banks.

3.2 STISA-P1 Implementation Milestones

Table 4 below summarizes the milestones of the Implementation Strategy for STISA 2024 Priority Area One - Eradicating Hunger and Achieving Food and Nutrition Security

Table 4: STISA-P1 – Milestones by STISA 2024 Implementation Phases

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	*Table 4* Phase 4 (2021 – 2023) & 5 (2024)
SAA 1.1.1: Adopt the S3A as the principal vehicle and framework for operationalizing the AR4D components of *Sustaining the CAADP Momentum* and STISA 2024	• Concise overarching strategy and theory of change for integrating, connecting and strengthening science developed • Communications strategy, mechanisms for dissemination and distribution, enhanced S3A website developed • Advocacy plan on STI/S3A role in eradicating hunger and achieving food security developed • Contact stakeholders, host high-level dialogues, lobby organisations outside of Africa, foster partnerships	• STI i*ntegrated* more effectively at national and regional levels • STI *connected* to end-users with greater impact especially for CAADP at national and regional levels • STI and its application to agriculture *strengthened* at national and regional levels.	• Strengthened systemic capacities to enable 3AGT to occur through consolidating existing STI Communities of Practices; strengthening partnerships and harnessing continental networks; advocacy and patronage of African champions for S3A and STI
SAA 1.1.2: Support and strengthen science and technology interventions for CAADP NAIPs implementation	• Continent-wide implementation strategy and roadmap • Regional/National guidelines for positioning STI within country and RECs agricultural plans and programmes - deploying S3A Vision and blue-print for developing long term science capacities for Africa • Country guidelines for mainstreaming S3A as part of	• Country, regional and continental specific strategies and operational plans for implementing the S3A within the frame of National Agriculture Food Security Investment Plans (NAFSIPs) and regional investment plans developed and implemented • Plans and support for SROs direct participation with RECs in building knowledge and innovation Platforms for CAADP implementation • Harmonisation of regional strategies and alignment of national implementation plans - 50 % of NAFSIPs	• Harmonised regional strategies and aligned national implementation plans - All NAFSIPs and RAIPs compliant with S3A guidelines and principles.

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
	CAADP Results Framework implementation at Level 3 and 2 • Collective action to take advantage of science and technology in resolving common problems across countries and building the basic science capacities mobilized.	and RAIPs compliant with S3A guidelines and principles • Reviewing and implementing policy and institutional reforms that strengthen leadership, management and technical capacity for science in agriculture	
SAA 1.1.3: Identify broad areas of science and guide the setting of continental, regional and national agricultural science priorities and themes connected with the needs and opportunities in Africa's agriculture.	• Continental, regional and national priorities aligned, priorities harmonised and mega/flagship programmes and projects developed	• Expert level validation, expert peer review and approval processes for mega/flagship programmes and projects • Capacity for evidence-based research planning, implementation, review and dialogue strengthened	• Knowledge generated across the complex agri-food system with the highest positive impact for socio-politico-economic, public and environmental benefits.
SAA 1.1.4: Develop instruments for aligning complex research challenges across multiple societal needs and across space (within and between member states and beyond),	• Entry points for operationalising S3A in implementing CAADP identified • New dimensions of transformation clarified • Entry points where policy reforms and decisions on public spending can make the 3AGT process inclusive of the poor, marginalized, women, and young people identified	• Identified entry points verified and shared through technology exchange and learning platforms • Analytical tools *(e.g. for quantitative foresight modelling to tackle a wider set of questions, application of GIS technologies for targeting and tracking the geographic spread of adoption, catalysing rigorous research on scaling up approaches used by the AAIS institutions and their partners, and political economy analysis to understand the constituencies for and against biotechnologies)* enriched	• Country and regional STI priorities aligned with principles and objective of STISA-P1 and the functions for achieving the objectives giving due emphasis to countries and populations in greatest need, and taking into account gender equality, universal coverage, as well as the economic, social and environmental determinants
SAA 1.1.5: Facilitate the necessary transformation and sustenance of basic science and technology capacity at national level, and ability to leverage knowledge and new technologies from the regional and global stocks of knowledge and partnerships	• Situational analysis and mapping to identify key stakeholders, players and institutions involved conducted • Issues papers on specific capacity needs determined and prepared	• General frameworks and training/skills improvement programs for key AAIS players and institutions developed and operationalised	• Strengthened and functioning systemic capacities, governance policies and legislation to conduct and apply science to agriculture • Enhanced skills, knowledge and agricultural education

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	*Table 4* Phase 4 (2021 – 2023) & 5 (2024)
	• Repositioning and refocusing of institutional core competences and interventions facilitated • Partnerships and strategic alliances to ensure efficiency in the implementation of core functions and making science work for Africa's agriculture renewed.		
SAA 1.1.6: Establish functional innovation partnerships, platforms and collaboration for deepening STI in agriculture, promoting an inclusive innovation culture and adoption of IAR4D, innovation and entrepreneurship, leveraging existing relationships with relevant partners within and outside Africa to deal with emerging challenges	• Existing Communities of Practices, continental networks, African champions for S3A identified, consolidated and harnessed • Frameworks, operational inclusive platforms, processes and stakeholder engagement mechanisms for regular and systematic priority setting, performance review and dialogue established and facilitated	• Functionality of existing/proven "innovation to impact pathway" platforms (e.g. CARP, IAR4D, IPTA, ULP, UniBRAIN) intensified • Consistent, predictable and credible platforms that provide systematic, focused and structured response to STI knowledge and capacity needs on the continent developed and maintained • Increased number of programs being implemented through partnerships • Functional regional training nodes and centres of excellence established and strengthened	• Well facilitated sustainable bio-economy and sharing of related science and institutional knowledge
SAA 1.1.7: Mainstream the visibility of science at national, supra-national and at community level	• Policies and regulations to promote the production, trade and use/application of agricultural STI outputs (technology, knowledge, innovations) developed and/or harmonized	• Public acquainted and engaged with the advances of and debates in science, engineering and technology through lectures, presentations and forums. • Science museums and science activity centres engaged with and their establishment (either actual or virtual) promoted in countries where they do not currently exist	
SAA 1.1.8: Production of scientific outputs – generate knowledge, appropriate technologies, policies and institutional innovations for promoting generation and	• Strategic planning function within AAIS and AET institutions and internal capacities of research and training units and actors to articulate agricultural	• National and regional efforts to foster public-private-partnerships in the production and use of knowledge, technologies and innovations promoted and supported • Mechanisms for identification, inventory, verification, adaptation and protection of	• Improved availability and access to and use of productivity-enhancing factors of production including new varieties and breeds and inputs by end users.

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	*Table 4* Phase 4 (2021 – 2023) & 5 (2024)
uptake of technologies and agribusiness for enhancing food security, jobs and wealth creation	STI/research and training needs strengthened • Strategic priorities determined and scientific/academic research and training initiated	technologies (including patenting of indigenous innovations and technologies) institutionalised • Working capacity of young researchers for problem solving and adaptive research, strategic/subject matter and disciplinary research and basic and fundamental research strengthened	
SAA 2.1.1: Promote solidarity among African countries in building shared science and educational capacities, sharing technologies across countries and regions including sharing information, facilities and staff	• Resources to invest in agricultural R&D infrastructure, priorities and scaling up existing innovations and technologies mobilised	• Cooperative higher education and research networks and communities of practice, both for research and innovation and for teaching created • Increased access, mobility, employability of different academic-research-student groups • Regional research networks aimed at solving regionally specific challenges created. • Increased investment in STI &AET facilitating development, promoting stability, enhancing access and equity, recruitment and retention of excellent academics and scientists, and pursuance of cutting-edge research and high quality teaching	• Regional development based on solidarity, social justice and peace, democracy, inclusion, equity, universality, trust and transparency • Greater investment in STI & AET, improved citizenry employability and enhanced diversification, differentiation and harmonisation at all levels to enable consolidation and assure the quality of educational provision against locally, regionally and internationally agreed benchmarks of excellence
SAA 2.1.2: Establish National and Regional multi-institutional Hubs/Centres of Excellence – research centres, research-intensive universities, vocational institutions, digital libraries	• Competitive analyses undertaken and information about the status of the present system in terms of needs, providers and outcomes compiled • Benchmarks and targets for establishment, rehabilitation, reform and re-equipment of institutions set • RUFORUM Regional Programmes, African Higher Education Centres of Excellence (AHECE) and Pan African	• National and Regional Centres of Excellence for agricultural R&D, AET and other STI areas (e.g. STEM) have the necessary resources to continue to fulfil their full range of purposes such as preparing students for life as active citizens in a democratic society; preparing students for their future careers and enabling their personal development; creating and maintaining a broad, advanced knowledge base and stimulating research and innovation. • Continental and Regional networks and Designated Technical Agencies *[Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), Forum for Agricultural Research in Africa (FARA), Pan African University (PAU), African Academies of*	• Africa repositioned as a major global actor, where all STI & AET institutions are responsive to the wider needs of society through the diversity of their missions and scientific productivity. • Greater compatibility and comparability and increased international competitiveness of the African STI and AET systems

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
	University (PAU) projects[7] supported to advance Africa's goal of enhancing its competitiveness and growth through the creation of high quality higher education and research capabilities	*Sciences, Association of African Universities, African Network of Science and Technology Institutes and similar bodies]* strengthened and serving as scientific think-tanks and academic governing bodies.	
SAA 2.2.1: Adopt AESIF as the instrument for a transformed Africa's AET system for the needed human capital to achieve CAADP and Malabo Declaration objectives on agriculture-led development in Africa	• Unified vision by all AET service providers and continental frameworks on AET (reform agenda with emphasis on job creation) developed and adopted	• AET integrated and effectively implemented in national and regional development priorities and actions.	• Enhanced agriculture education, skills development and knowledge support
SAA 2.2.2: Strengthen Regional research and training nodes and centres of excellence as the instrument for developing high level STI capacity for STISA-P1 and other Priority Areas	• Functional regional training nodes and centres of excellence established and strengthened	• Functional regional training nodes and centres of excellence established and strengthened	• High quality, massive, vibrant, diverse, differentiated, innovative, autonomous and socially responsible STI & AET sectors producing the human capital and STI needed for inclusive and sustainable development, democratic citizenship
SAA 2.2.3: Undertake institutional and organizational reviews and mapping to align mandate and human capacity for effective implementation	• Competitive analyses undertaken and information about the status of the present AET system in terms of needs, providers and outcomes compiled • Benchmarks and targets for the implementation of the AESIF and	• Institutional reviews done in 50% of countries to generate knowledge to inform decision making for developing human capital in science, implementing institutional reforms and synthesizing policy options	• Institutional reviews done in all countries and reforms initiated/on-going • High performing African universities that produce skilled, proactive graduates, demand driven research outputs and innovation in response to national, regional and

[7] PAU Institute of Basic Sciences, Technology and Innovation (PAUSTI) at Jomo Kenyatta University of Agriculture and Technology (JKUAT); PAU Institute of Life and Earth Sciences (PAULESI) at the University of Ibadan (UI); PAU Institute of Governance, Humanities and Social Sciences (PAUGHSS) at The University of Yaoundé II (UYII)

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
	national, regional and continental strategies set • Investment and human capital development in Higher education and other Tertiary institutions tracked		continental agricultural development priorities
SAA 2.2.4: Provide support to countries and RECs that enhances implementation and institutional learning, including training and education programs that respond to country and regionally identified capacity building needs.	• Guidelines for determining local learning agenda developed and learning platforms and tools developed • International collaboration promoted at the regional and global level among all stakeholders in IBSE/STEM and STI in general	• Learning networks and platforms functioning • Inquiry Based Science Education(IBSE) and Science Technology Engineering and Mathematics (STEM) Education promoted in all levels of education as a way for students to attain understanding of fundamental scientific concepts in particular and evidence-based critical thinking skills in general.	• Improved quality and relevance of science education in all African countries. • Peer learning impacting on adaptation and refinement of STI/S3A/AET governance policies and practice
SAA 2.2.5: Improve planning, governance and implementation of Agriculture Education and Training (AET) at country, regional and continental levels	• Greater collaboration fostered among actors and agencies concerned with agriculture in general and with AET in particular • Policy formulation guided and frameworks for the maintenance, coordination, implementation and review of AET developed	• Science academies, social science academies, academies of engineering and technology, scientific communities, ministries of science and education and decision maker actively involved in working with educators, teacher-trainers and scientists in the task of educating the future generation about science, scientific thinking and the impact of science and technology on society. • Adoption of appropriate legislative and regulatory frameworks necessary to protect the education and training rights and interests of agricultural and rural role players facilitated	• Increased public accountability and public confidence in the AET system as a crucial element of its success • Development and provision of nationally/regionally coordinated, effective, responsive and quality assured AET that is accessible
SAA 2.2.6: Review and update relevant curricula and design and implement training programmes that, in addition to strengthening the instruction in traditional agricultural science disciplines, enhance capacity for implementation and accountability and impart	• Agricultural education and vocational training curricula in place • Strategy for equipping young 'agripreneurs' with relevant skills in agricultural value chains developed	• Reforms undertaken for the AET system in the agricultural sector in at least 25 countries • Universal provision of market-oriented training courses for young 'agripreneurs' on agricultural value chains • Train the next generation of scientists in African Universities - enhance the knowledge and skills of the teaching staff, facilitate emergence of competitive postgraduate programs ensuring	• Spectrum of disciplines included in AET incorporate current and future trends and opportunities • Strengthened science education - with a focus on the proven methods of inquiry-based science education (IBSE) and Science, Technology, Engineering

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
practical and entrepreneurial skills	• Integrate ICTs in teaching, learning and research in African Universities	quality of graduates and relevance of research, make graduate students confident, life-long learners creative and able to take the initiative and adapt their learning to the local situation	and Mathematics (STEM) Education
SAA 2.2.7: Africa-wide "Academic and Scientific Mobility Programs", including mobilising diaspora through national and regional initiatives	• Regional and conceptual framework for integration processes developed • Concepts and definitions of student and staff mobility, existing programmes and mobility projects[8] -their structure and objectives, trends in student-academic-scientific staff mobility and the impact of 'free movers' into, out of and within the region reviewed and guidelines for the future of inter- and intra-regional mobility proposed • Within the context of a wider African Economic Community (the Africa Free Trade Area) – foster a multifaceted model for greater cooperation that will see the *free movement of technologies, innovations, knowledge, services, investment, skilled labour and freer flow of capital* - single market and production base	• Greater Intra-African mobility of people and exchanges of faculty and students in order to encourage networking and increase diversity of experience in teaching and research facilitated • *"Common Space for Higher Education and Agricultural Research" (CoSHEAR)* based around four main priorities: *student mobility, credit transfers, quality assurance, and research clusters* created • ***"Science without Borders"*** - drive towards greater integration of Africa's higher education and research institutions, academic and professional/technical links and staff mobility for academic and knowledge transfer/exchange allowing people to study, train, work or volunteer abroad strengthened.	• Competitive economic position (relating mainly to regulatory structures and policy development with respect to consumer protection, intellectual property rights and taxation) • Equitable economic development among member states; full integration into the global economy.
SAA 2.2.8: Strengthen ongoing training, retention of trained	• Higher AET and other STI disciplines on the African	• Targeted investments to reverse effects of long periods of neglect, the brain drain, poor	• Strengthened science education - with a focus on the proven

[8] Some examples: The EDF funded intra-ACP academic mobility scheme; the Mwalimu Nyerere Scholarship Scheme for Africa of the African Union Commission (AUC); The Young Professionals Program (YPP) at the African Development Bank (AfDB)Group; The Pan African University Project; Scholarships, Grants, Fellowships and Financial Aid Positions for Bachelors, Masters, and PhD studies - See more at: http://www.scholarshipsbar.com/africa-scholarships-fellowships-grants-financial-aid.html, Regional and Institutional protocols and partnership agreements, etc.

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
academics, agricultural scientists and researchers and establish/support agricultural research and training networks, institutions twinning, collaborative research, etc.	continent promoted - *by supporting among others the main functions of universities including teaching, research and community engagement, cooperation and exchange of ideas, training, curriculum development, and dissemination of information, networking universities and building capacity*	infrastructure, inadequate technical skills, weak leadership and management skills, poor ICT access, low research capacity, and weak university-research-industry linkages.	methods of inquiry-based science education (IBSE) and Science, Technology, Engineering and Mathematics (STEM) Education
SAA 2.3.1: Develop/strengthen M&E systems – improving baseline data and statistics, enhancing data generation and analytical capacities, working with partners at multiple scales for harmonized data collection, analysis and dissemination.	• Overall M&E Framework for STISA-P1 developed - *gaps in data and statistics on key indicators identified, capacity needs to collect and manage the data assessed and data collection instruments finalized; key indicator metrics identified and analytical capacity needs assessed* • Robust agriculture related integrated M&E and data systems established and implemented effectively by the RECs and the countries • Processes for identifying and designing the key indicators, recording and reporting progress against the key indicators as well as steering the process for designing the format of such progress reports guided	• Functional Observatory on agricultural research for development and the application of science in agriculture in Africa established • Data and statistics for evidence-based planning, implementation, monitoring and evaluation strengthened - *capacity to collect, manage and analyse data enhanced; data and statistics on all relevant key indicators generated and available in standard electronic formats* • All RECs and at least 70% of countries with robust agriculture related National Integrated Monitoring and Evaluation Systems (NIMES) and data systems at regional and continental level • Annual Progress Reviews, Participatory Impact Assessments, Process Monitoring, Operations Monitoring and Lessons-learned Workshops regularly conducted • Data sharing platforms and protocols reviewed/strengthened/developed and data on key indicators shared across and within AAIS actors & agencies and availed to the general public	• Data and statistics on all relevant indicators are available in standard electronic formats • All RECs and countries with robust agriculture related National Integrated Monitoring and Evaluation Systems (NIMES) and data systems

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
SAA 2.3.2: Facilitate the launch of new and improve existing systems, strengthen capacity for knowledge management and improve communication and knowledge exchange that is inclusive and respectful of cultural complexity and informs policy and other forms of decision making.	• Existing knowledge management approaches and management information systems reviewed - agree on any required changes • Knowledge Management Strategy with an emphasis on capturing knowledge and documenting experiences, ideas and common practices, strategies for support and resources developed • Knowledge and information support platforms and systems provided for evidence-based planning and decision/policy-making in the implementation of AR4D & AET & other STI programmes and the application of science in agriculture. • Lessons of experience from other successful Communities of Practice captured and adopted • Communities of STISA-P1 actors nurtured	• Workspaces for document management, knowledge sharing and team collaboration in support of the Knowledge Management (KM) Strategy created and populated for supporting virtual teams • Digitally enhanced electronic platforms provided - *for continually capturing the demand and supply of innovations, capacities and competencies and overlaying the relevant metrics for revealing gaps for informing and targeting of investments and interventions* • Increased and informed engagement of communities, and enhanced technical and political support for STI, S3A, AET and agriculture transformation • Knowledge base, including identifying STI experts for a "Help Desk", keep it running, capture and summarize knowledge emerging from online discussions updated and maintained • Learning products designed and produced	• Best practices from the various portfolios for knowledge management as per the Knowledge Management agenda of the STI/S3A/AET actor platforms captured
SAA 2.3.3: Establish and implement a framework for tracking investment and human capital development in African Universities and other Tertiary institutions	• Capacity of RUFORUM network partners to collect and analyse data from government, higher education, non-profit, and (where possible) private-sector agencies involved in AR&D and AET strengthened. • Datasets continuously analysed; results of this analysis disseminated to promote advocacy, support policymaking, and build national and regional	• Accurate, reliable, and internationally comparable quantitative information on investments, human capacity, and the institutional structure of AR&D and AET fundamental to understanding the contribution of STI to agricultural growth provided to African countries and partners. • Regular status updates and trends of key indicators of performance of Africa's AR&D, human capital development and investments at African universities and other AET/STI institutions analysed and provided • Key indicators provide both a diagnostic tool for assessing the allocation and use of existing	• Information supplied promotes greater understanding of the status and direction of national STI systems and constitutes a powerful resource for national and regional AR&D and AET managers, policymakers, donor organizations, and other stakeholders.

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
	capacity for data collection and analysis.	resources and an advocacy tool for increasing resources and improving the efficiency and effectiveness of resource use.	
SAA 3.1.1: Support and promote science & technology commercialization and agribusiness innovations	• Base line survey to assess the current situation on scientific research and academic institution conducted • Common frameworks for networking and for conducting specific studies of value chains provided to AAIS actors.	• Frameworks and programmes that take scientific research to reality by putting in place facilities and hubs that incubate scientific innovations, and agricultural value chains developed and implemented on ground • Demand-driven innovations validated; • Increased capacity to generate and uptake technologies for enhancing food security; and for developing agribusinesses for job and wealth creation and stimulating agricultural production • Youth and women nurtured through incubation to the level where they can initiate businesses and grow them • Enhanced value chains through training, research and production units.	• An agriculture that is technically dynamic, embedded in an inclusive process of transformation, and served by well-functioning value chains that create opportunities for income growth and improved food security created
SAA 3.1.2: Support tertiary educational institutions to offer trans-disciplinary scholarship to produce "liberally educated, scientifically literate and professionally prepared students", developing human resources capable of creating and sustaining globalised and knowledge-based societies	• Historical emphasis on primary production addressed and the spectrum of disciplines included in AET widened to incorporate current and future trends and opportunities	• Increased access to quality education • Improved student mobility and access to study and training opportunities and to related services • Improved staff (academics, researchers and administrative) mobility and employability; recognition and valorisation of periods spent in an African context researching, teaching and training, without prejudicing their statutory rights.	• AET programmes able to encourage, enable and promote attraction and retention of students along with mobility of staff (academic and administrative), while increasing the competitiveness and attractiveness of the institutions themselves.
SAA 3.1.3: Support development and delivery of agribusiness management training programmes backed by appropriate contextual research.	• Professionals looking to use business incubation to enable the start-up and growth of innovative agribusiness enterprises identified and trained	• Agribusiness management and entrepreneurship capabilities of leaders and managers of producers' associations as well as those of technicians from government, NGOs and the private sector, who provide technical assistance to agro-enterprises improved.	

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
SAA 3.2.1: Support Networks to lead Agribusiness transformation in Africa	• Business relationships forged across borders, sharing knowledge and insights, influencing the policy agenda and championing the investment opportunities that exist in the STI sector • Demonstration cases that catalyse new business start-ups created.	• Access to market linkages, technology, finance, equipment and facilities facilitated • Guidance on regulatory requirements, quality and safety standards provided • Entrepreneurs enabled to successfully establish and grow their businesses, manage risks associated with agricultural STI products • Increased coordination between actors within target value chains	• Successful Agribusiness Incubator programmes
SAA 3.2.2: Strengthen outreach and community engagement programmes (of Universities, research institutions, HIEL) to foster the turning of research results into innovations of value to small-scale producers and the private agro-enterprises and agro-industries that serve them.	• Understanding of science, engineering and technology through engagement with society across a wide range of communities and contexts promoted • Effective partnerships with the mass media for societal outreach of science and technology, interaction with social media for direct communication with a wide range of communities	• Public acquainted and engaged with the advances of and debates in AET, science, engineering and technology through lectures, presentations and forums. • Science museums and science activity centres engaged with and their establishment (either actual or virtual) promoted in countries where they do not currently exist	
SAA 3.2.3: Develop incubation centres and industry linkage programmes for transfer of technology and creation of PPP to assist in agribusiness financing	• Advice on strategy, management, operations, marketing and technology provided through Agribusiness Incubation programmes	• Industry assisting national academies of science, universities, research institutions and their national governments to enhance IBSE/STEM education and STI policies and initiatives	• Formation of a creative and innovative human capital that will enable enterprises to remain competitive in the increasingly fast-paced science and technology-based development environment.
SAA 4.1.1: Facilitate development of models of governance for ensuring agricultural STI is integrated in strategies, plans and programs at national and regional levels; connected to	• Knowledge to inform policy, strategy, decision-making for developing human capital in science, implementing institutional reforms and	• Formation of Parliamentary Science and Technology Committees and President/Prime Ministers' Science Advisor Offices in all countries.	•

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
end-users at national level; is appropriately applied to agriculture at national and regional levels	synthesizing policy options generated and applied		
SAA 4.1.2: Facilitate the development and application of harmonised mechanisms for identification, inventory and protection of technologies (including patenting of indigenous innovations and technologies)	• Existing policies and programmes *(e.g. IPR, trade and exchange of germplasm and technology, research/education standards and quality control, etc.)* reviewed, harmonized and integrated in agricultural and STI policies and programmes	• Integrated approaches to support STI, S3A and AET promoted and up-scaled	• Scaled up and coordinated implementation across sectors at national, regional and continental levels
SAA 4.1.3: Establish policies, quality assurance, registration, accreditation and qualifications frameworks at national and regional levels for the achievement of greater compatibility and comparability, increasing the international competitiveness, ensuring operational autonomy of higher education and research systems	• Comparable criteria and methodologies, with regards to curricula development, inter-institutional co-operation, mobility schemes and integrated programmes of study, training and research developed	• Greater push for all 54 AU member countries to ratify the UNESCO-backed 2014 Addis Convention[9] on the continental "Bologna Process" based on the "need for increased attention to quality assurance, qualifications frameworks and higher education integration in Africa"	• AAIS and STISA-P1 actors continuously adapt to changing needs, society's demands and advances in scientific knowledge • Effective exercise of free movement promoting citizens' mobility and employability.
SAA 5.1.1: Facilitate the analysis and review of existing policies, support policy development and formulation, design and implementation of institutional reforms that are evidence-based, transparent and inclusive of all stakeholders	• Credible ***"Policy Practice Indices"*** for peer review and country comparisons (policy coherence, responsiveness, effectiveness) to stimulate policy reforms and best practice developed, adopted and used	• Policy reforms initiated in all countries • Noticeable shifts from factor-based to knowledge-based and innovation-led development strategies	•

[9] – the Revised Convention on the Recognition of Studies, Certificates, Diplomas, Degrees and Other Academic Qualifications in Higher Education in African States that replaces the 1981 Arusha Convention, which has only been endorsed by 20 countries. The Addis Convention is meant to be similar to the Bologna process – one of the world's most successful processes of harmonising university degrees. Through a mutual agreement, Bologna has created a European Higher Education Area involving more than 40 countries.

Table 4

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	Phase 4 (2021 – 2023) & 5 (2024)
SAA 5.1.2: Facilitate the provision and sharing of tools, including incentives to support the adoption and implementation of effective STI policies at the country and regional scales.	• Continental strategies and frameworks for providing ongoing incentives to implement and report on the Malabo, STISA, S3A and AET goals developed and adopted	• Continental strategies on rewards and sanctions implemented at AU summits and among 50% of the RECs	• Rewards and sanctions implemented among all countries, RECs and at continental level
SAA 5.1.3: Establish and strengthen/foster effective partnerships (both horizontal and vertical) and multi-stakeholder platforms for coordination, review, dialogue and debate among partners and stakeholders at country, regional and continental levels	• Guidelines and tools for review, dialogue and mutual accountability on pursuing the Malabo, STISA, S3A, AET goals and targets in place	• Institutionalized mechanisms for mutual accountability and peer reviews at continental level (biennial reviews at AU Summits) and in at least 50% of the countries and 5 RECs	• Coordinated and aligned mechanisms of peer review and mutual accountability on achievement of the STISA and Malabo goals and targets taking place at continental, regional and country level
SAA 5.2.1: Identify and enhance innovative financing models for increased public and private sector finance and strengthening the contribution of STI to 3AGT	• Regional and country proposals and guidelines for new, innovative and best practice financing models and products for generating public and private money to finance technology generation and use developed	• Reviewed and regularized informal systems for public and private sector financing of agricultural science education, training and practice integrated into mainstream financing options	• Increased public and private sector finance • Well facilitated STI sector development - *promote stability, enhance access and equity, recruit and retain excellent researchers and academics, and pursue cutting-edge scientific assessment, technology generation and use, high quality teaching and innovation processes that will strengthen the contribution of STI to 3AGT*
SAA 5.2.2: Provide evidence and guidance to countries on financing principles and strategic investments in STI for accelerated increases in agricultural productivity, equitable development and	• Expenditure reviews undertaken and used to mobilise funds • Access to existing funds by STISA-P1 institutions – e.g. the	• At least 70% of the national agricultural R&D investment plans funded by government – STISA 2024 target of investing 1% of GDP in R&D (international average is 1.77%)	• 100% of the national agricultural R&D investment plans funded by government – STISA 2024 target of investing 1% of GDP in R&D

STISA-P1 Sub Actions	Phase 2 (2015 - 2017)	Phase 3 (2018 – 2020) Milestones	*Table 4* Phase 4 (2021 – 2023) & 5 (2024)
sustainably productive environments	Global Innovation Fund[10], African Centres of Excellence (ACE) Project… facilitated		
SAA 5.2.3: Provide incentives for sustainable financing of STI through increased investment into agricultural R&D and education by domestic public and private sector, African philanthropy, international private foundations, bilateral donors, multilateral programs of donors, and development banks.	• International and regional organisations, like the UN, UNESCO, development banks, African philanthropy encouraged and engaged in order to expand scientific literacy and STI financing through their programmes		

[10] The Global Innovation Fund (GIF) is a $200 million joint initiative of the international development departments of the UK, US, Australia, Sweden, and of the Omidyar Network launched in 2014. The fund invests and provides support for the development, rigorous testing, and scaling of cost-effective innovations targeted at improving the lives and opportunities of millions of the poorest people in developing countries. Through grants and risk capital, GIF supports breakthrough solutions to global development challenges from social enterprises, for-profit firms, non-profit organisations, researchers, and government agencies. At the Pilot stage, GIF provides seed capital to support the start-up and field-testing of innovations. At the Test & Transition stage, GIF funds innovations that have already demonstrated success at a small scale. At the Scaling Up stage, GIF supports the expansion of innovations that have already demonstrated a strong track record of social impact and effectiveness.

4. IMPLEMENTATION MODALITIES

4.1 STISA Implementation Framework

For STISA to ensure science-centred technological innovation as the driver for economic development in Africa and to "Accelerate Africa's transition to an innovation-led, knowledge-based economy", the state of STI readiness in Africa in terms of infrastructure, technical and professional competence, and entrepreneurship development has to be improved; and specific policies and programs in science, technology and innovation that address societal needs implemented. The broad implementation framework outlined for STISA (Figure 4[11]) is critically reliant on the intrinsic STI capacity that is needed to support the six priority areas, through flagship programmes. Central to the STI capacity are four mutually reinforcing pillars or "prerequisite conditions for success" that focus on: *a) Upgrading and/or building research infrastructure; b) Enhancing technical and professional competencies; c) Innovation and entrepreneurship; and, d) Providing an enabling environment for STI*. Further, the pillars are equally important across the six priority areas and will require strategic focus to ensure that they play their roles in achievement of STISA 2024.

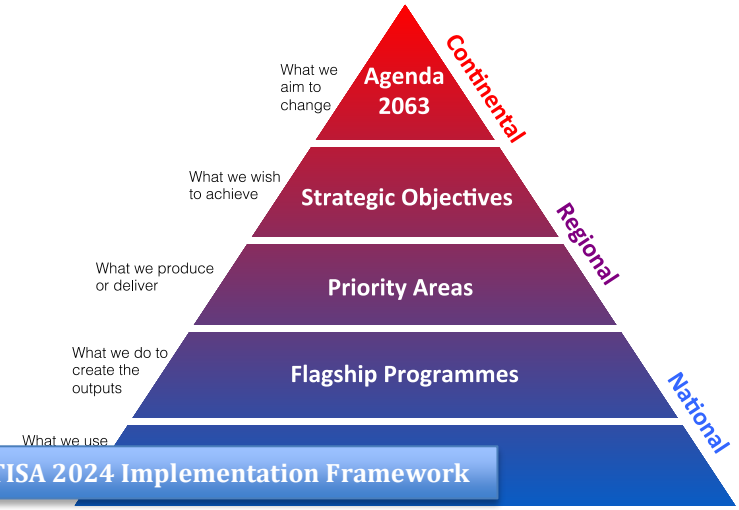


Figure 4: STISA 2024 Implementation Framework

Fundamental to this re-orientation, and in the context of STISA-P1, is the need for enhanced agricultural education capacity to produce skilled agricultural labour and devising appropriate remedial measures to problems of food and nutrition insecurity and poverty, in addition to general human capital development, building STI capacity, providing evidence based information to policy makers and other key stakeholders and fostering community development through transfer of knowledge and skills. Hence, the successful implementation of flagship programmes, aligned to the priority area, requires efforts by member states and RECs to build and strengthen these pillars within their respective NASTIS and RASTIS, with strong monitoring and evaluation systems in place to ensure and demonstrate the impact on the ground.

4.2 Implementation Principles

4.2.1 CAADP Implementation Principles

The operationalization of the CAADP IS&R is underpinned by a set of crosscutting principles. These principles, which are relevant to all 11 SAAs, are:

a) ***Accountability:*** Lead institutions will be held responsible and accountable for what they commit to, what they actually do and what they achieve.

[11] NPCA: Implementation plan for STISA-2024. Draft of August 2015

b) ***Evidence-based:*** All decisions will be made based on the best and most credible data, information, analyses and knowledge available.

c) ***Transparency:*** Strongly linked to the principle of evidence-based decision making, all decisions will be made in an open manner with full disclosure of the process, rationale and evidence used. The processes used will also be inclusive and participatory drawing on broadly-based stakeholder representation.

d) ***Inclusiveness:*** All initiatives will be purposefully designed and targeted so as to ensure that women, young people, the poor and other marginalised and vulnerable groups amongst smallholders, pastoralists and fisher folk, as well as the more powerful and able, actively participate and enjoy their fair share of the benefits.

e) ***Local ownership and leadership:*** The IS&R will be implemented by and for Africa, with continued political commitment and leadership at all levels – from continental, through regional and national, to sub-national. Local ownership will be ensured through the use of inclusive and participatory processes.

f) ***Subsidiarity:*** Decisions and actions will lie with the lowest level of government or organisational entity or structure practicable.

g) ***Sustainability:*** All initiatives will be designed so as to be both environmentally and economically sustainable; they will neither deplete natural resources nor be dependent in the long-run on one-off or short-lived funding sources.

h) ***Commercial orientation with a deliberate effort to nurture the domestic private sector:*** Closely aligned with economic sustainability, in most cases the private sector will be an important implementation partner, often taking the lead. Although special effort will be made to nurture and support the domestic private sector, the enormity of the task at hand demands that all levels of the private sector - from fledgling domestic businesses to long-established multinationals - will need to be pro-actively engaged as partners.

4.2.2 STISA Implementation Principles

Africa's STI landscape will be guided by systemic overarching principles of inclusivity, collaboration, co-ordination, transparency, accountability, co-investment, indigenous ownership, sustainability and communication. These principles are intended to move Africa's development journey towards an innovation-led and knowledge based economy, which will be aligned with the key societal priorities based on the following interrelated guiding principles:

a) ***Social Innovation:*** Programmes and projects will be developed to effect a social change for wealth creation by re-directing innovation to address the needs of the society at the base of the consumer pyramid. Social innovation is an inclusive system that leads to affordable access to quality goods and services for the poor on a sustainable basis. These will ensure that new goods and services are developed for and/or by those who have been excluded from the development mainstream. This will lead to the development of new ideas, technologies or methodologies that challenge and improve upon existing processes, services, communication and organizations, thereby improving the lives of citizens or the function of the society that they live within. It offers a new approach to solving community problems

b) ***Gender, Youth and Persons with Disabilities:*** All initiatives will be purposefully tailored to include active participation of youth, women and persons with disabilities, both in the development and implementation of the strategy at all levels as well as uptake and utilization of products.

c) ***Green Innovation:*** Most of programmes, projects and activities will be implemented taking cognizance of the "green concept" that is driven by concern for quality of life and resource security in the African continent as well as securing a clean and green image as a means to achieve sustainable growth. It presents, opportunities for exploiting greater potentials for synergies between economic, social and environmental challenges that drive concern for realizing a low-carbon, conservation of natural resources, recycling, and nature-conscious society as well as an effective way for adaptation and reduction of greenhouse gas emission in the overall context of climate change impacts.

d) ***Partnership Innovation***: The initiatives are construed to consider the public and private sectors as key players in developing measures to ensure stability and fiscal consolidation, as well as actions to foster growth, competitiveness and employment. Implementation of partnership innovation is emergent, generative, resilient, participatory, human-centred, and driven by a process of validated learning where core assumptions are tested quickly and interactively – and lead to better solutions that are both impactful and durable. It will also lead to information sharing and knowledge flow across the continent.

4.2.3 S3A Implementation Principles

a) ***Mainstreaming the Science Agenda:*** Guided by the Sustaining CAADP Momentum strategic outcomes and strategies, regional and continental entities, and development partners at that level, need to weave the S3A into support programmes to national CAADP investment plans. In turn these support activities will focus on ways of infusing the S3A into national programmes and priorities. Development Partners and the CGIAR in particular, will value the use of the S3A in crafting their partnerships and collaboration with African institutions.

b) ***Strengthening African ownership and leadership:*** African scientists and science administrators have to embolden themselves to own the problem analysis role, and as science leaders deepen the problem analyses and bring better quality evidence (both qualitative understanding of issues and quantitative measurement of the same), to better ably craft scientific initiatives, policies and development models that Africans own intellectually and practically.

c) ***Sustaining a basic science capacity at the national level:*** Each country will necessarily have its own strategy that defines its needs for science and agricultural research in transforming its food and agricultural sector. Well-structured and well-resourced national systems have a wide array of potential partners and are attractive to new funding from national treasuries and the private sector as well as from donors. Facilitating uptake and utilisation of technologies needs a well thought out long-term strategy for professional, technical and vocational education aimed at enhancing the skills and expertise of its professional and technical human resources, agricultural producers and agri-business actors. Country strategies will reflect the sustainable scale of operation and the different investment trade-offs between accessing global knowledge, generating its own technology, and adapting research results from regional networks. This requires effective linkages between research, education, and advisory services and recognising the utility of an innovation systems approach in diagnosing constraints in internal flows of information, coordination, resources and people.

d) ***Integrating higher agricultural education with research and extension:*** Building the research, policy, service delivery and private sector capacities that will underlie the transformation especially of small-holder-farmers in Africa will depend critically on developing the human capital that is essential for effective and efficient agricultural institutions. Africa needs to train and retain high calibre agricultural researchers with postgraduate degrees, who are essential for the development of robust programmes and institutions in national agricultural research, higher agricultural education, agricultural policy and leadership across the agricultural sector.

e) ***African solidarity in science:*** Identifying and agreeing on important challenges and opportunities at national and regional levels, and then owning these collectively and collaboratively requires sharing of information and facilities to a greater extent than at present. "Solidarity for Science" is a commitment by African countries to a new approach to science and agricultural transformation characterized by openness to new knowledge, regional collaboration, shared benefits of discovery, and significant increases in academic and scientific mobility.

f) ***Regional (continental) and Sub-regional cooperation:*** Regional collaboration exploits natural comparative advantages through networks; allows specialization (whether acquired or natural); and facilitates attainment of economies of scale - particularly in the use of expensive laboratory equipment and data bases that are beyond the reach of individual countries. Regional collaboration is most effective when it addresses common problems that a country could not address on its own and when benefits are perceived to be shared fairly. Critical scientific mass can be built around dynamic portfolios of research projects, including capacity building, thus generating well balanced long term partnerships.

g) ***Integrating the knowledge institutions:*** With the growing numbers of universities, and established capacity in some natural "lead" universities, Africa is developing innovative approaches to regional collaboration. Regional university consortia, such as RUFORUM, have a role in raising standards across the region, generating economies of scale in use of training facilities, pioneering collaboration with new partners, and sharing scarce resources through offering regional post graduate degree programmes.

h) ***Role of the RECs:*** The RECs have a particularly important role to play in creating the regional environment and support to planning at the national level, sub-regional mobility and opening of trade and collaboration. As with economic exchange, scientific mobility and economies of scale in capacity building may begin first at the sub-regional level before taking off at the continental level.

i) ***Global partnerships in science:*** Science is a global enterprise; the most productive countries scientifically are those most strongly networked globally. New ideas, access to new technology and competition for funds all raise the quality of science and the productivity of scientists. The S3A will strengthen the framework for collaboration with global partners while, at the national level, an established programme of cross-ministerial scientific priorities will facilitate access by external partners to the differing capacities found in universities, research institutes and other actors in the national innovation system.

j) ***National commitment is the key that unlocks other support:*** Once a country has defined its optimal scale and scope of its system, it must make a strong commitment to sustain it from domestic resources, supplemented by but not dependent on, external support.

k) ***Mobilizing revenues from Africa's growing economies:*** The rising revenues from the growing economies in Africa have to be invested into the development of agriculture, especially through: building capacity of farmers' associations, finance institutions, and agribusiness agencies to work together; offering tax incentives and making preferential procurement choices for companies that source from small farmers; developing inclusive financial models that combine incentives, reduce debt risk and promote longer term agribusiness models.

l) ***The "Africa Science for Agricultural Transformation Initiative" (ASATI):*** A solidarity fund for science and a means to demonstrate long-term commitment to building science capacity in all countries of Africa through *Science honours, increasing scientist mobility, engaging the African diaspora.*

m) ***Transparent legislative and regulatory environment:*** A favourable policy environment for the performance of science will require clear legislation and regulations.

n) ***Managing the science-policy interface:*** Strengthening the science-policy interface requires that scientists become excellent communicators. It is important to disaggregate the messages to target specific audiences. Messages must be "credible, salient and legitimate", provide sensible proxy indicators in the language of policy makers to help in understanding risk and causal relationships and general support in making decisions in uncertain contexts.

o) ***Strong commitment to women and youth:*** A country cannot ignore the potential of 50% of its population when training and using its science capacity. Women will continue to expand their proportion in the scientific disciplines; the human resource and policy environments must ensure equity in their advancement. The attraction of the best young people to scientific pursuits, to field-oriented agriculture, and to technical support skills for servicing farm equipment is a demographic plus, if educational policies stimulate orientation in these directions.

5. GOVERNANCE AND MANAGEMENT

Building systemic capabilities at all levels is key to implementing STISA-P1. Africa indeed does have institutions in place at national, regional and continental levels. Partnerships with international research institutions have also matured over time. The challenge in realizing the STISA-P1 vision, therefore, lies in strengthening the capacity of these institutions and more especially in rebuilding the sharing, collaborative and learning capabilities. Doing research does not in itself necessarily lead to innovation, rather scientists in teams and individually, as well as science administrators in Africa have to refresh their capacity for innovation by actively and consciously seeking breakthroughs across 'technical', 'infrastructural' and 'institutional' innovations.

The S3A and AESIF are therefore about how to do agricultural research and education more innovatively than hitherto. Most challenges in the search for agricultural productivity and competitiveness require the capacity for simultaneous solutions across technical, infrastructural and institutional bottlenecks. Innovation therefore becomes largely a function of the capacity of research teams to learn faster and deeper across disciplinary, subject matter and sectoral boundaries, and this often requires sharing and/or collaboration across stakeholder groups. It is this capacity for behavioural change and working in more practical and creative ways on the part of national and sub-regional organisations and higher education institutions that is likely to lead to greater impact.

5.1 Institutional Setting

Collective action and solidarity across stakeholder groups is necessary for effective and efficient implementation of STISA and CAADP programmes. Stakeholders across the board who are important in deciding STI priorities include, among others: a) organized farmer groups at national, regional and continental levels; b) education and training institutions including institutions that train farmers; c) extension services; d) NGOs that support farmers in various ways; e) private sector especially those based on inclusive business models; f) various government entities across various sectors involved in agriculture and rural development; and g) the various governmental and non-governmental institutions doing science for agriculture in Africa.

Given these multiple actors that are responsible for implementing various facets of this implementation plan, it is crucial that the roles and responsibilities of each are clearly delineated. Such delineation must be codified in a manner that the respective activities of these actors converge at a systems level. In addition, the monitoring and reporting architecture must be clear among these actors to allow for effective evaluation

and remedial action in a well-coordinated manner. The focal points representing these various actors must also be identified to ensure effective coordination through consultation and joint action. Such coordination efforts must also be channelled to mobilize resources, both human and financial, to give optimal effect to all S3A and AET endeavours. In this regard, it is recognised that the RECs have an exceedingly important role to play in such coordination efforts, as they represent the critical interface between the member states and the continental level STI organs and forums.

The implementation of STISA-P1 therefore requires minimum information on institutional setting and prerequisites. In order to establish benchmarks and baseline for the R&D and AET agenda in Africa and subsequently for future assessment of STISA-P1 and all other contributing frameworks and sectors, it is important to establish the current status of AR&D and AET; institutional organization capabilities and competencies; STI programming at country and REC levels; mapping of research and educational institutions and centres; and establishment of a Registration/Accreditation system.

5.2 Institutional Arrangements and Actors

The broad modalities for the implementation of the 2003 Maputo and 2014 Malabo declaration commitments and the STISA 2024, as operationalized in their respective IS&Rs seek to optimize linkages among national, regional and continental mandates and adhere to the subsidiarity principle. This is based on the recognition that STI and agriculture development are first-and-foremost national responsibilities to be pursued at the country level. There are, however, critical support functions, such as harmonization of policies, standards, and regulations across member states, which are best provided at both regional and continental levels where the comparative advantage lies.

5.2.1 Coordination Mechanisms

To be successful, the implementation of this plan has to be effected through effective coordination mechanisms for both state and non-state actors and stakeholders at each of the continental, regional and national levels. At each of these levels, programs have to be designed, elaborated, implemented, communicated and evaluated. Countries provide leadership to garner active participation and contribution of public, private, education and research, societal and funding sector stakeholders to design and implement various flagship programs and initiatives. RECs, AU Member States and designated Technical and Professional Agencies will also coordinate with the AUC and NPCA in implementing the broad STI Framework and CAADP Agenda and submitting implementation status reports. RUFORUM like all other continental institutions will largely provide catalytic support functions, including advocacy through continental and international platforms, facilitating linkages to continental and regional strategies and plans, and contributing to the strengthening of systemic capacities at national levels.

Core to the successful implementation of the STISA-P1 and CAADP will be strategic engagement of African countries with existing and emerging continental and international Communities of Practice (CoP) relevant for the delivery of agricultural transformation through the application of STI and agricultural education. A coordinated and systematic mechanism is required for identifying these CoP and developing modalities for working with them at national, regional and continental levels in a more coordinated and strategic manner, to leverage their interests and investments through partnership arrangements that meaningfully, efficiently and effectively contribute to the agriculture transformation agenda. International and continental development partner institutions and other stakeholders, including civil society and the media will also support the implementation by developing and/or aligning their programmes and providing financial and technical assistance. They will also play an important role in popularizing the importance of STI, S3A and AET in Africa's development.

The private sector will work closely with governments, academia, R&D institutions and development agencies to support building the necessary capacities and technical competencies required for countries, RECs and other continental organizations to reach the requirement for meaningful contribution towards addressing the priorities set forth in the STISA-P1 and CAADP. Development and technical partners - state and non-state institutions, private sector and civil society organisations - will be engaged to provide strategic support to the implementation at national levels, but this will require proactive engagement of countries.

Coordination seeks to ensure that:

a) Communication mechanisms are in place for regular sharing of ideas and plans among stakeholders at national, regional and continental levels, and that these mechanisms bring on board international partners as appropriate.
b) There is explicit and effective leadership charged with coordination responsibility of initiatives that involve multiple stakeholders and interests.
c) Investments are being made on highest priority actions as determined by countries – within and between the STISA-P1 and CAADP objectives and goals.
d) Investments from multiple sources are coordinated to avoid duplication and to achieve synergies as much as possible.
e) Regular reviews are done which inform reprioritization as may be necessary.

At the National level, *Joint Sector Reviews* have been agreed as the principal instrument for tracking and reporting on the sector specific agreed actions of implementation and provide the platform for discussing implementation. Other national platforms such as parliament, national budget review meetings and others provide critical additional review points. At Regional level, several regional platforms exist including: all stakeholder regional review platforms; thematic specific platforms and stakeholder meetings. Other major regional platforms include Regional Ministerial Meetings and Regional Heads of State Summits. At *Continental* level, coordination mechanisms include:

a) Biannual *AUC-NPCA-RECs Joint Planning and Review Meetings*, which allow the continental institutions to identify support needs at country level and gaps or overlaps in the support for programme implementation.
b) The STISA establishes *the African Scientific, Research and Innovation Council (ASRIC)* platform for the development of flagship programmes. The platform brings together scientific community academics, researchers, innovators, STI managers, funding agencies, entrepreneurs, business leaders, private sector, civil society and other stakeholders – to promote the production of high level scientific research agenda, strengthen the institutional basis of scientific knowledge production in Africa, promote a sustained dialogue of the sciences in Africa, be the voice of the scientific community, and encourage the development of sub-regional research and knowledge systems as the demand for these emerge and grow. ASRIC will work closely with various regional R&D institutions, operate on the basis of a Congress, and will be supported by specialized Scientific Committees that may further be composed of a number of sub-committees working on specific issues. The Scientific Committees under ASRIC will take charge of a specific research agenda, for instance, the Science Agenda for Agriculture in Africa.
c) Annual CAADP Partnership Platform (CAADP-PP) meeting, which serves as a continental mutual accountability mechanism, assesses progress and identifies emerging challenges among stakeholders. The commitments made by different stakeholders to support the implementation of CAADP are reviewed in that continental mutual accountability platform. The CAADP-PP Business

Meeting organized twice a year among key CAADP implementing institutions (AUC, NPCA, RECs, Development Partners, and key African institutions) conducts and guides implementation of commitments.

d) Conferences of the **Specialized Technical Committees (STC)** on *Agriculture, Rural Development, Water and Environment (STC-ARDWE)* and on *Education, Science and Technology (STC-EST)* which are organs of the AU and ministerial forums serving as the technical committees of Heads of State and Government. Each STC meets at least once in two years to discuss and review the implementation of previous commitments at country level. The STC is responsible for establishing policies, strategic priorities and coherent, coordinated approaches to developing and implementing strategies, and exercising policy oversight including mobilizing resources in the implementation. The STISA also proposes to establish a select Taskforce composed of ten Heads of State and Government to champion STI and education.

5.2.2 AUC, NEPAD Agency, and Designated Technical Agencies

The **African Union** (African Union Commission, NEPAD Agency, and *Designated Technical Agencies - DTAs*) will take the lead in facilitating the implementation of the STISA-P1 implementation plan. The main functions are to: coordinate the implementation of the different strategic actions – within and across the objectives and goals; facilitate harmonization of policies, standards, regulations and indicators across the countries and RECs; coordinate and facilitate analysis, synthesis and reporting of different commitments, including bi-annual reviews; mobilize resources and foster partnerships for coordinated financing and coordination in countries across regions and on the continent; assist countries in benchmarking, lessons leaning and scaling up working models across countries; and coordinate M&E and mutual accountability actions.

The **African Union Commission Secretariat,** through its ***Departments of HRST and DREA***, is responsible for providing political and policy leadership on all issues relating to implementation of the plan. Its specific roles will include:

a) convening meetings of STC–EST, STC-ARDWE and ensuring that resolutions of such meetings are transmitted to the AU summits;

b) initiating policy processes that are aimed at addressing specific agricultural science, technology, innovation, education and training issues;

c) supporting resource mobilization processes for the implementation of the strategy;

d) leading delegations to international processes and negotiations on agricultural science, technology, innovation, education and training issues;

e) providing a focal point for liaising with the United Nations agencies, its conventions and related agricultural, education and scientific bodies on matters pertaining to policy;

f) convening annual partnership platforms; and

g) creating various advocacy schemes for promoting agricultural science, technology, innovation, education and training.

The **NEPAD Agency**, through its ***Science, Technology and Innovation Hub (NSTIH)*** and the ***Designated Technical Agencies (DTAs)*** will provide technical and intellectual leadership and support when it comes to implementation of STISA-P1. Its specific roles include:

a) mobilizing and directing technical expertise, including regional and continental networks of centres of excellence to implement the programmes and projects established during the implementation of this strategy;

b) mobilizing financial resources for the provision of technical support to implement strategic programmes;

c) providing support in the development of national and regional strategies and action plans;

d) providing technical support to AU Commission's policy processes and activities;

e) monitoring international trends in agricultural science, technology, technology, education and training, ensuring that the necessary adjustments are made to the strategy to respond to the trends; and

f) monitoring, impact measurement and reporting on the implementation of the strategy.

The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) is a consortium of 55 African universities in 22 countries of sub-Saharan Africa (SSA) and has been facilitating innovative and responsive post-graduate degree programs and research since 2004. RUFORUM is expected to integrate North Africa in the near future. It promotes high performing, proactive graduates, a dynamic platform for university networking, and carries out advocacy for agricultural higher education. RUFORUM has considerable experience in facilitating staff and student mobility in the region, including supporting universities in the region to mobilize funding for mobility of postgraduate students, creation and nurturing of regional graduate programs, strengthening grassroots orientation and inter-disciplinarity of university research, and training and linking African Universities to policy. The Forum for Agricultural Research in Africa (FARA) is repositioning as a knowledge institution that uses data and knowledge management and development to drive capacity and technology development, partnerships and communication so that Africa and CAADP can maintain greater competitiveness, productivity and integration through science for agriculture. FARA led the development of the S3A. The Pan African University (PAU) is a continental academic and research institution comprising five institutes. The African Academies of Sciences, Association of African Universities, African Network of Science and Technology Institutes and similar bodies should be strengthened, to better serve as scientific think-tanks and academic governing bodies.

5.2.3 Non State Actors Coalition

The Non State Actors Coalition on CAADP (NSA Coalition) was formed in 2004. This coalition includes all actors in the agriculture sector who are not government or intergovernmental players: farmers, farmer organizations, civil society, non-governmental organisations, community-based organisations, faith-based organizations, grassroots movements, eminent persons, business and the private sector. Engaged effectively, this collation has the potential to garner a critical constituency for STI (S3A and AET) development in Africa. The strategy will be to use the NSA Coalition as a vehicle for civil society organisation (CSO) engagement to ensure that the efforts and investments by the CSO constituency at sub-national, national, regional and continental levels are most effectively harnessed to contribute to strategic priorities in a coordinated manner and that this constituency helps in advocating for best practices in the implementation of the IS&R; to effectively engage the private sector as a critical partner in transforming African agricultural science and education, through policy and institutional reforms that encourage and support private investments; support mechanisms and processes designed to create and strengthen farmer organizations; and create mechanism for media engagement to ensure appropriate messaging and as a means of awareness creation and promotion of best practices.

5.2.4 Development and Technical Partners

Development and technical partners have made significant contributions to African agricultural development through their investments, particularly in improving institutional capacity as well as financing of technical programmes critical to agricultural development. Although coordination of international development resources has been identified in the past as a challenge and some efforts have been made to address this, much remains to be done in this area. The implementation of this strategy will require more robust coordination mechanisms - not just among partners but also among relevant sectors and agencies responsible for agriculture within countries and at regional and continental levels. Explicit mechanisms will be developed as part of the implementation, strengthening what has been established and working towards consistent practice of coordination commitments that have been made.

5.3 Resourcing

STISA-2024 and the CAADP offer the African continent an opportunity to rapidly move towards a science-based agriculture and innovation-led economy. The success of STISA-2024 and CAADP Phase II depends on a number of factors, among them, is the increased R&D budgets at all levels and complete ownership of the programmes by member states. Each country is encouraged to take concrete actions to allocate at least 1% of GDP to R&D to ensure that Africa can define its developmental path with minimum reliance on external support. To ensure effective implementation, especially of the S3A and AESIF, at the regional and continental level, a strategy to mobilize domestic and alternative financial resources will be developed. Increased domestic funding would improve implementation and reduce over-reliance on external resources.

5.4 Communications

Communication mechanisms are important for regular sharing of ideas and plans among stakeholders at national, regional and continental levels, and that these mechanisms bring on board international partners as appropriate. The S3A and AESIF Implementation Plans should be popularized within AU structures, national, regional and international stakeholders. In the short- and medium term AU Member States and RECs should develop appropriate and complementary national and regional plans for STI communication and outreach and such plans should encourage dialogue with the public using their local language. A key aspect of communication and outreach is to regularly report progress and showcase local, national and regional achievements through case studies.

6. MONITORING AND EVALUATION

The broader STISA M&E strategy demands ensuring alignment to the Agenda 2063 and to the African Sustainable Development Goals (AfSDGs) and adopts the taxonomy developed for the broader M&E of the first ten-year implementation plan (2014-2023) of Agenda 2063. The monitoring and evaluation of this plan shall be based on the RUFORUM Theory of Change (Figure 5) - that lays out the impact being sought; outcomes that must change in order to achieve the impact; strategies to be used by partners to bring about the outcomes desired; and processes that will create the conditions and capacity of the system to put these strategies in place.

Monitoring refers to a continuing function that uses *systematic collection of data on specific indicators* of an on-going development intervention to indicate, to management and the main stakeholders, the extent of progress and achievement of objectives and progress on the use of allocated funds. *Evaluation* is the *systematic and objective assessment* of an on-going or completed intervention focusing on its design,

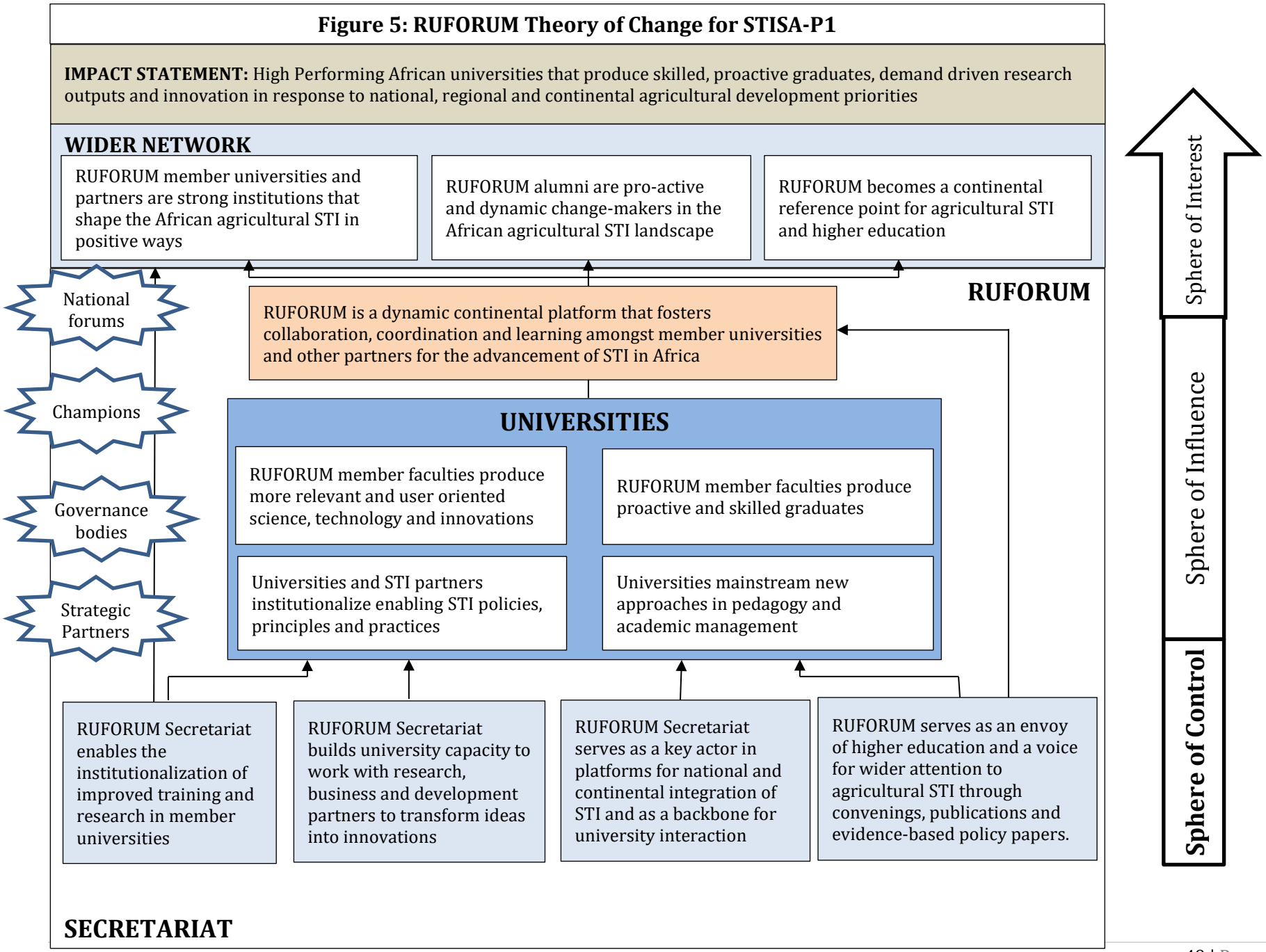
implementation and results so as to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact and sustainability. It should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision–making process of both management and the main stakeholders. The monitoring and evaluation system shall capture data and provide timely information on*:*

- Progress of implementation
- Effectiveness and efficiency of the implementation process
- Relevance of products and services generated
- Outcomes and impacts of products and services on target beneficiaries

A STISA-PA1 scoreboard shall be built from a list (data bases) of relevant indicators and statistics, which shall be obtained from African and internationally recognised sources. The scoreboard shall be organized in terms of inputs, activities, outputs and outcomes indicators for each of the member states of the African Union, as well as at the level of Regional Economic Communities (RECs). The component indicators and weights will be used to build composite indices, their scores collated and used to assess progress made in achieving the targets set in Priority Area One as well as the strategic objectives. Composite indices have the advantage of being comparable.

The appropriateness of outcome indicators are judged with reference to the Strategic Actions they intend or are expected to change by inducing policy actions. Outcome indicators may take various forms including: changes in rates, ratios, percentages and differences. By definition, any indicator captures only some aspects of the outcome that it is supposed to measure and to that end, expected outcomes envisaged in the context of STISA-PA1 may require more than one indicator. The M&E system shall use the scoreboard indicators and populate the selected outcome indicators in order to establish baselines. This will form the basis upon which outcome targets shall be set. The process must be inclusive and the targets should be relevant to ensure ownership by the stakeholders.

Figure 5: RUFORUM Theory of Change for STISA-P1



6.1 Categorization of Indicators

Systematically measuring the impact of agricultural STI interventions shall involve the application of an analytic framework in which both *performance* and *results indicators* will be tracked. In results-based systems, relatively greater weight is attached to indicators that are used to measure impact than to performance indicators, which are comparatively cheap and easy to monitor. This represents a departure from conventional M&E.

Performance indicators are used to measure the effective use of inputs to generate outputs, and to compare the actual effects of the inputs to their expected effects. Inputs are the *financial, physical,* and *human* resources that are employed by STI to produce outputs. *Outputs* are the STI *products – the goods and services* produced by introducing the inputs. Monitoring performance by determining how effectively and efficiently inputs are converted into outputs consists largely of book keeping and analysing financial records to produce financial reports and data that are entered into financial and management information systems. This information is used for cost-benefit analysis, and to calculate the costs per unit of output and a variety of input-output ratios that are used for financial reporting and in periodic progress reports.

Results indicators are generally classified as outcomes and impacts. *Outcomes are changes in people's behaviour—often through their response to incentives—that result from their access or exposure to STI outputs.* Optimally, these behaviour changes will advance the intended goals or impacts of STI. *Impacts are the ultimate effects of STI, whether intended or unintended.* Monitoring these higher-level effects of STI is significantly more involved than examining the information internally available in financial and management information systems, and entails soliciting information from clients and beneficiaries about how STI has affected them. It is important to correct any misapprehension that results indicators are monitored after performance indicators, for no such sequence applies. Results need to be tracked throughout the program's implementation so that corrective action can be taken mid-course – for instance identifying intended beneficiaries who are not being reached and determining why. This tracking of early results addresses a traditional weakness in M&E that is attributable to the time lag between when project outputs are provided and when higher level outcomes are or are not achieved.

There is an abundant literature regarding the selection of appropriate indicators, and extensive lists have been prepared suggesting suitable indicators for monitoring different types of projects and programs. These are useful reference materials, but in many cases, impractical to apply. Not only are there hundreds of indicators, but also, the data that underpin them usually cannot be secured with the necessary precision or regularity. When choosing indicators, the starting point should be the question *"Is this proposed indicator measurable?"* This helps considerably in the quest to identify a minimum list that requires the lightest of M&E structures. Even so, the range of possible indicators is still sizeable, which reflects the fact that the M&E systems still have to satisfy the needs of a broad range of users, and that their needs are not identical by any means.

The FAO and World Bank under the auspices of the Global Donor Platform for Rural Development published a Sourcebook in 2008 [12] of indicators for tracking results in agriculture and rural

[12] GDPRD/FAO/World Bank (2008): Tracking results in agriculture and rural development in less-than-ideal conditions, 2008

development that outlines a systematic approach that can be adopted to help prioritize the most critical indicators that need to be selected. It provides examples of how the methodology can be applied and used for different ARD subsector programmes. It should be noted that the number of indicators and the data required to compute them can grow rapidly. Even though there will always be good reasons for which the list of indicators needs to be expanded, there are also good reasons for starting small and making use of whatever data are available before collecting more. The Sourcebook strongly encourages the idea of integrating statistical capacity building into national M&E programmes from the beginning, so as to ensure a reliable supply of core statistics from which the required indicators can be extracted.

Table 5 presents a prototype set of core agricultural STI indicators as proposed by Speilman and Birner (2008)[13]. A more comprehensive menu from which a selection of indicators can be picked is presented in Tables 6 and 7. The actual selection of indicators should be a reflective and participative activity involving the key stakeholders who are most intimately associated with the project design and implementation – not an imposition of demands from outside. The Organisation for Economic Co-operation and Development (OECD) pioneered international efforts to develop innovation indicators in 1963. The publication of the *Proposed Standard Practice for Surveys of Research and Experimental Development* (better known as the Frascati Manual) set down a common methodology for collecting and analysing indicators on science, technology, and innovation in OECD member countries. The Frascati Manual contributed to the design of the Science, Technology and Industry Scoreboard, a compilation of OECD country data on innovation. The scoreboard provides country-level measures in the areas of research and development, human resources in science and technology, intellectual property rights performance, information and communications technology infrastructure, knowledge flows embedded in trade and investment, and global enterprise and the impact of knowledge on productive activities.

Several other measures of innovative performance exist, with indicators designed to measure country stocks of "innovation capital" and "imitation capital" that rely on indicators for (1) adult male literacy, (2) agricultural research investment/agricultural value added, (3) agricultural extension/agricultural value added, (4) foreign direct investment/GDP, (5) R&D in manufacturing firms/value added, and (6) strength of the intellectual property rights regime. Other procedures measure innovative performance with a Malmquist Index Analysis of total factor productivity (TFP) growth in agriculture, providing data on both technical efficiency and technical change. The agricultural science and technology indicators (http://asti.cgiar.org/) datasets and reports feature a wide range of indicators and time-series data across countries, regions, and at the global level, including: levels and trends in agricultural research investments and capacity; developments in the institutional arrangements surrounding agricultural research; agricultural R&D funding levels and donors; and allocation of research capacity to crop, livestock, and other agricultural areas. The 5 major global indices used to measure innovation include: (1) *Knowledge Economy Index Score (WB) for overall innovation climate; (2) Innovation Index Score (EU) for innovation performance; (3) Global Competitiveness Index Score (WEF) for competitiveness; and (4) R&D intensity (OECD) and (5) Public Sector Agricultural R&D Intensity (CGIAR/ASTI) for investment in knowledge creation.*

Table 5: Prototype set of core agricultural STI indicators

[13] World Bank (2008): How innovative is your agriculture? Using innovation indicators and benchmarks to strengthen National Agricultural Innovation Systems. Agriculture and Rural Development Discussion Paper 41, (authored by David Spielman and Regina Birner).

Classical Indicators	*Table 5* AIS-oriented Indicators
Indicators of Innovative Outcomes in the Agricultural Sector ("Innovation Outcomes")	
• Agricultural GDP and GDP growth rate • Total agricultural factor productivity • Yields per hectare of major food staple and high value crops/livestock • Share of cultivable land under modern varieties	• Share of farmers who have tried/adopted some new agricultural production practice (e.g., new crop variety or livestock breed) - disaggregated by income group (poverty), gender • Share of farmers who have tried/adopted some new agricultural marketing practice (e.g., pre-production contracts, collective marketing) - disaggregated by income group (poverty), gender • Share of farmers who have tried/adopted some new natural resource management technique (e.g., conservation tillage, soil erosion controls, water harvesting) - disaggregated by income group (poverty), gender • Share of agricultural firms who have tried/introduced some new product or process innovation
Research and Education in the Agricultural Sector	
• Expenditure on agricultural research and education (disaggregated by public, private, and civil society sectors where applicable) • Number of agricultural researchers and educators by degree and area of specialisation (disaggregated by public, private, and civil society sectors, gender where applicable) • Number of new plant varieties, livestock breeds, natural resource management techniques, or other technologies released (disaggregated by public, private, and civil society sectors where applicable) • Number of international journal publications per agricultural researcher • Enrolment rates in primary, secondary, or tertiary levels of agricultural education (disaggregated by public, private, and civil society sectors, gender where applicable) • Number of plant variety protection certificates, agricultural patents, approvals for field testing, or approvals for commercialization issued	• Share and quality of research that are based on collaborations among innovation system actors - (disaggregated by public, private, and civil society sectors where applicable) • Share of research and education expenditures that involve multiple stakeholders in (a) priority setting and strategic planning or (b) decision making and resource allocations (disaggregated by public, private, and civil society sectors where applicable) • Frequency of priority setting, strategic planning, and reform exercises in research and education institutions (disaggregated by public, private, and civil society sectors where applicable) • Extent of individual or organizational membership in regional and international research and education networks (disaggregated by public, private, and civil society sectors where applicable) • Quality of information and communications technology available to the research and education systems (disaggregated by public, private, and civil society sectors where applicable) • Share of agricultural students sent abroad for advanced training; share of agricultural graduates that leave the sector or country for other opportunities (disaggregated by gender)
Value Chains in the Agricultural Sector	
• Share and growth rate of agricultural value chains in overall agricultural sector value added • Share of farm output that is marketed commercially; share of farmers engaged specifically in value chain activities - disaggregated by income group (poverty), gender • Value of private firms operating in the production, processing, distribution, or marketing of agricultural inputs or outputs	• Share of farmers who say that they have access to/are satisfied with agricultural inputs, financial services, transportation services, and marketing services - disaggregated by income group (poverty), gender • Quality of interactions among actors in a specific value chain in terms of product and process innovation • Share of farmers participating in different types of value chain arrangements, e.g., membership in a producer organization, preproduction contracts with agricultural firms,

Classical Indicators	*Table 5* AIS-oriented Indicators
• Share of value added domestically to a commodity within a specific value chain; Share of free on board (FOB) price retained by farmers for specific value chains • Share of value added at each point along a specific value chain (production, processing, distribution, certification, marketing, branding) • Return on net assets for households and firms operating at all points along a specific value chain - disaggregated by income group (poverty) • Degree of market or price volatility for a specific commodity; share of value chain actors with access to risk management arrangements	or market-based sales of output - disaggregated by income group (poverty), gender • Quality of standardization systems or their implementing agencies • Share of actors adhering to certain product or process standards within a specific value chain
Bridging Institutions in the Agricultural Sector	
• Public expenditure on agricultural extension • Number of agricultural extension agents by degree and area of specialization (disaggregated by public, private, and civil society sectors, gender where applicable) • Share of farmers with regular access to extension services; ratio of farmers to extension agents - disaggregated by gender, income group (poverty) • Percentage of farmers reporting satisfaction with the quality and timeliness of extension services (disaggregated by public, private, and civil society sectors, gender, income group (poverty) where applicable) • Share of state subsidy and farmer co-payment in extension services	• Share and quality of extension services that are based on collaborations among innovation system actors (disaggregated by public, private, and civil society sectors where applicable) • Share of extension expenditures that involve multiple stakeholders in (a) priority setting and strategic planning or (b) decision making and resource allocations • Frequency of priority setting, strategic planning, and reform exercises in extension services (disaggregated by public, private, and civil society sectors where applicable) • Number of different consultation methods used by extension services (disaggregated by public, private, and civil society sectors where applicable) • Frequency of training and skills upgrading for extension agents (disaggregated by public, private, and civil society sectors, gender where applicable) • Quality of extension services with respect to enhancing agricultural production, managing natural resources, and facilitating market linkages for farmers (disaggregated by public, private, and civil society sectors where applicable)
Enabling Environment for Agricultural Innovation	
• Membership in the international treaties, conventions, and regimes including UPOV, ITPGRFA, and the Cartegena Protocol • Ratio of agricultural investment to agricultural subsidies • Rate of agricultural protection or taxation • Road density, average distance of farm households to markets • Share of rural households with access to fixed or mobile telephone lines and Internet services • Share of rural population in total population • Rural labour force with primary, secondary, or tertiary education or rural enrolment rates - disaggregated by gender, income group (poverty) • Rate of rural infant mortality, access to safe drinking water, and related health and nutrition indicators - disaggregated by gender, income group (poverty)	• Quality of policies on agricultural research, education, and extension/advisory services • Quality of legislation and enforcement of intellectual property rights • Quality of legislation and enforcement of biosafety and food safety regulations • Quality of government effectiveness and quality of agricultural regulation • Quality of investment climate or competitiveness of agricultural sector • Level of entrepreneurial activity or behaviour in the rural economy • Quality of rural innovation system and local innovation networks and partnerships • Level of openness to indigenous or foreign knowledge sources (disaggregated by public, private, and civil society sectors where applicable)

Table 6: Common Outcome Indicators for the Agricultural Sector

Table 6 Outcome indicators for the agricultural sector	
A. Sector-Wide Indicators for Agriculture and Rural Development	
Early outcome	1. **Public spending on agriculture as a percentage of GDP from the agriculture sector**
	2. **Public spending on agricultural input subsidies as a percentage of total public spending on agriculture**
	3. **Percentage of underweight children under five years of age in rural areas**
	4. Percentage of population who consider themselves better off now than 12 months ago
Medium-term outcome	5. **Food Production Index**
	6. **Annual growth (percentage) in agricultural value added**
Long-term outcome	7. **Rural poor as a proportion of the total poor population**
	8. Percentage change in proportion of rural population below US$1 per day or below national poverty line
	9. Percentage of the population with access to safe or improved drinking water
	10. Consumer Price Index for food items
	11. Agricultural exports as a percentage of total value added in agriculture sector
	12. Proportion of under-nourished population
	13. Producer Price Index for food items
	14. Ratio of arable land area to total land area of the country
	15. Percentage change in unit cost of transportation of agricultural products
	16. Percentage of rural labour force employed in agriculture
	17. Percentage of rural labour force employed in non-farm activities
	18. Percentage of the labour force underemployed or unemployed
	19. Annual growth rate of household income in rural areas from agricultural activity (percentage)
	20. Annual growth rate (percentage) of household income in rural areas from non-agricultural activity
B. Specific indicators for Subsectors of Agriculture and Rural Development	
1. Crops (inputs and services related to annual and perennial crop production	
Early outcome	1. Access, use and satisfaction with services involving sustainable crop production practices, technologies and inputs
Medium-term outcome	2. **Percentage change in yields of major crops of the country**
Long-term outcome	3. Yield gap between farmers' yields and on-station yields for major crops of the country
	4. Percentage of total land area under permanent crops
2. Livestock	
Early outcome	1. Indicators of access, use, satisfaction with respect to livestock services
Medium-term outcome	2. **Annual growth (percentage) in value added in the livestock sector**
Long-term outcome	3. Livestock birth rate
	4. Percentage increase in yield per livestock unit
	5. Percentage change in livestock values
3. Fisheries and Aquaculture	
Early outcome	1. Indicators of access, use, satisfaction with respect to fisheries/aquaculture services
	2. Water use per unit of aquaculture production
Long-term outcome	3. **Capture fish production as a percentage of fish stock**
	4. Share of small-scale fishers in the production of fish
	5. Percentage of total permitted catch earmarked for local fishing communities as rights
	6. Annual percentage change in production from aquaculture farms
4. Forestry	
Early outcome	1. Indicators of access, use, satisfaction with respect to the forestry services:
	2. Employment in forestry-related activities (full-time equivalents)
	3. Value of removals of wood and non-wood forest products
	4. Value of services from forests

Table 6 Outcome indicators for the agricultural sector	
Medium-term outcome	5. Area of forest under sustainable forest management
Long-term outcome	6. **Percentage of land area covered by forest**
	7. Annual growth in rural household income from forest-related activities
	8. Growing stock per hectare (m^3/ha) of forest
	9. Percentage rate of deforestation
5. Rural Micro and SME Finance	
Early outcome	1. Indicators of access, use, satisfaction with respect to rural finance
	2. **Percentage of the rural population using financial services of formal banking institutions**
	3. Percentage of bank branches that are located in rural areas
Long-term outcome	4. Percentage of total savings that are mobilized from rural areas
	5. Percentage of rural population using non-bank financial services
	6. Recovery rate of rural credit
6. Agricultural Research and Extension	
Early outcome	1. Indicators of access, use, satisfaction with research and extension advice
	2. **Public investment in agricultural research as a percentage of GDP from the agriculture sector**
Long-term outcome	3. Percentage change in yields resulting from improved practices, for major crops of the country
	4. Change in farmer income as a result of new technologies (by gender)
7. Irrigation and Drainage	
Early outcome	1. Indicators of access, use, satisfaction with respect to irrigation and drainage services
	2. **Irrigated land as percentage of crop land**
	3. Percentage of users who report a significant increase in crop yields as a result of irrigation and drainage services
	4. Service fees collected as a percentage to total cost of sustainable Water User Association (WUA) activities
Long-term outcome	5. Percentage change in average downstream water flows during dry season
	6. Percentage change in agricultural value added created by irrigated agriculture
	7. Percentage of irrigation schemes that is financially self-sufficient
	8. Percentage increase in cropping intensity
8. Agribusiness (agricultural marketing, trade and agro-industry)	
Early outcome	1. Indicators of access, use and satisfaction with respect to agribusiness and market services,
	2. Percentage change in number and value of activities managed by agro-enterprises
	3. Percentage of agro-enterprises adopting improved/ certified hygiene/food management system
Medium-term outcome	4. **Percentage change in sales/turnovers of agro-enterprises**
Long-term outcome	5. Percentage change in number of agricultural inputs outlets
	6. Percentage increase in private sector investments in agriculture
	7. Percentage increase in market share of cooperatives/agribusiness enterprises
C. Indicators for Thematic Areas Related to Agriculture & Rural Development	
1. Community-based Rural Development	
Early outcome	1. Access, use, satisfaction with respect to services provided by community-based rural development organizations
	2. Percentage of farmers who are members of community/producer organizations
	3. Proportion of community/producer organizations capable of meeting the production and marketing needs of their members
	4. Proportion of producer organizations/NGOs with functional internal system of checks and balances
	5. Percentage change in number of community associations exercising voting power in local government budget
Long-term outcome	6. Percentage increase in number of local enterprises in rural area
2. Natural Resource Management	
Medium-term outcome	1. **Withdrawal of water for agricultural as a percentage of total freshwater withdrawal**
	2. **Percentage change of land area formally established as protected area**

Table 6 Outcome indicators for the agricultural sector	
	3. **Percentage change in soil loss from watersheds**
Long-term outcome	4. Percentage change of farm l and under risk of flood/drought
3. Land Policy and Administration	
Early outcome	1. Percentage of land area inventoried
	2. **Percentage of land area for which there is a legally recognized form of land tenure**
Long-term outcome	3. Percentage change of land over which there are disputes
	4. Percentage of agricultural households that have legally recognized rights to land
	5. Percentage change in number of formal land transactions (quarterly or yearly basis)
	6. Percentage change in land access for women and minority groups
4. Policies and Institutions	
Long-term outcome	1. Ratio of average income of the richest quintile to the poorest quintile in rural areas

Table 7: General STI Indicators

OECD Science, Technology, and Industry Indicators (OECD-STI Scoreboard)	European Innovation Scorecard (EIS) Indicators (European Union)	*Table 7* Knowledge For Development (K4D) Indicators (World Bank)
A. R&D and innovation: creating and diffusing knowledge A.1. Investment in knowledge A.2. Trends in domestic R&D expenditure A.3. R&D financing and performance A.4. R&D in non-OECD economies A.5. Business R&D A.6. Business R&D by size classes of firms A.7. Business R&D by industry A.8. Health-related R&D A.9. R&D linkages A.10. Internationalization of manufacturing R&D A.11. Government R&D budgets A.12. Tax treatment of R&D A.13. Innovation in small and medium-sized firms A.14. Scientific articles A.15. Venture capital **B. Human resources in science and technology: knowledge and skills** B.1. Flows of university graduates B.2. International mobility of doctoral students B.3. S&E doctorates and post-doctorates to foreign citizens in the United States B.4. Employment of tertiary-level graduates B.5. Human resources in science and technology B.6. International mobility of the highly skilled B.7. R&D personnel B.8. Researchers B.9. Foreign scholars in the United States B.10. Human resources in S&T in non-OECD economies **C. Patents: protecting and commercializing knowledge** C.1. Triadic patent families C.2. Patent intensity	**1. Human resources** 1.1 S&E graduates (% of 20–29 years age class) 1.2 Population with tertiary education (% of 25–64 years age class) 1.3 Participation in lifelong learning (% of 25–64 years age class) 1.4 Employment in medium-high and high-tech manufacturing (% of total workforce) 1.5 Employment in high-tech services (% of total workforce) **2. Knowledge creation** 2.1 Public R&D expenditures (% of GDP) 2.2 Business expenditures on R&D (% of GDP) 2.3.1 EPO high-tech patent applications (per million population) 2.3.2 USPTO high-tech patents granted (per million population) 2.4.1 EPO patent applications (per million population) 2.4.2 USPTO patents granted (per million population) **3. Transmission and application of knowledge** 3.1 SMEs innovating in-house (% of all SMEs) 3.2 SMEs involved in innovation cooperation (% of all SMEs) 3.3 Innovation expenditures (% of total turnover) 3.4 SMEs using non-technological change (% of all SMEs) **4. Innovation finance, output and markets** 4.1 Share of high-tech venture capital investment 4.2 Share of early stage venture capital in GDP 4.3.1 Sales of “new to market” products (% of total turnover) 4.3.2 Sales of “new to the firm but not new to the market” products (% of total turnover) 4.4 Internet access 4.5 ICT expenditures (% of GDP) 4.6 Share of manufacturing value-added in high-tech sectors	**1. Overall performance of the economy** 1.1 Average annual gross domestic product (GDP) growth (%) 1.2 Gross domestic product (GDP) per capita, 2005 1.3 Gross domestic product (GDP) 1.4 Human development index (HDI) 1.5 Poverty index (UNDP) 1.6 Composite risk rating 1.7 Unemployment rate (% of total labour force) 1.8 Employment in industry (% of total employment) 1.9 Employment in services (% of total employment) **2. The economic regime** 2.1 Gross capital formation as % of GDP (Average) 2.2 Trade as % of GDP 2.3 Tariff & nontariff barriers, 2006 (Heritage Foundation) 2.4 Intellectual property protection, 2006 (2006/7 WEF Global Competitiveness Report) 2.5 Soundness of banks, 2006 (2006/7 WEF Global Competitiveness Report) 2.6 Exports of goods and services as % of GDP, 2004 2.7 Interest rate spread (lending rate minus deposit rate) 2.8 Intensity of local competition, 2006 (2006/7 WEF Global Competitiveness Report) 2.9 Domestic credit to private sector (% of GDP) 2.10 Cost to register a business (% of GNI per capita) (doing business) 2.11 Days required to start a business (doing business) 2.12 Cost to enforce a contract (% of debt) (doing business) **3. Governance** 3.1 Regulatory quality (Governance Indicators, World Bank) 3.2 Rule of law, 2005 (Governance Indicators, World Bank) 3.3 Government effectiveness (Governance Indicators, World Bank) 3.4 Voice and accountability (Governance Indicators, World Bank) 3.5 Political stability (Governance Indicators, World Bank) 3.6 Control of corruption (Governance Indicators, World Bank) 3.7 Press freedom (Freedom House)

Table 7

OECD Science, Technology, and Industry Indicators (OECD-STI Scoreboard)	European Innovation Scorecard (EIS) Indicators (European Union)	Knowledge For Development (K4D) Indicators (World Bank)
C.3. Patent applications to the European Patent Office C.4. ICT-related patents C.5. Biotechnology patents C.6. Foreign ownership of domestic inventions C.7. Domestic ownership of inventions made abroad C.8. International cooperation in patenting activity C.9. Internationalization of ICT-related inventions C.10. Internationalization of biotechnology inventions C.11. Geographic concentration of patents **D. ICT: an enabler for the knowledge society** D.1. Investment in ICT equipment and software D.2. ICT occupations and skills D.3. Telecommunications networks D.4. Internet hosts and domain names D.5. Internet subscribers and secure servers D.6. Broadband and security D.7. ICT access by households D.8. Use of the Internet by individuals D.9. Internet use by businesses D.10. Electronic commerce volume D.11. Internet commerce activity D.12. Telecommunication pricing D.13. ICT in non-OECD economies D.14. Size and growth of the ICT sector D.15. Contribution of the ICT sector to employment D.16. International trade in ICT goods D.17. R&D in selected ICT industries **E. Knowledge flows and the global enterprise** E.1. Trends in international trade and investment flows E.2. International trade E.3. Exposure to international trade competition by industry E.4. Intra-firm trade E.5. Foreign direct investment flows E.6. Activity of affiliates under foreign control in manufacturing		**4. The innovation system** 4.1 FDI outflows as % of GDP (UNCTAD) 4.2 FDI inflows as % of GDP (UNCTAD) 4.3 Royalty and license fees payments, US$ millions 4.4 Royalty and license fees payments (US$ millions) per million population 4.5 Science and engineering enrolment ratio (UNESCO) 4.6 Researchers in R&D, 2004 (UNESCO) 4.7 Researchers in R&D per million population 4.8 Total expenditure for R&D as % of GDP (UNESCO) 4.9 Manufacturing trade as percentage of GDP 4.10 University-company research collaboration (WEF Global Competitiveness Report) 4.11 Scientific and technical journal articles, 2003 4.12 Scientific and technical journal articles per million population 4.13 Availability of venture capital (WEF Global Competitiveness Report) 4.14 Patent applications granted by the USPTO (USPTO) 4.15 Patent applications granted by the USPTO per million people 4.16 High-technology exports as % of manufactured exports 4.17 Private sector spending on R&D (WEF Global Competitiveness Report) 4.18 Firm-level technology absorption (WEF Global Competitiveness Report) 4.19 Value chain presence (WEF Global Competitiveness Report) **5. Education** 5.1 Adult literacy rate (% age 15 and above) (UNESCO) 5.2 Average years of schooling (15 years old and above) (WDI) 5.3 Secondary enrolment (% gross) (UNESCO) 5.4 Tertiary enrolment (% gross) (UNESCO) 5.5 Life expectancy at birth 5.6 Internet access in schools (WEF Global Competitiveness Report) 5.7 Public spending on education as % of GDP 5.8 Professional and technical workers as % of the labour force (ILO) 5.9 8th-grade achievement in mathematics, (Trends in International Mathematics and Science Study, TIMSS) 5.10 8th-grade achievement in science (Trends in International Mathematics and Science Study, TIMSS) 5.11 Quality of science and math education (WEF Global Competitiveness Report)

Table 7

OECD Science, Technology, and Industry Indicators (OECD-STI Scoreboard)	European Innovation Scorecard (EIS) Indicators (European Union)	Knowledge For Development (K4D) Indicators (World Bank)
E.7. Activity of affiliates under foreign control in services E.8. Trends in the employment of foreign affiliates E.9. Share of turnover under foreign control in selected manufacturing and services sectors E.10. Contribution of multinationals to value added and labour productivity E.11. Contribution of multinationals to productivity growth E.12. Technological balance of payments **F. The impact of knowledge on productive activities** F.1. Income and productivity levels F.2. Labour productivity growth F.3. Growth accounts for OECD countries F.4. Labour productivity growth by industry F.5. Technology- and knowledge-intensive industries F.6. Structure of OECD economies F.7. International trade by technology intensity F.8. Exports from high- and medium-high-technology industries F.9. Contributions to the manufacturing trade balance F.10. Interdependence of services and manufacturing F.11. Changing nature of manufacturing		5.12 Extent of staff training (WEF Global Competitiveness Report) 5.13 Quality of management education (WEF Global Competitiveness Report) 5.14 Brain drain (WEF Global Competitiveness Report) **6. Gender** 6.1 Gender development index (UNDP Human Development Report) 6.2 Females in labour force (% of total labour force) 6.3 Seats in parliament held by women (as % of total) (UNDP Human Development Report 2006) 6.4 School enrolment, secondary, female (% gross) (UNESCO) 6.5 School enrolment, tertiary, female (% gross) (UNESCO) **7. Information and communication technology** 7.1 Telephones per 1,000 people (telephone mainlines _ mobile phones) (ITU) 7.2 Telephone mainlines per 1,000 people (ITU) 7.3 Mobile phones per 1,000 people (ITU) 7.4 Computers per 1,000 persons (ITU) 7.5 TV households with television 7.6 Daily newspapers per 1,000 people 7.7 International Internet bandwidth 7.8 Internet users per 1,000 people (ITU) 7.9 Price basket for Internet, US$ per month 7.10 Availability of e-government services (WEF Global Information Technology Report) 7.11 Extent of business Internet use (WEF Global Competitiveness Report) 7.12 ICT expenditure as % of GDP 2005

6.2 Monitoring and Evaluation of Plan

The M&E plan shall consist of a conceptual mutual accountability framework to track set targets and generated outputs, outcomes and impact. The monitoring and evaluation of performance will be undertaken at all levels of implementation. Annual reviews will be undertaken and these will be followed by a rigorous and extensive mid-term review at the mid-point of the implementation cycle. Evaluation will focus on both operational and administrative issues in order to enhance effectiveness and efficiency.

While AUC-NPCA-RUFORUM will maintain a regular oversight over the interventions to ensure timely and effective impact, it is important to note that investment in knowledge-based processes has a long gestation period. The effort has to be systematic, carefully targeted and sustained over a reasonable period of time for desired results to be achieved. Thus, in the short term, the outcomes and impacts of an intervention may not be readily visible. Also worthy of note in the evaluation of interventions in the field of STI application is the fact that efforts of this nature are inherently risky, particularly in unstable policy environments and inadequately resourced country level interventions. Effort will be made to minimize risks and ensure that there are adequate control mechanisms and mitigating measures in operations to protect the interventions.

In monitoring performance, the schedule of outputs based on the milestones (Table 4) will be used to track annual progress. In evaluating performance, agreed Intermediate Outcomes selected from the list of core agricultural STI indicators will be used to document those results that can be attributed to the implementation efforts by 2024, and complemented by an assessment of contributions to the higher CAADP and STISA outcomes.

7. RISKS AND RISKS MANAGEMENT STRATEGIES

7.1 Risk Factors and Mitigating Measures

The implementation of the interventions proposed in this recast MTOP faces a number of risks. The three principal ones are inadequate financial and technical resources for the implementation of the proposed interventions; inadequate STI infrastructure, both human and physical; and donor changing priorities, which may limit availability of financial resources. Successful implementation of this plan is, to a large extent, dependent on the commitment and support from Countries and RECs. The awareness levels amongst all key stakeholder groups may not be sufficient to secure necessary buy-in. This risk will be mitigated by actively advocating and promoting the plan, and supporting regional and national awareness raising campaigns by RECs and Countries. An advocacy plan that outlines targeted messages for different stakeholder groups must be developed. The contribution and impact of STI in Africa's agricultural development is currently not adequately assessed, recognized and prioritized in policy formulation. This risk should be lessened by integrating STI into all national and regional development frameworks. An evidence based approach must be implemented, establishing comparable baselines and performance metrics at national and regional level.

7.2 Success Factors

The plan relies on active engagement of the public, private and civil society sectors in all Countries, all the Regional Economic Communities and several international agencies, which reduces the risk of failure. Africa must embark on transformational changes in how STI is socially defined, prioritised, constructed, funded, communicated, monitored and evaluated for African development. Africa must grow out of knowledge dependence to become "producer" in the new knowledge economy, encourage bottom-up innovation and democratic governance of STI. More inclusive forms of knowledge generation and knowledge circulation in which the voices of the African is treated with equal respect irrespective of social or academic status, income, gender, country, race, religion, or age are a prerequisite for success. Local needs and priorities that focus on poverty reduction, inclusive wealth and environmental sustainability, and respect for the diversity of knowledge systems, should drive the STI agenda within the context of global agendas. Coordination and collaboration through national and continental platforms to foster innovation through collaboration amongst the relevant actors is also critical. The implementation mechanisms and most actions are based on the experiences gained through various pilot programs that includes lessons learnt, best practices, failures and success stories.

8. CONCLUSION

This plan sets the stage for a launch and implementation of a comprehensive STI agenda in agriculture in Africa. It represents an expression of the need of an STI-led transformation in agriculture on the continent. RUFORUM is poised to deliver the plan and be held accountable for results, if adequately resourced to implement the plan. It has the institutional capacity and organizational leadership at the level of the Secretariat and its network of Universities and AAIS partners to effectively and efficiently implement this Plan.

RUFORUM therefore makes a passionate call for the Africans to take responsibility and act in every capacity to secure STI for African development. This plan kicks off the participatory dialogue that will lead the African people to collectively implement the new STISA 2024 agenda. The final word belongs to all Africans who are willing to take the necessary action to change the status quo and mainstream STI in national and pan-African policy dialogues; it belongs to those visionary leaders who would buy into the vision and prioritise STI in national budgets and investment strategies. RUFORUM further wishes to call on African stakeholders and development partners to rise up in support of efforts to realize the objectives of this STISA-P1 implementation plan to enable the continent to leap onto the path of an STI-led and knowledge based transformation in Africa's agriculture and give the continent a much-needed head-start in the implementation of the AfSDGs.

We finally invite you all Africans and friends of Africa who share in this responsibility to share their views, make their contributions, keep the dialogue going, but more importantly take action to implement the proposed interventions. We call on you to abundantly contribute to the effort to make African science, technology and innovation speak to all Africans, listen to all Africans, address the needs of African society, and is owned by Africans. We call on you to build once again an African development paradigm that is anchored on science, technology and innovation as the norm.