



FORUM FOR AGRICULTURAL RESEARCH IN AFRICA

SCIENCE AGENDA STUDIES AND ANALYSIS (SASA)

**Lessons from the CAADP Country and Regional Processes on ARD and Entry Points for the
Application of Science in the Implementation of Country and Regional Agriculture and Food Security
Investment Plans**

by

Simbarashe Sibanda

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ABBREVIATIONS AND ACRONYMS

ARD	Agriculture Research and Development
ASARECA	Association for Strengthening Agricultural Research in East and Central Africa
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CCARDESA	Centre for Coordination of Agricultural Research for Development in Southern Africa
CGIAR	Consultative Group for International Agricultural Research
CORAF	Conseil pour la Recherche Agricoles en Afrique
CRP	CGIAR Research Programme
CYMMYT	International Maize and Wheat Improvement Centre
ECOWAS	Economic Community of West African States
FAAP	Framework for African Agricultural Productivity
FARA	Forum for Agricultural Research in Africa
GDP	Gross Domestic Product
HOS	Heads of State
IAR4D	Integrated Agricultural Research for Development
IP	Investment Plan
NAIP	National Agriculture Investment Plan
NARS	National Agricultural Research System
NEPAD	New Partnership for Africa's Development
NPCA	NEPAD Planning and Coordinating Agency
MTOP	Medium-Term Operational Plan
NARS	National Agricultural Research Systems
NSF	Network Support Functions
R&D	Research and Development
REC	Regional Economic Community
SP	Strategic Priority
SRO	Sub-regional Research Organisation
S3A	Science Agenda for Agriculture in Africa
S&T	Science and Technology
SSA-CP	Sub-Saharan Africa – Challenge Programme

EXECUTIVE SUMMARY

The Science Agenda for Agriculture in Africa (referred to as the Science Agenda or S3A) articulates the science, technology, extension, innovations, policy and social learning Africa needs to apply in order to meet its agricultural and overall development goals. The Forum for Agricultural Research in Africa (FARA) has commissioned studies to serve as companion documents to the main Science Agenda document-*Connecting Science-Science Agenda for Transforming Agriculture in Africa*. The studies will provide the status on institutional, policy and strategic issues that are key to the successful implementation of the Science Agenda. This paper describes one of the studies under FARA's Strategic Priority 3 (SP3), namely *Creating an enabling environment for implementation through advocacy and communication*.

The objective of the study was to conduct a critical review of the application of science and technology in the implementation of the Comprehensive Africa Agriculture Development Programme (CAADP) to date and recommend how the science agenda will strengthen CAADP implementation in the next decade. The study comprised a review and analysis of regional and National Agricultural Investment Plans (NAIPs), NAIP technical review reports, sub-regional research organization (SRO) programme plans and other relevant documents. The analysis was based on how and to what extent the CAADP NAIPs, regional agriculture investment plans and SRO programmes were aligned to the Framework for African Agricultural Productivity (FAAP) principles, the Science Agenda and the new Sustaining CAADP Momentum Results Framework. This would allow identification of gaps, lessons learnt and recommendations on how to operationalize the Science Agenda in support of CAADP processes in the short-medium term.

The review showed that all the nine FAAP principles are incorporated into the six strategic thrusts and focus areas of the Science Agenda. In addition, the Science Agenda covers many other areas that are not covered by FAAP, making S3A a much broader framework. This is understandable as FAAP was targeted at Pillar IV of the CAADP, while the Science Agenda goes beyond CAADP in both scope and timeframe. There is good alignment between the strategic thrusts and focus areas of the Science Agenda and those of the CAADP Results Framework. Therefore, this confirms that S3A can be used to advance the implementation of CAADP in the short-medium term.

The CAADP Results Framework is organised into three levels showing the relationships of the different results that should be delivered to meet CAADP's long-term goals of agriculture making a significant contribution to Africa's economic development (Level 1). Level 2 deals with focus areas that should deliver improved production, productivity, competitiveness and regional integration, while Level 3 deals with the building of an enabling environment through systemic transformation of capacity in policies, institutions and leadership. The areas of focus for the NAIPs within Levels 2 and 3 of the CAADP Results Frameworks were (i) improved management of natural resources for sustainable agricultural production; (ii) increased availability and access to food and productive safety nets; (iii) increased agricultural productivity, production and market access and the need for increased investment; and (iv) commercialisation of agriculture. The areas of focus of the NAIPS within Level 3 were (i) capacity building of agricultural stakeholders and access to information through improved training and extension, intensified agricultural research, use of science and technology and timely access to statistics; (ii) strengthening of institutions; (iii) increased public/private financing and partnerships; (iv) improved sectoral coordination; and (v) creating a predictable, consistent and enabling policy environment.

In qualitative terms, there is good agreement between the areas of focus of the NAIPs and the strategic thrusts of the Science Agenda when viewed at continental level. However, at individual country level, there are some gaps. For example, communication of science to ordinary citizens as well as sustainable financing of science, especially from in-country resources such as the private sector, are far from satisfactory. Similarly, development of commodity value chains and value addition, though appreciated, did not feature prominently in the NAIPs. In addition, there was little

evidence of participation of farmers and other value chain actors in setting the research agenda and implementation, monitoring and evaluation of programmes.

The regional agricultural policies and investment plans and SRO programmes, having been influenced by CAADP, are aligned to the CAADP Framework and Science Agenda. SROs are implementing a number of regional projects located in various countries, facilitating information and cost sharing among countries with similar conditions.

The Science Agenda provides an overarching strategic framework to guide and rationalise investments in science by African countries, RECs and their partners as a tool for catalysing agricultural development across all the focus areas of the CAADP Results Framework. It provides a framework for issues covered by FAAP under Pillar IV and integrating other systemic transformational areas (institutions, policies and regulations) that were traditionally not considered as “scientific” but which can benefit from the application of the scientific approaches by providing evidence for decision making.

Possible entry points for operationalizing the Science Agenda were proposed for each of the NAIP focus areas. The recommendations were as follows:

- (i) African countries should use the CAADP Results Framework to identify issues that can be addressed by science and technology, incorporate these into the NAIPs and ensure adequate budgetary provision for technology development and dissemination.
- (ii) There seemed to be no targets in the investment plans for R&D outputs. Where resources are invested, there must be mechanisms for measuring the output from the research process, the impact of that research process. These mechanisms or the targets need to be spelt out clearly in the strategic plans
- (iii) It was clear from the NAIPs that some priority areas are common to a number of countries, some of which may be neighbours sharing the same agro-ecological environments. In such circumstances, it is recommended that countries pool resources, conduct joint R&D activities and share the results.
- (iv) There is need to strengthen sub-regional research cooperation through sub-regional groupings such as CORAF, ASARECA and CCARDESA. These bodies should be responsible for mobilizing resources, forging partnerships with CGIAR centres and conducting research on common regional problems, becoming hubs for regional solidarity in science for agricultural development. They can host regional knowledge and information hubs, publishing forums and scientific meetings which may be too expensive and less effective when done by a single country.
- (v) To increase adoption of improved technologies, it is necessary for potential users of innovations to be involved in the setting up of the research agenda. This may include involvement of farmer groups in the design, implementation, evaluation of agricultural research projects and participation in innovation platforms at local level.
- (vi) Agricultural training institutions (universities and colleges) are an integral part of national innovation systems, training research scientists and extension personnel. They have an advantage in mobilizing funds for research over government institutions. It is, therefore, imperative that their research priorities are in sync with the national aspirations and that they too are part of the national agricultural research systems.
- (vii) African Governments should be encouraged to invest at least 1% of GDP to agricultural research and technology transfer.
- (viii) FARA should develop guidelines for mainstreaming science into CAADP processes, specifically NAIPs.

1. INTRODUCTION

1.1 Background

The Science Agenda for Agriculture in Africa (referred to as the Science Agenda or S3A) articulates the science, technology, extension, innovations, policy and social learning Africa needs to apply in order to meet its agricultural and overall development goals. It identifies issues and options for increasing the contributions of science to agriculture in Africa, at the local, national, regional and continental levels. It provides a basis for the alignment of national, regional and international research providers in coordinating their actions to meet the demands of African agricultural stakeholders. The preparation of the Science Agenda was guided by an African-led process.

The Forum for Agricultural Research in Africa (FARA) has commissioned studies to serve as companion documents to the main Science Agenda document-*Connecting Science-Science Agenda for Transforming Agriculture in Africa*. The studies will provide the status on institutional and policy aspects that are key to the successful implementation of the Science Agenda, while filling the gaps in literature on some of the issues that need to be fully understood for strategic planning and implementation. In addition, the studies will identify where the Consultative Group on International Agricultural Research Programmes (CRPs) will align with and facilitate the country, CAADP and mapping processes as outcomes of the Dublin Process.

This paper describes one of the studies under FARA's Strategic Priority 3 (SP3), namely, *Creating an enabling environment for implementation through advocacy and communication*.

1.2 Rationale for the Study

Harnessing the potential of the Comprehensive Africa Agriculture Development Programme (CAADP) to achieve agriculture-led economic development depends on the effectiveness, efficiency and relevance of agricultural research and the contribution of science to agriculture in Africa. In 2006, FARA developed the Framework for African Agricultural Productivity (FAAP) to support the implementation of CAADP Pillar IV. FAAP outlines the principles and guidelines for integrating research, extension, education and training in CAADP national agricultural investment plans (NAIPs). In addition, FAAP advocates for the reform and evolution of national agricultural research systems (NARS), increasing the scale and quality of investments in agricultural research for development (ARD) and harmonizing support to agriculture. Through the Network Support Functions 1 and 3 (NSF1/3), FARA has supported African countries to develop and implement their national agricultural investment plans (NAIPs) in accordance with the FAAP principles and guidelines. As of July 2013, 31¹ countries had signed Compacts and 26 of them had developed NAIPs, while the Economic Community for West African States (ECOWAS) and the Inter-Governmental Agency for Development (IGAD) had developed regional compacts. Some NAIPs had gone through a technical review led by the NEPAD Planning and Coordinating Agency (NPCA), with support from FARA and other technical institutions.

The Science Agenda provides Africa with an instrument to guide the development of broad areas of science to deliver new knowledge to drive agriculture. The Agenda is a tool for setting and updating priorities in line with emerging trends and achieving coherence among the institutions engaged in the generation, transfer and utilisation of agricultural science.

¹ These countries include: Burundi, DRC, Ethiopia, Malawi, Kenya, Rwanda, Seychelles, Swaziland, Uganda, Zambia, Djibouti, Benin, Burkina Faso, Cape Verde, Cameroon, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Togo, Sierra Leone, Senegal, Mozambique, Tanzania, CAR, and Mauritania. As of March 2012, 12 countries (Comoros, Lesotho, Sudan, Sao Tome and Principe, Gabon, Tchad, Congo-Brazzaville, South Africa, Zimbabwe, Angola, Cameroon and South Sudan) have launched CAADP implementation and working towards signing a Compact. Lastly, 6 countries (Algeria, Mauritius, Namibia, Madagascar, Botswana and Egypt) are already engaging and expecting to formally launch CAADP implementation.

Given FARA's new strategic orientation and the need to continue to support the *CAADP momentum*, it is essential to have an appraisal of FARA's support to the CAADP process, draw lessons there from, and to determine key areas where FARA's continuous support can be enhanced through science and technology. By reviewing progress made and drawing lessons learnt in the implementation of Pillar IV, FARA will be able to re-position itself within the context of its new strategic orientation and to deliver more effective support to the CAADP country process. Equally, by identifying key entry points for the Science Agenda, FARA and its stakeholders will be able to marshal and tailor support from the science community to the CAADP country process.

1.3 Objective of the Study

The main objective of the study was to conduct a critical review of the application of science and technology in the implementation of CAADP to date and recommend how the Science Agenda will strengthen CAADP implementation in the next decade. This would be achieved through the following specific objectives:

- (a) Review the application of science and technology (S&T) in the implementation of CAADP to date at country level;
- (b) Review how support to country CAADP implementation has been buttressed by science and technology efforts at regional and/or continental levels; and
- (c) Make recommendations on how best to operationalize the Science Agenda in the implementation of CAADP.

2. METHODOLOGICAL APPROACH

The methodology included an inception meeting of the consultant with the FARA Director of Capacity strengthening and leader of the Strategic Priority 3 to gain a common understanding of the objectives, tasks to be performed and expected outputs; compilation of relevant documents to be reviewed and analysed, including NAIPS, country technical review reports and regional IPs; and review and analysis of the compiled documents.

Analysis was based on how and to what extent the CAADP national and regional agriculture investment plans were aligned to FAAP principles, the Science Agenda and the new CAADP Momentum Results Framework. This would allow identification of gaps, lessons learnt and recommendations on how to operationalize the Science Agenda in support of CAADP processes in the short-medium term.

3. THE CAADP AND THE SCIENCE AGENDA

3.1 The CAADP

CAADP is the framework to transform Africa's economies through agriculture-driven growth. The framework was adopted by African leaders during the second session of the African Union Summit held in Maputo, Mozambique, in July 2003. CAADP represents a shared vision by Africa's leaders to put their countries on a positive development path that will eliminate poverty and usher in food and nutrition security throughout the continent. At the summit, the leaders envisaged that by the year 2015, the agricultural sectors should be growing by at least 6% annually, underpinned by the commitment they made to allocate at least 10% of their national budgets to the agricultural sector.

CAADP focused on four main thrusts or pillars to deliver the envisaged agricultural growth:

- Pillar 1: Extending the area under sustainable land management;
- Pillar 2: Improving rural infrastructure and trade-related capacities for market access;
- Pillar 3: Increasing food supply and reducing hunger, and

Pillar 4: Agricultural research, technology dissemination and adoption.

The leadership and coordination of work under each thrust has been delegated to Pillar leaders. FARA is responsible for leading and coordinating Pillar IV. CAADP provides a framework within which member countries and Regional Economic Communities (RECs) can formulate and implement customized policies and investment plans through the principles of building partnerships, dialogue, peer review and mutual accountability at all levels, while exploiting regional complementarities.

Each country implements the CAADP Agenda using a common set of tools, including pillar frameworks and roundtable processes. The national roundtable processes are supposed to lead to national compacts between individual governments, non-state actors and funding partners that help to achieve the objectives of the four pillars. The roundtable processes aim at achieving stakeholder participation and ownership of national agricultural development strategies. The key responsibilities of the roundtable are:

- aligning state policies with regional priorities and the four pillars;
- exploiting synergies and discussing economic bottlenecks between neighbouring countries, and deciding appropriate action on those matters;
- identifying gaps in the funding needed to achieve agreed priorities; and
- initiating work to monitor and evaluate CAADP's progress at the national, regional and continental levels.

3.2 Sustaining the CAADP Momentum and the CAADP Results Framework

Following the first decade of implementation of CAADP, an extensive and inclusive *Sustaining CAADP Momentum* exercise was carried out in 2012-13. This culminated in the identification of key result areas based on achievements and lessons from the initial decade of implementation. The identified key result areas related to enhancing local capacity and systems to accelerate and expand execution and delivery of results and impact of African agriculture. The exercise took into account emerging issues such as trends in global food and energy prices; growing attention to nutrition; and better informed understanding of climate change dynamics, population and migration trends.

The *Sustaining CAADP Momentum* exercise also developed a Results Framework to facilitate and compel results-based planning and budgeting for tracking resource use and strengthen accountability. The CAADP Results Framework provides, in concrete terms, Africa's agriculture development agenda and basis to foster alignment, harmonization of programmes, initiatives and partnerships. The CAADP Results Framework is illustrated in Figure 1.

The Results Framework is not an attempt to replace the CAADP document, ignore the four pillars or re-launch a new planning process. Rather, it provides a theory of change, capturing the necessary and sufficient conditions for attaining the growth that African agriculture should deliver for the continent's economic development. It puts the four pillars of CAADP into context, indicating how they are to be supported to ensure delivery of results. It provides tangible parameters to benchmark advancements in agricultural performance, reinforces a culture of results and evidence-based programming, objective analysis and return on investment. The framework provides Africa and partners with a solid agricultural development agenda, political and technical pillars and a mechanism to respond to emerging issues, including climate change, globalized food and energy systems, Africa's population growth and urban migration trends, nutrition and improvements in governance.

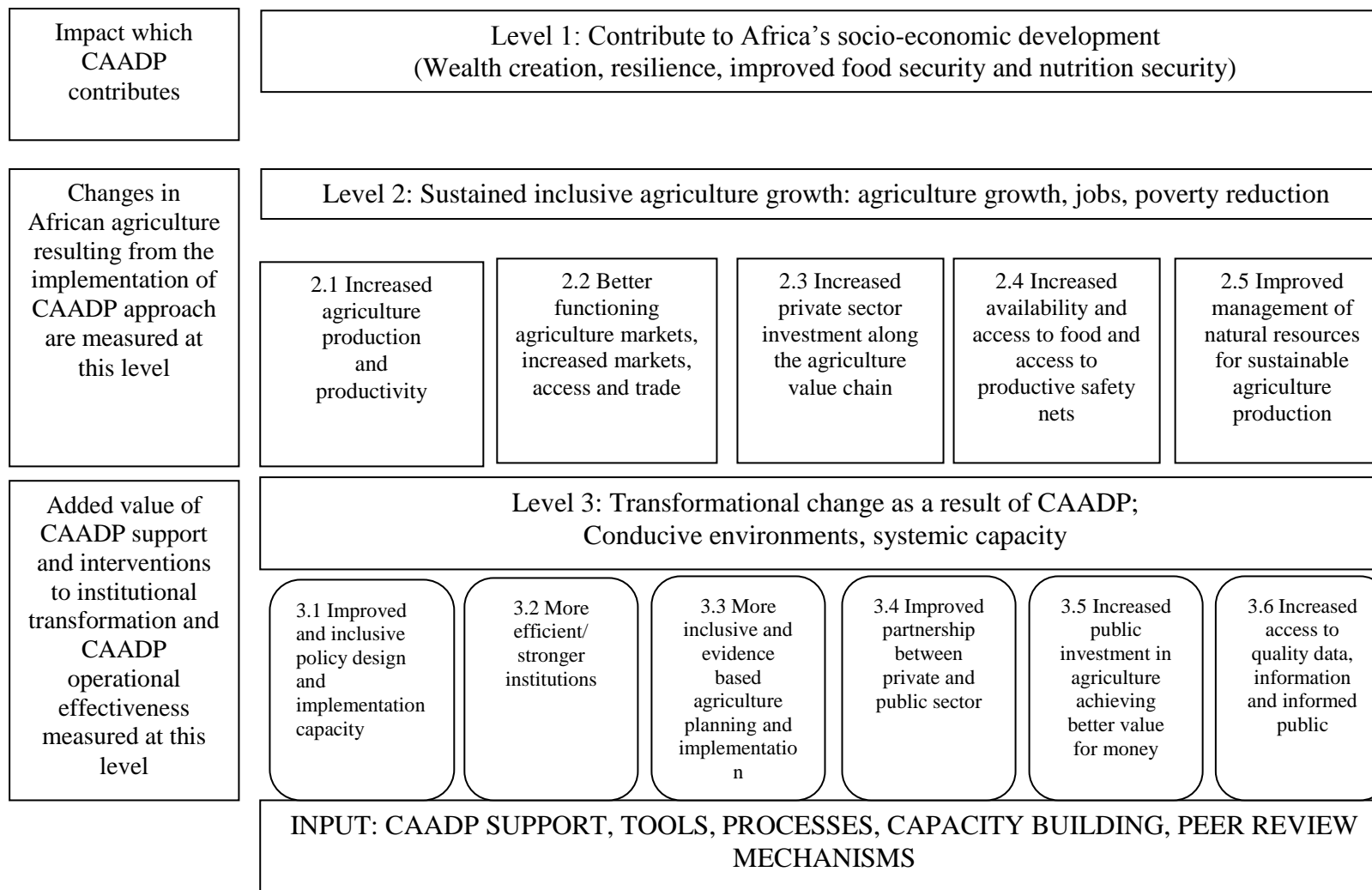


Figure 1 CAADP Results Framework

3.3 Sustaining CAADP Momentum and the CAADP Pillars

Through the *Sustaining CAADP Momentum* exercise, an evaluation of progress, achievements and lessons from the first decade of CAADP implementation confirmed that the thematic priorities defined in the CAADP Pillars are just as relevant and valid now as they were in 2003. The *Sustaining CAADP Momentum* strategy was based on the four CAADP pillars, but went further to incorporate other issues and lessons learnt from the initial ten years of CAADP implementation. The issues in the original CAADP pillars form the basis of the CAADP Results Framework and as such, remain the “pillars” guiding and supporting the efforts to ensure increased agricultural production and productivity in Africa. The *Sustaining CAADP Momentum* and CAADP Results Framework both bring to the fore the transformational issues essential for building systemic and institutionalised capacities, rendering them integral to the processes involved in delivering in the most effective, efficient and competitive manner, the change and increase desired within the goals and objectives of the four CAADP pillars.

The *Sustaining CAADP Momentum* Results Framework expands on the four CAADP Pillars across the three levels of the Results Framework:

- (i) Pillar 1 of CAADP focuses on land and water management and its results are mainly captured at Level 2 of the CAADP Results Framework in relation to production, productivity and improved management of natural resources.
- (ii) Pillar 2 deals with improvement of rural infrastructure and trade-related capacities for market access. Its results are captured in Level 2 of the CAADP Results Framework.
- (iii) Pillar 3 of CAADP puts emphasis on food security and nutrition as well as social protection. This is one of the key Level 1 results which also include wealth creation and resilience. Some of the actions necessary to achieve food security and resilience are included in Level 2.
- (iv) Pillar 4 is concerned more with effective systems of science and technology. It is one of several thrusts required for sustainable and systemic capacities for effective delivery of results in Levels 1 to 2 and is largely found as part of Level 3 and is cross-cutting.

3.4 Operationalizing the CAADP Results Framework at Country Level

The design of the CAADP Results Framework took cognisance of the existence of various tools and processes for monitoring and evaluating progress and performance in agriculture at national level. As countries move forward with their NAIPs, the CAADP Results Framework is strategic in strengthening and aligning existing systems and tools into systemic evidence-based accountability in agriculture.

The inception phase will involve country-tailored support to “internalise and domesticate” the CAADP Results Framework. In this way, the regional CAADP Results Framework will offer direction and aggregate target and performance measures at country level to regional level. Specifically, the CAADP Results Framework will serve as a guide and tool to:

- examine and align the goals, targets and associated performance indicators set in the NAIPs;
- help the countries to refine and focus set performance targets, including ensuring planned interventions and associated assumptions are realistic and appropriate to deliver the set targets in the defined time and available resources;
- rally unit of purpose around a common national agenda and deliverables; and
- examine, refine, strengthen and align existing national level tools and systems for monitoring, assessing and evaluating agricultural performance, facilitating learning and strengthening accountability.

This will mobilise planning, implementation, monitoring and valuation constituencies into a systematic engagement which will enable the country to determine and align the national priorities and NAIPs in the following aspects:

- (i) Level 1: Position agriculture in overall national socio-economic growth and development. With clear evidence-based articulation, this should elaborate the extent of growth and development attributed to agriculture.
- (ii) Level 2: Articulate the extent of performance required to achieve the level and rate of agriculture growth necessary for agriculture to contribute to results and impact articulated at Level 1;
- (iii) Level 3: Applying the results framework will compel reflection and in-depth examination of the anticipated or assumed change process. The main thrust in the Level 3 impact areas is transformational change in terms of ability and capacity relating to systematic action to unlock the potential for commercial agriculture in Africa, including increased support to and performance of agricultural research for technology generation and dissemination.

3.5 The FAAP and the Science Agenda

3.5.1 The FAAP

Science is expected to play a pivotal role in driving agricultural development in Africa in the next few decades. Most African nations have registered positive growth in their agricultural sectors in the last few years (Tambi, 2013). Nevertheless, this growth has largely been driven by expanding the land under agricultural production, with little improvements in the production per unit area of land. Such gains are not sustainable in the long run and are likely to be overtaken by population growth, thereby plunging the continent into more poverty and food insecurity. Improvements in agricultural practices and technology will drive agricultural production to levels that lift whole nations out of poverty and food insecurity in a sustainable way.

To achieve an annual agricultural growth rate of 6%, FAAP envisages an annual growth rate in productivity of 4.4%. This can only be achieved if the failures in various institutional areas are addressed: capacity weaknesses, insufficient end-user involvement, ineffective farmer support systems, and systematic fragmentation of the innovation system comprising research, extension, training, farmer organisations, private sector and consumers, among others.

FAAP has set out nine principles which should be observed in order for Africa's agricultural productivity efforts to be successful:

- (i) Empowerment of end-users of innovations from agricultural research and development to meaningfully participate in setting the priorities for research, extension and training to ensure their relevance;
- (ii) Planned subsidiarity to give responsibility and control over resources for agricultural research, extension and training to the lowest appropriate level of aggregation (local, national and regional);
- (iii) Pluralism in the delivery of agricultural innovations by diverse service providers such as universities, NGOs, public and private sectors;
- (iv) Evidence-based approaches with emphasis on data, economic and policy analysis in policy development, priority setting and strategic planning for agricultural research, extension and training;
- (v) Integration of agricultural research with extension services, private sector, training and capacity building and education programmes to respond in a holistic manner to the needs and opportunities for innovation;
- (vi) Incorporation of sustainability criteria in evaluation of public investments in agricultural productivity and innovation programmes;

- (vii) Systematic utilization of improved management information systems for planning, financial management, reporting and monitoring and evaluation;
- (viii) Introduction of cost sharing with end-users to increase their stake in the provision of services and financial sustainability;
- (ix) Integration of gender at all levels, including farmers, farmer organisations, private sector, public institutions, researchers and extension staff.

3.5.2 The Science Agenda

The Science Agenda has six strategic thrusts: an enduring collective vision for Science in Agriculture by Africa; implementation of the CAADP momentum strategy in the short-medium term; research themes that connect institutions and policies with producers, consumers and entrepreneurs; strengthening solidarity and partnerships at national, regional and international levels; sustainable financing of science and technology and establishing a special fund for the Science Agenda; and creating a favourable policy environment for science.

The vision of the Science Agenda is that *by 2030, Africa ensures its food and nutrition security; becomes a recognized global scientific player in agriculture and food systems and the world's bread-basket*. CAADP's objective was to achieve 6% annual growth of the agricultural sector by 2015, which would require 4.4% growth in productivity as envisaged by FAAP. Therefore, CAADP provides, in the short-medium term, the framework for operationalizing the Science Agenda, while the Science Agenda is the broader framework for implementing FAAP. The details of the strategic thrusts of the Science Agenda are described in Table 1.

A review of Table 1 shows that all the FAAP principles are incorporated into the Science Agenda areas of focus. In addition, the Science Agenda covers many other areas that are not covered by FAAP, making S3A a much broader framework. This is understandable as FAAP was targeted at Pillar IV of the CAADP, while the Science Agenda goes beyond CAADP in both scope and timeframe.

Table 1. The Science Agenda's Strategic Thrusts and Areas of Focus

Strategic Thrust	Areas of Focus
Collective vision: <i>By 2030, Africa ensures its food and nutrition security; becomes a recognized global scientific player in agriculture and food systems and the world's bread-basket</i>	<ul style="list-style-type: none"> Science to be valued better by Africa's ordinary citizens (demystifying science) Scientists, policy makers and politicians to deploy a vision of science-driven agricultural transformation
CAADP implementation in the short-medium term	<ul style="list-style-type: none"> Science Agenda aligned with and implemented through the Sustaining CAADP Momentum Strategy
Research themes that connect institutions and policies with producers, consumers and entrepreneurs	<ul style="list-style-type: none"> Market-led high productivity systems through improved crop varieties, better breeds, feeding and health of livestock, exploitation of genetic-environmental interactions, better management of natural resources, good agricultural practices, use of improved inputs (seed, fertilizer, mechanization), access to credit, availability of labour, market access and value chain development. Sustainable productivity in major production systems Food systems and value chains (food and nutrition security, processing, storage, food safety and post-harvest handling) Agricultural biodiversity and management of land and water (soil fertility and irrigation) Mega trends and challenges for agriculture in Africa (climate change, adaptation and mitigation, policy and institutional research, rural livelihoods) Cross-cutting themes of sustainable intensification, modern genetics and genomics and foresight capabilities in planning and modeling – horizon scanning, early warning systems)
Strengthening solidarity and partnerships at national, regional and international levels to build institutional capacity in science and technology	<ul style="list-style-type: none"> Sustaining basic science capacity at national level: countries to strategise on how to borrow from knowledge stock at regional and global levels; address poor linkages between research, education and extension Sub-regional organisations (ASARECA, CORAF and CCARDESA) to strengthen regional commodity centres to share results with neighbouring countries and to represent NARS in the CGIAR system and Global Forum RECs supporting country implementation of CAADP, e.g. COMESA, ECOWAS and IGAD

Strategic Thrust	Areas of Focus
Sustainable financing of science and technology	<ul style="list-style-type: none"> • Mobilising resources for NAIPs from technical partners and bilateral and multilateral funding partners • Harnessing country resources from national governments, private sector and donors: building capacities of value chain actors to work together; tax incentives for companies to facilitate smallholders to participate in markets; development of inclusive financial models; use of corporate social responsibility to fund science foundation(s)
Creating a favourable policy environment for science	<ul style="list-style-type: none"> • Crafting credible and legitimate policies, supported by evidence from science • Enabling legislation and regulations on biosafety, seed, enforcement of plant breeders' rights and management of intellectual property rights (IPRs) • Communication of science to various stakeholders: policy makers, scientists and the general public • Creation and use of higher scientific bodies to advance the cause of science, e.g. science councils • Strong commitment to women and youth
Establishing a special fund for the Science Agenda	<ul style="list-style-type: none"> • Set up the African Science for Agricultural Transformation Initiative (ASATI) fund to ensure all countries have minimum scientific capacity • Potential ASATI activities: increase mobility of scientists and engage African diaspora

4. THE NATIONAL AND REGIONAL AGRICULTURAL INVESTMENT PLANS

4.1 Areas of Focus in National Agricultural Investment Plans

The areas of focus of the NAIPs vary among countries as indicated by their investment plans (Table 2 and Annex 1). The areas of focus for the NAIPs have been arranged to align with the CAADP Results Framework for purposes of analysis. On sustained agricultural growth (Level 2), the main areas of focus were improved management of natural resources for sustainable agricultural production, increased availability and access to food and productive safety nets, increased agricultural productivity, production and market access and the need for increased investment and commercialisation of agriculture. Although development of commodity value chains and value addition were appreciated, these did not feature prominently in the NAIPs. These areas of focus will benefit from ARD and are in line with the third thrust of the Science Agenda, that is, *Research themes that connect institutions and policies with producers, consumers and entrepreneurs*. However, as will be discussed later under integration, there is little evidence of participation of farmers and other value chain actors in setting the research agenda and implementation of programmes.

For Level 3 issues, the highest priorities were capacity building of agricultural stakeholders and access to information through improved training and extension, intensified agricultural research, use of science and technology and timely access to statistics; followed by strengthening of institutions; increased public/private financing and partnerships; improved sectoral coordination; and creating a predictable, consistent and enabling policy environment. All the issues being considered under Level 3 fit into the last four strategic thrusts of the Science Agenda. This confirms the position that the Science Agenda will facilitate the implementation of CAADP in the short-medium term.

In qualitative terms, there is good agreement between the areas of focus of the NAIPs and the strategic thrusts of the Science Agenda when viewed at continental level. However, at individual country level, there are some gaps. For example, communication of science to ordinary citizens as well as sustainable financing of science, especially from in-country resources, are far from satisfactory.

The formulation of NAIPs and their implementation need to be supported by quality data and increased knowledge sharing through the use of knowledge and innovation platforms, among other initiatives. This is an area that seems to be getting little attention in terms of investment.

The poor linkages between research, extension, agricultural education and the end-users of innovations need to be addressed by all countries where there is a tendency to consider these as separate stand-alone entities. The integration of agricultural research and extension is discussed in

more detail in the paper on extension. The identified gaps would need to be addressed when the countries undertake technical reviews of their NAIPs, taking into account the potential contribution of science and technology to these areas.

4.2 Areas of Focus in Regional Agricultural Investment Plans and Sub-Regional Research Organizations' Programmes

Among the RECs, only ECOWAS and IGAD have developed regional compacts and agricultural investment plans. ECOWAS is largely focusing on management of natural resources, especially soil, water, forestry and fisheries management. The other areas of focus are development of supply chains for different agricultural commodities, promotion of national, regional and international trade, food security and disaster risk management and institutional capacity strengthening in gender sensitivity, policy, funding, communication, coordination and monitoring and evaluation. The ECOWAS regional agricultural investment plan has been used to guide the formulation of member country NAIPs. IGAD is focusing on sustainable use and management of natural resources, rural infrastructure and market access, improved agricultural production and food security, institutional capacity development and harmonization of policies in the region.

COMESA and SADC have not yet developed regional agricultural investment plans. However, COMESA has a regional agricultural policy (CAP) based on CAADP principles and has a focus on two strategic thrusts: removal of barriers to trade in agricultural commodities and harmonization of policies, systems, regulations and procedures to facilitate trade with backward and forward linkages from the farmer to the market. SADC has recently formulated a Regional Agricultural Policy (RAP) whose focus areas are in line with the CAADP Results Framework: production and productivity, regional and international trade and access to markets, public and private engagement and investment in agricultural value chains and reduced vulnerability food and nutrition insecurity.

The Sub-regional Research Organizations (SROs) are promoting regional initiatives that support the CAADP processes and are in line with the Science Agenda. Their focus areas are shown in Table 3. The Conseil pour la Recherche Agricoles en Afrique/West and Central African Council for Agricultural Research and Development (CORAF/WECARD). CORAF/WECARD is implementing a number of regional projects located in various countries in the region, for example rice research in Ghana, Nigeria and Liberia; yam research in Ghana, Nigeria, Togo and Benin; maize in the savannah zone of Cameroon and Nigeria; and cow peas in Mali and Sierra Leone. This facilitates information and cost sharing among countries with similar conditions. Similarly, the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA), is taking a similar approach in East and Central Africa.

Table 2. Areas of focus of reviewed NAIPs in relation to CAADP Results Framework

Level 2: Sustained inclusive agriculture growth: agriculture growth, jobs, poverty reduction					
<i>2.1 Increased agriculture production and productivity</i>	<i>2.2 Better functioning national agriculture and food markets & increased intra/inter-regional trade</i>	<i>2.3 Empowered and expanded local agro-industry and value addition</i>	<i>2.4 Increased investments in Agriculture (commercialisation of agriculture)</i>	<i>2.5 Improved management of natural resources for sustainable agriculture production</i>	<i>2.6 Food and nutrition security and safety nets</i>
Increased production, intensification of production systems, productivity and competitiveness (13): (i) Use of improved inputs – seed, fertilizers and agro-chemicals, reduced post-harvest losses, mechanisation (ii) Diseases, pest and vector control (iii) Intensification of sustainable production systems (iv) Reduced post-harvest losses	Improved market access and trade (14): (i) Integration into domestic and export markets – safety and quality standards (ii) Rehabilitation of rural market infrastructure – feeder roads, storage and processing facilities and equipment (iii) Market information	Development of commodity value chains and agri-business development, processing (3)	Commercialisation (farming as a business) of smallholder farmers for improved growth and income (8): (i) Rural commercialisation – farmer organisation strengthening, input supply, access to finance and basic services (ii) Promoting private sector participation	Sustainable land and water management - access, land degradation, irrigation (20): (i) Managing shared resources (ii) Climate change adaptation (iii) Irrigation development (iv) Preservation and decentralised management of natural resources and wildlife (v) Sustainable production and environmental management (vi) Management of fisheries and forestry resources	Food and nutrition security and prevention and management of food crises (15): (i) Emergency preparedness (ii) Early warning systems (iii) Improved nutrition and diversified food systems (iv) Disaster risk reduction management and food security for the vulnerable – social protection (v) Food safety and quality
Level 3: Transformational change as a result of CAADP; Conducive environments, systemic capacity					
<i>3.1 Improved and inclusive policy design and implementation capacity for agriculture</i>	<i>3.2 More effective and accountable institutions to drive planning and implementation of public policies and investment programmes</i>	<i>3.3 More inclusive and evidence based agriculture planning and implementation processes</i>	<i>3.4 Improved coordination, partnerships and alliances within and across sectors and countries (regional trade and collaboration)</i>	<i>3.5 Increased (public/private) investment financing in agriculture achieving better value for money</i>	<i>3.6 Enhanced knowledge support and skills development for agriculture through improved S&T, Education and value addition & Training; Peer learning; Analytical capacity & strategic thinking</i>
Policy and institutional framework - clear and predictable policies (3)	Strengthening institutional capacity for planning, coordination and implementation of programmes and improved service delivery (9): (i) Strengthening local institutions (CBOs), farmer groups and rural public institutions	Evidence-based policy formulation and programme planning (1)	Sector, institutional coordination and policy within and among ministries, public-private sectors, donors (4)	Creating an enabling environment for private sector participation and public-private partnerships (6): (i) Promote access to rural economic opportunities (ii) Private sector promotion – policies, reforms and regulations (iii) Promotion of public-private partnerships	Capacity building and information for agricultural stakeholders at all levels (14): (i) Promotion of demand-driven agricultural research, intensification of applied research and technology dissemination (ii) Application of S&T in agriculture (iii) Timely agricultural statistics for M&E and planning (iv) Review and strengthening of agricultural training

Numbers in parentheses indicate the number of countries prioritising an issue in their NAIPs

Table 3. Areas of focus for Regional Agriculture Investment Plans and Sub-regional Research Organizations' Programmes

Region	Focus Area 1	Focus Area 2	Focus Area 3	Focus Area 4	Focus Area 5	Focus Area 6
ECOWAS	Improved water management by: (i) Promoting irrigation (ii) Integrated water resource management	Improved management of other natural resources through: (i) Organised transhumance and rangeland development (ii) Sustainable forest resource management (iii) Sustainable fishery resource management	Sustainable agricultural development at farm level through: (i) Integrated soil fertility management (ii) Better support services for producers (iii) Dissemination of improved technology	Developing agricultural supply chains and promoting markets by: (i) Developing the different supply chains (foodcrops, peri-urban agriculture, export crops, short-cycle livestock rearing, agro-forestry food products, artisanal fishing and fish farming) (ii) Developing processing operations (iii) Strengthening support services for operators (iv) Promoting national, regional and international trade	Preventing and managing food crises and other natural disasters by: (i) Promoting early warning systems (ii) Developing crisis management systems (iii) Assisting the recovery of crisis-hit areas (iv) Formulating mechanisms for disaster related insurance and compensation	Institutional building through: (i) Gender-sensitive approaches (ii) Support for capacity building in the formulation of agricultural and rural policies and strategies (iii) Long-term funding for agriculture (iv) Communication (v) Capacity building in steering and coordination (vi) Capacity building in monitoring and evaluation
IGAD	Sustainable use and management of natural resources	Improving rural infrastructure and trade-related capacities for market access	Increasing agricultural production and improving food security and nutrition	Support for institutional development and the harmonization of policies		
COMESA	Open up the region to freer flow of agricultural trade by removing all barriers to such trade to ensure commodities move from surplus to deficit areas in the region in response to demand and market forces	Policies, systems, regulations and procedures harmonized across the region to create a conducive, transparent and facilitative environment for conducting regional agricultural trade with forward and backward linkages across the region from the farmer to the market				
ASARECA (OP2)	Natural Resource Management and Ecosystems Services: (i) Improving agricultural water productivity; (ii) Improving soil health; (iii) Adoption of climate smart forestry, agroforestry and biodiversity conservation; (iv) Enhancing resilience of drylands; (v) Gender-responsive climate smart policies and	Markets, Market Linkages and Trade: (i) Enhanced commercialization of smallholder farming through improved access to input and output markets; (ii) Creating enabling domestic and regional trade policies; (iii) Developing and	Sustainable Agricultural Productivity, Food Security and Nutrition: (i) Developing and promoting breeds, varieties and management practices for adaptation to climate change; (ii) Managing diseases and pests of strategic crops, livestock and	Knowledge and Information Hub: (i) Focal point for generating and exchanging knowledge, developing new ideas and networking (ii) Mainstream new scientific concepts in technologies, innovations and	Institutional capacity strengthening, including in gender mainstreaming	Platforms and partnerships to address issues of a sub-regional nature

Region	Focus Area I	Focus Area 2	Focus Area 3	Focus Area 4	Focus Area 5	Focus Area 6
	governance; (vi) Managing ecosystems for quality, and equitable and sustainable services	promoting institutions for enhanced market access; (iv) Developing business incubation models and generating lessons to catalyse uptake of promising market innovations by the private sector	fisheries; (iii) Promoting enabling gender responsive policies and institutions for sustainable agriculture, food and nutrition; (iv) Post-harvest handling and processing of crops, livestock and fisheries resources; (v) Expanding the efficient production of crops, livestock and fisheries resources; (vi) Promoting conservation and utilisation of plant, animal and fish genetic resources; (vii) Promoting food and nutrition security for improved health of the people in eca.	management practices in the region (iii) Facilitate learning and increase the capabilities of ASARECA stakeholders (iv) M&E processes standardized and aligned with CAADP/FAAP principles		
CORAF/WECARD	Productivity of food and non-food crops, livestock, fisheries and aquaculture	Management of natural resources	Biotechnology and biosafety	Policies, Markets and Trade	Institutional capacity	Knowledge management
CCARDESA	Farmer empowerment and market access	Research and technology generation and farmer demand-driven advisory services	Knowledge, information and communication	Institutional development and capacity building		

5. LESSONS LEARNT

5.1 Public and Private Funding of Agriculture and Research and Development

A few countries such as Malawi, Tanzania, Liberia and Zimbabwe presented budgets for application of science and technology, but most did not have a separate budget for agricultural research and extension. The budgets for agricultural research and extension ranged from 6.5% of the NAIP budget for Ethiopia, to 39.3% for Uganda. In many of the countries, it was noted that, while public expenditure on agricultural research and development has risen over the years, much of this increase had been in recurrent expenditure and realignment of salaries of research staff to regional parity, with little or no change in capital and operational expenditure.

In Ethiopia for example, budgetary allocation to the agricultural sector exceeded the 10% of the national budget as recommended by the Maputo Declaration. However, a significant percentage of those funds were used for disaster mitigation and food hand-outs for vulnerable households (Ministry of Agriculture and Rural Development, 2010). In Malawi, input subsidies consumed about 36% of funds allocated to the agricultural sector (Government of Malawi, 2010). In such countries, little was left for carrying out research and development projects at field level. The result was that much of the field work on R&D had to be financed by development partners. The problem is that donor funding is usually short-term in nature, covering only a few years, whereas it normally takes longer to develop technologies to a stage where they can be adopted by farmers.

Given the broad-based potential benefits of applying science to solve the challenges and opportunities facing agriculture in Africa, it is imperative that African countries make a concerted effort to increase funding for agricultural research and technology dissemination to at least 1% of GDP, the target set by NEPAD. The top performers during the period 2003–2010 were Botswana and Mauritius (which spent 4–5%), followed by South Africa and Namibia (2–3%), and Burundi, Uganda, Kenya, Tunisia, Morocco, Mauritania and Malawi (slightly above the 1% target) (ReSAKSS, 2012).

Major agricultural export commodities such as coffee, tea, sugar, tobacco and cocoa, among others, have a higher potential to improve overall agricultural growth to levels comparable to the targets set by CAADP (Government of Uganda, 2009). However, such growth may have little positive impact on national poverty, food and nutrition security. Nevertheless, they are important commodities. Research work on such commodities would best be left to private actors because they can reap immediate benefits from their investments. Areas which are attractive for private sector research also include the seed sector.

Most agricultural research is funded by external partners, while African Governments are not making enough use of instruments at their disposal to get the private sector to fund science. Such instruments include a combination of tax incentives, inclusive financial models and use of corporate social responsibility. A good example of how to involve the private sector is that of Rwanda which has placed private sector involvement as the top priority to drive agricultural investment and development by creating an enabling environment through reforms in policy and regulations.

5.2 Integrating, Connecting and Strengthening Science

Agricultural research for development is expected to play a key role in raising Africa's agricultural output through improvements in yields, better use of inputs, new innovations and improved knowledge and innovation transfer systems. Every African nation seems to have in place institutions that are responsible for agricultural research and transfer of innovations. These institutions include the NARIs, universities conducting research and offering agricultural training, private sector entities with an interest in some agricultural commodities, producer/farmer organizations and non-governmental organizations (NGOs). It is now generally accepted that public agricultural research and extension services alone cannot handle all the ARD required by Africa's agriculture and that a pluralistic

approach has become entrenched. This calls for better integration and coordination among these diverse practitioners to improve efficiencies in resource-use and achievement of results.

Innovative products of ARD from public institutions have been low, mainly due to weaknesses caused by inadequate funding. While universities conduct research and tertiary level training in agriculture, their research agendas are not necessarily informed by the demands of farmers and other end users. In addition, there is little collaboration between the tertiary education institutions and the NARIs as in most cases they belong to different ministries administratively. Usually, universities are staffed with better qualified and well remunerated researchers compared to NARIs. This has often resulted in human capital flight from government research institutions to universities. The lack of coordination between NARIs and universities has led to a continuation of fragmented research efforts, resulting in low supply of innovations to farmers. One of the positive outcomes of countries implementing CAADP has been the involvement of all stakeholders in formulating and coming up with national priorities for the agricultural sectors. However, the involvement of universities and NARIs was largely limited to the scoping stages, with little participation in subsequent stages of the NAIPs. More detailed proposals on how to integrate agricultural education and training with extension and farmers may be found in the sister companion paper on agricultural education and training.

The other cause for concern has been the poor linkages between research, extension services and farmers. Extension services come into more contact with farmers and should, together with the farmers, participate in the setting up and implementation of the research agenda. Extension services and farmer groups can also help by influencing curricula of agricultural universities and training colleges. A good example of how to involve farmers is found in Rwanda where the government has established district platforms composed of farmers so that they are able to define and drive what kind of service they desire from the agriculture ministry (Government of Rwanda, 2009). In addition, the government has proposed restructuring the mandate and leadership of seven of the country's research stations to carry out participatory research with farmers. For many other countries, the important role of farmers in setting up the research agenda is noted but they lack specifics of how the end users would be integrated into the processes.

Some African nations share the same ecological environments as one or two neighbouring countries, for example, Rwanda, Burundi and Uganda in East Africa; Botswana, Namibia, southern Angola and southern Zambia in southern Africa; and Ghana, Liberia, Sierra Leone in West Africa. Such countries often share the same agricultural and livelihoods systems and challenges in raising agricultural productivity. Such countries could engage in joint research programmes through their SROs, freeing resources for other activities that are country specific. Countries can also intelligently borrow results and innovations produced by their neighbours at little cost. Examples of such practices have been discussed in Section 4.2 and are covered in greater detail in the companion paper on partnerships.

The SROs are also better placed to coordinate activities for solidarity in science activities. Such activities would be very cumbersome and costly if undertaken by individual nations. There is need for sub regional or continental publishing platforms in Africa where scientists can publish and share cutting edge research done in Africa. They can organise and host scientific meetings at regional and pan African levels. These activities would be to increase the visibility of African agricultural research.

When national systems (public or otherwise) are well linked and coordinated, it becomes easier to work with the SROs and continental and CGIAR centres in a way that maximizes returns on research investments. Alliances could then be built across countries and beyond the continent.

5.3 Technology Uptake

A review of the national investment plans indicated the low uptake of agricultural technology by end users and other stakeholders, including the limited use of biotechnology. The inconsistencies in technology uptake were ascribed to out-dated agriculture research and technology dissemination frameworks as well as weak institutions for coordination and management of the sector.

Much has been said of Malawi's subsidised input programme, consuming a large proportion of the agricultural sector budget (Government of Malawi, 2010; Chirwa *et al.*, 2013). However, when viewed from another angle, it was an innovative way of getting key technologies to be adopted on a nationwide level. Before the subsidies, fertiliser usage was low because the maize varieties grown by the farmers had a low fertiliser use efficiency. Therefore, farmers had no reason to use a lot of fertiliser as returns were low. The national research system and CIMMYT then released high yielding hybrid maize varieties with good fertiliser use efficiency and then the government began a programme of distributing improved seed and fertiliser starter packs (Government of Malawi, 2010). The result has been that during the few years that the programme has been in place, Malawi was transformed from being a net maize importer to an exporter. Food security is now assured and prices of staple grains have stabilised at lower levels.

Moving forward, there is need to considerably increase investment in research, technology development, efficient extension and farmer capacity development to adopt and adapt these technologies. This should include incorporation of climate smart technologies.

5.4 Targeting and Measuring the Impacts of R&D

Many studies have shown that investments in agricultural research rank first or second in terms of returns to growth and poverty reduction, along with investments in infrastructure and education (Fugliey and Heisey, 2007; Huffman *et al.*, 2011), averaging 49.6% in Sub-Saharan Africa (von Braun *et al.*, 2008). For example, in Tanzania, it was shown that investing Tsh 1 million in ARD has the effect of generating an increase in average household income by Tsh 12.5 million and in the process, taking 40 people out of poverty (Mwaseba *et al.*, 2004; Fan, 2007).

One of the major problems limiting agricultural growth in Africa is low total factor (land, labour and capital) productivity; there is huge potential for science and innovation to address this. In Kenya, Tanzania, Uganda and Malawi, it was noted that increasing growth of the different sub-sectors has differential effects on poverty and spin offs to other non-agricultural sectors, although they have the same effect on agricultural GDP (Government of Uganda, 2009; Government of Kenya, 2010; Pauw and Thurlow, 2010). Certain major cash crops, for example, are dominated by large farmers and estates and increasing their output may have positive effects on exports and GDP but not on poverty and food security. On the other hand, growth in the production of commodities such as maize, resulting from improved technologies and methods, has been found to impact a wider cross-section of the population because most smallholder farmers produce maize. A Kenyan study prioritised staple grains and livestock products ahead of other agricultural commodities (Government of Kenya, 2010).

This dual system is largely applicable in East and Southern Africa and not so much in West and Central Africa, where cash crops such as cocoa and oil palm and food crops are both produced by smallholders. Therefore, the solution may not necessarily lie in supporting food crops rather than cash crops, but in adopting inclusive models which promote fair trade and build the capacity of smallholders to partner with the private sector to improve market access. This is the approach advocated by the Science Agenda.

5.5 Knowledge and Innovation Platforms

The importance of science in the agricultural transformation process lies in the fact that it produces new knowledge, innovations and technologies that can make farm operations easier, cheaper, cost effective and increase production levels. However, the products from science need to get to the farmers and other value chain actors, who, through their use, would transform economies. There is acknowledgement in the NAIPs of nearly every nation that the systems for knowledge and technology dissemination are weak. Much work has been done by the NARS which has not reached the farmers. Some of that work may not have been relevant owing to the lack of farmer and extension involvement in the setting up of the research agenda. The response by countries to this weakness has been to make policy and other interventions. For example, the Rwandan government has in its agricultural sector

policy, made participatory research with farmers an important strategy. It has also set up district agricultural platforms composed of farmers and other stakeholders. These platforms can function as innovation platforms where stakeholders identify challenges and agree on actions needed to solve those challenges. Uganda is also implementing its own form of innovation platforms through the National Agricultural Advisory Delivery Services (NAADS) where farmer institutions are strengthened and given a voice in the innovation process. In Malawi, the subsidised input programme has, embedded in it, modern knowledge on how to use the inputs to improve yields.

Innovation platforms facilitate dialogue between the main players in the science agenda: researchers (scientists), farmers, policy makers and the private sector. By identifying bottlenecks and opportunities in application of science for agricultural transformation, these innovation platforms identify strategies that will lead to agricultural transformation. They bring together various stakeholders in the science agenda and provide them with a stage to voice their needs/requirements and in the process, generate country-specific solutions for aligning the science agenda with the CAADP country processes for agricultural transformation. A common feature of many NAIPs is the use of thematic or technical working groups for coordination and as innovation platforms with participation by relevant value chain actors. These have been organised along the four pillars of CAADP, with sub-groups dealing with specific subjects. However, most of these have remained at the planning stage, with little examples of how these would work. A good example of successful innovation platforms has been demonstrated by the CGIAR and FARA through the implementation of the integrated agricultural research for development (IAR4D) approach in the Sub-Saharan Africa Challenge Programme (SSA-CP) at the three sub-regional pilot learning sites (Adekunle et al, 2013) (for details, see companion paper on partnerships).

Communication of science products has been weak between science institutions in individual nations and also with extension systems. There is need to improve these so as to avoid costly duplications and inefficiencies. While innovation platforms as described above could help address this problem, there is also need for science institutions to be visible and accessible to each other through joint planning, if they are in the same country. They should also have interactive internet presence, where their output would be accessible to all stakeholders. They can also have publications for different levels of stakeholders, for example peer reviewed publications for the scientists, and farmer magazines and annual activity reports for farmers and other stakeholders. It may be expensive and not cost effective for every country to have their own peer reviewed scientific publications. Regional or continental bodies can shoulder the responsibility, a situation that would enhance solidarity in science.

With respect to the application of science and technology in food and agriculture development, NAIPs for countries such as Rwanda, Ghana, Mali, Uganda, Kenya, Liberia, Malawi and Gambia clearly outline the importance of increasing private sector participation in agricultural transformation through development of a platform for private sector-civil society engagement, improved coordination with development partners as well as strengthening of both intra and inter-ministerial coordination. Provisions are also made for establishment of appropriate legal and governance framework management to ensure accountability to client, funders and other stakeholders in relation to research in agricultural development within the platform. It should also be noted that although the private sector could be an important stakeholder in the research process, it tends to focus primarily on areas that have significant profit opportunities, meaning a market with strong intellectual property rights and regulatory systems (Huffman *et al*, 2011). Therefore, it is possible that private sector-derived innovations may not easily be accessible to all actors in the short-term.

Communication and knowledge sharing platforms are key to the success of the innovation platforms in delivering and aligning the science agenda with the CAADP processes. A good example of an information and knowledge sharing platform is given by Zimbabwe where the Food and Agriculture Organization (FAO) jointly chairs monthly meetings of the Agricultural Coordination and Information Forum (ACIF) which is attended by representatives of state and non-state actors comprising public researchers, extension services, private sector, civil society, farmer organisations, development

partners and any other agricultural value chain actors. In addition, the ACIF maintains a website which is regularly updated.

5.6 Collective Action and Solidarity in Implementing Science and Technology in CAADP Programmes

The CAADP envisions a continent-wide growth in which no nation is left behind others. While challenges requiring scientific solutions may be identified at national or regional levels, action on solutions may require collaborative efforts by more than one nation. Less resourced countries would benefit if actions are carried out in solidarity. Thus the vision is of national and multinational research teams sharing facilities, human resources and ideas to conduct research on common problems.

Within the NAIPs, coordination arrangements are weak in some countries. This would result in unnecessary duplication and inefficient use of resources. Regional and international cooperation in research is not explicitly stated in the agricultural strategies of the majority of the countries. However, there is evidence that some cooperation is taking place, for example, the East African Agricultural Productivity Program (EAAPP) being run in Ethiopia, Kenya, Tanzania and Uganda under the auspices of ASARECA (Government of Kenya, 2010) and the competitive grant schemes for regional collaborative research run by both ASARECA and CCARDESA.

The solidarity envisioned here could also promote mobility of African scientists from one institution to another. Nations such as Rwanda and Malawi point to shortages in skilled human capital as a constraint to addressing some researchable problems. These could benefit from mobility programmes for scientists by engaging the required expertise from another country for a specified duration. For this to happen at the scale envisaged, it could be coordinated by SROs who would keep up to date databases of experts on particular disciplines. The SROs could recommend experts if requested by any national entity. ASARECA already has a database of experts in different fields and their institutional affiliation. National research systems could also engage each other and forge collaborations outside of SRO coordination by sharing facilities, human resources and working on common challenges. The result of cross national collaboration in science is that eventually all national systems become more strengthened in comparison to what they would have been if they tried to do it alone.

6. OPERATIONALIZING THE SCIENCE AGENDA

Most of the reviewed NAIPs identified the potential contribution of science and technology to most, if not all, priority investment areas. The FAAP largely focuses on applying agricultural research and development to improve productivity and production. However, the Science Agenda provides an overarching strategic framework to guide and rationalise investments in science by African countries, RECs and their partners as a tool for catalysing agricultural development, well beyond the issues articulated by FAAP. The S3A provides a framework for integrating areas that were traditionally not considered as “scientific” but which can benefit from the application of the scientific approaches. Possible entry points for operationalizing the Science Agenda in implementing are shown in Table 4.

Table 4. Possible entry points for the Science Agenda in National Agriculture Investment Plans

Priority Areas	Possible entry points for the science agenda
Increased production and productivity	<p>Application of existing and novel technologies to increase efficiency and competitiveness in commodities of comparative advantage.</p> <p>Technologies include those related to use of improved inputs (germplasm, pest and diseases control, reducing post-harvest losses, mechanisation etc).</p>
Improved management of natural resources for sustainable agriculture production	Applying existing and new technologies for maintaining and improving the management of the production base (land/soil, water, forestry, fisheries and wildlife).
Better functioning national agriculture and food markets and increased intra/inter-regional trade	Applying results of past experiences and market research and development, including market information, SPS issues, food safety and standards, mechanisms to reduce transaction costs, post harvest handling, processing, and infrastructure such as feeder roads, storage, processing facilities, public-private partnerships and inclusive market access models.
Empowered and expanded local agro-industry and value addition	Value chain studies, product development and support for local small scale agro-processing.
Increased investments in agriculture (commercialization)	<p>Entrepreneurship and business development for smallholder farmers and promotion of investment by private sector following needs assessments and analysis of potential returns on investment.</p> <p>Promotion of private sector investment through catalytic public investments to reduce risk and initial cost of entry and use of fiscal instruments such as tax incentives on rural investments and corporate social responsibility projects.</p>
Food and nutrition security and safety nets	Application of lessons and research on DRRM, early warning systems, integration of nutrition into food security and disaster risk reduction and management strategies, use of agriculture-based social safety nets and food for assets programmes
Creating an enabling environment for agricultural growth and increased contribution to development	<p>Evidenced-based policy formulation to support developments in other priority areas:</p> <ul style="list-style-type: none"> • Promotion of private sector participation in agricultural value chains. • Coordination of agricultural sector actors, institutional capacity building for rural public and local level institutions. • Provision of timely agricultural statistics and related information. • Capacity building and coordination of agricultural research and extension systems, training of farmers and agricultural personnel (researchers and extension agents). • Development of national and regional knowledge and innovation platforms to communicate and share scientific information and lessons. • Empowerment of women and youth through improved access to rural business and employment opportunities

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

In qualitative terms, there is good agreement between the areas of focus of the NAIPs and the strategic thrusts of the Science Agenda when viewed at continental level. However, at individual country level, there are some gaps. There is, therefore, great scope for achieving the objectives of the CAADP through application of science and technology. However, this can only be achieved if there is sustainable alignment and coordination of the actions of national, regional and international researchers with the CAADP Results Framework and the Science Agenda. It is apparent from country reports to date that there has been variable adoption and application of science and technology among

the different countries. The CAADP Results Framework may be used to identify and review priority areas for NAIPs as well as potential entry points for science and technology-based solutions.

Most countries have not clearly allocated resources to agricultural research and technology transfer. This may be linked to the fact that most countries do not have targets on the contribution of science to agricultural development, are not able to sustain science and technology budgetary requirements and the cross-cutting nature of research. This is also compounded by governments' over-reliance on development partners for driving the research agenda. Such funding is normally of a short-term nature to sustain the requisite agricultural research inputs. NEPAD has recommended a minimum budgetary allocation of 1% of GDP to agricultural research.

Integration, coordination and linkages between technology generators, extension services, farmer organisations and the private sector are weak areas in the NAIPs. Where mechanisms were outlined, there was no clarity on cost-sharing mechanisms for cost-effective transfer of technology to intended users and empowerment of smallholder farmers. All these shortcomings result in low uptake of technologies and other innovations.

Private sector involvement in agricultural development is generally low, and even lower when it comes to financing science and technology. Governments could increase private sector participation and investment by making catalytic investments to reduce risk, creating an enabling policy and regulatory environment and making use of fiscal tools such as tax incentives on rural and corporate social responsibility investments.

The potential entry points for science and technology are many and varied across the different priority areas and are not limited to improvement of production and productivity. Virtually all priority areas, including policy, institutional capacity and information, can benefit from the scientific approach by using evidence from scientific enquiry. The specific applications for each country will need to be supported by results of research and needs assessments.

6.2 Recommendations

- (ix) African countries should use the CAADP Results Framework and the Science Agenda to identify issues that can be addressed by science and technology, incorporate these into the NAIPs and ensure adequate budgetary provision for technology development and dissemination.
- (x) There seemed to be no targets in the investment plans for R&D outputs. Where resources are invested, there must be mechanisms for measuring the outputs, outcomes and impact from the research efforts. These mechanisms or the targets need to be spelt out clearly in the strategic plans.
- (xi) It was clear from the NAIPs that some priority areas are common to a number of countries, some of which may be neighbours sharing the same agro-ecological environments. In such circumstances, it is recommended that countries pool resources, conduct joint R&D activities and share the results, with assistance of the SROs.
- (xii) There is need to strengthen sub-regional research cooperation through sub-regional groupings such as CORAF, ASARECA and CCARDESA. These bodies should be responsible for mobilizing resources, forging partnerships with CGIAR centres and conducting research on common regional problems, becoming hubs for regional solidarity in science for agricultural development. They can host regional knowledge and information hubs, publishing forums and scientific meetings which may be too expensive and less effective when done by a single country.
- (xiii) To increase adoption of improved technologies, it is necessary for potential users of innovations to be involved in the setting up of the research agenda. This may include

involvement of farmer groups and other value chain actors in the design, implementation, evaluation of agricultural research projects and participation in innovation platforms at local level.

- (xiv) Agricultural training institutions (universities and colleges) are an integral part of national innovation systems, conducting research and training research scientists and extension personnel. They have an advantage in mobilising funds for research over government institutions. It is, therefore, imperative that their research priorities are in sync with the national aspirations and that they too are part of the national agricultural research systems.
- (xv) African Governments should be encouraged to invest at least 1% of GDP to agricultural research and technology transfer.
- (xvi) FARA should develop guidelines for mainstreaming science into CAADP processes, specifically NAIPs.

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ANNEX

Annex 1: Country priority areas for the application of science & Technology

Country	Priority Area 1	Priority Area 2	Priority Area 3	Priority Area 4	Priority Area 5	Priority Area 6
Benin	Strengthening of institutional capacity for planning, coordination and implementation of programmes	Capacity building for agricultural stakeholders – capacity of staff	Promotion of agricultural research			
Burkina Faso	Sustainable land management and climate change adaptation	Improved water management	Development of agricultural chains and market promotion	Sustainable farming - managing shared resources	Prevention and management of food crises	Institutional capacity strengthening
Gambia	Sustainable land management and climate change adaptation	Improved water management	Development of agricultural chains and market promotion	Sustainable farming - managing shared resources	Prevention and management of food crises	Institutional capacity strengthening
Ghana	Food security and emergency preparedness – productivity improvement, improved nutrition, diversified livelihoods, food storage and distribution, early warning systems, irrigation and water management, mechanisation	Commercialisation for improved growth, income and reduced income variability – cash crops, livestock and fisheries, new product development, pilot value chains, outgrower schemes, rural infrastructure, urban and peri-urban agriculture	Integration into domestic and export markets – grading and standards systems, export promotion, increased marketing of produce	Sustainable management of land and water	Science and technology applied in food and agriculture development – funding for research (1% of national budget), biosafety	Institutional coordination – intra- and interministerial, partnerships between public, private and civil society, coordination with donors, and statistics for M&E of policies and programmes
Liberia	Land water development – land policy and capacity building, land husbandry, expansion of irrigation, wet and degraded land management	Food and nutrition security – food crops production and productivity, nutritional status and management of emergencies, smallholder tree crops and agro-	Competitive value chains and markets – rehabilitation of rural roads, rural agricultural infrastructure and energy, financial services, labour saving devices and	Institutional development – rebuilding ministry of agriculture and parastatals, increased agricultural research,		

Country	Priority Area 1	Priority Area 2	Priority Area 3	Priority Area 4	Priority Area 5	Priority Area 6
		forestry development, sustainable fisheries development, livestock development, special women and youth initiatives	technology, market and enterprise development	technology dissemination, review of agricultural education and training, strengthening farmer organisations, and increased coordination		
Mali	Development of crop agriculture – irrigation development,	Development of livestock sector	Development of fisheries and aquaculture	Preservation and decentralized management of natural resources and wildlife	Accompanying measures and support for implementation	
Niger	Promote access to rural economic opportunities – rural finance, rural infrastructure and extension support	Food security and sustainable management of natural resources	Institutional capacity strengthening – local CBOs, research organisations and rural public institutions			
Nigeria	Development of agricultural chains and productivity enhancement – seed industry development, dam irrigation rehabilitation,	Surveillance and quarantine – disease and pest control	Fisheries and aquaculture development	Livestock sector development	Intensification of applied research	
Senegal	Secure production base – land, water and natural disaster management	Increased production and productivity	Coordination of sector policies	Creating an enabling environment for private sector participation		
Sierra Leone	Commodity commercialisation – value chain development for small scale and value addition for medium and large farms	Rural infrastructure and market access rehabilitation of feeder roads, irrigation, storage, processing facilities and equipment, rehabilitation of research centres	Private sector promotion – policies, reforms and regulations	Sector coordination and management		

Country	Priority Area 1	Priority Area 2	Priority Area 3	Priority Area 4	Priority Area 5	Priority Area 6
Togo	Intensification and sustainable development of production systems	Diversification of production systems and agri-business development	Agricultural commercialization and capacity building of farmers	Food nutrition and security, right to food	Strengthening institutional capacity and coordination	
Burundi	Enabling environment	Professionalisation of farmers	Market access	Sustainable production and environmental management	Equitable distribution of benefits and products	
Ethiopia	Production and productivity of food, cash crops and livestock Increased. Intensification of input use, irrigation, seed systems, agricultural research and extension, reduce post-harvest losses	Rural commercialization – marketing, farmer organization strengthening, private sector development, fertilizer supply and access to finance	Natural resources management – land and forestry management	Disaster risk management and food security – DRM and food security for the vulnerable	Policy and institutional framework	
Kenya	Increasing productivity, commercialization and competitiveness – intensified use of farm inputs, post-harvest management, conservation agriculture, disease and pest control, feed resources development for dry areas, agro-forestry, drought early warning systems	Market access and trade	Promoting private sector participation	Sustainable land and natural resources management	Institutional capacity strengthening – reforming service delivery, effective coordination and implementation	
Rwanda	Intensification and development of sustainable production systems – erosion control, water management, input use, technology creation, adaptation and transfer	Professionalisation of producers – farming as a business	Commodity chains and agri-business development – inputs, processing sector, infrastructure, enabling environment and private sector initiatives	Institutional development – capacity of Ministry of Agriculture to implement strategy		
Uganda	Enhancing production and productivity – agricultural	Market access and value addition – enforcement of	Enabling environment for agricultural sector - clear	Institutional development –		

Country	Priority Area 1	Priority Area 2	Priority Area 3	Priority Area 4	Priority Area 5	Priority Area 6
	research and technology development, better delivery of technologies, improved diseases, vector and pest control, sustainable management of soil and water, increased use of water for agriculture production, mechanization and labour saving technologies, improved livelihoods in drier areas	safety and quality standards, access to high quality germplasm, value addition, rural market infrastructure, strengthening of farmer organisations	and predictable policy framework, improved and transparent formulation of policies, strategies, programmes and projects, public education and communication around key agricultural and natural resources issues, coordination of sector, timely agricultural statistics and climate information	strengthening and reconfiguring public institutions for improved service delivery		
Tanzania	Increased productivity – irrigation, mechanization, R&D and extension, improved inputs, renewable natural resources and climate change	Market expansion – rural infrastructure, agro-processing and value addition	Promotion of public-private partnerships	Capacity building at all levels		
Democratic Republic of Congo	Improve access to markets and value addition – infrastructure,	Increased productivity – mechanisation, labour saving	Farming as a business – decentralised financing of agriculture	Institutional capacity strengthening – public and private sector, rural organisations,	Access to basic services	
Malawi	Food security and risk management - improving crop productivity, reduced post harvest losses, diversification of food production and diets diversification with a (crops, livestock and fisheries), DRRM for food stability	Commercial agriculture, processing and market development – export of high value commodities, value addition/processing, import substitution, development of input/output markets through public-private partnerships	Sustainable agricultural land and water management, including irrigation development	Technology generation and dissemination		
Mozambique	Improved agricultural research	Productivity and production	Access to markets	Value chain development		
Seychelles	Agricultural land and infrastructure	Agricultural research,	Sustainable fisheries development	Marketing and trade development	Food and nutrition security	

Country	Priority Area 1	Priority Area 2	Priority Area 3	Priority Area 4	Priority Area 5	Priority Area 6
		irrigation and extension				
Swaziland	Land and water management – irrigation development, land degradation management	Market access - sustainable markets	Food security and nutrition – small livestock breeding centres, dairy productivity, small scale crop production, feed and fodder production, agricultural bank, capacity building of extension and farmers	Agricultural research – natural resources programme and infrastructure		
Zambia	Sustainable land and water management – improved access to land, policies	Rural infrastructure and markets – trade polices, coordination and dialogue between government, and private sector, infrastructure development, including for livestock and fisheries, private sector investment in production, input/output markets	Food supply and reduction of hunger – social protection with private sector and civil society, diversified extension messages, including the vulnerable	Agriculture research and technology dissemination – demand-driven research and extension linkages focusing on public-private partnerships		
Zimbabwe	Production and productivity – use of land, water, forestry and wildlife resources, land rights, land management, irrigation development	Increasing access to domestic and export markets – rural infrastructure, institutions, market information, private sector participation, policies	Ensuring food and nutrition security by facilitating a cohesive multi-policy on social protection, food safety and quality	Increasing agricultural research and technology and information dissemination and adoption – skills for extension, research and farmers, equipment for research	Coordination of sector	