AU NAIP Toolkit for Malabo Domestication

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Foreword

Back in 2016, the Country CAADP Implementation Guidelines under the Malabo Declaration were developed based on a long participatory process that absorbed information from a range of studies, meetings, country visits and events. These Guidelines were validated by all CAADP constituencies and provide very broad directions to countries to design and implement National Agriculture Investment Plans that are aligned to and consistent with the spirit, values and principles of CAADP as encapsulated in the Malabo Declaration. Having adopted such a document was an important step towards the right direction. However, there was an overwhelming consensus among CAADP constituencies that the Guidelines were not enough as they were not meant to be robust enough in supporting countries in their evidence-based planning efforts. It was therefore natural that another piece of work, focusing on the key metrics, main analytical questions, and tool for design, appraisal and tracking of countries' performance was vital and had to be added to the package countries would need. This is how the idea of developing a NAIP 2.0 Toolkit was arrived at to support the second generation of NAIPs.

Working with IFPRI and ReSAKSS, the African Union Commission and the NEPAD Agency were able to mobilize and coordinate refined expertise from several institutions that had expressed interest in supporting this endeavor. Contributing institutions to the Toolkit include: University of Pretoria, IFPRI, ReSAKSS, CORAF, FAO, ReSAKSS, CIAT and Africa Lead. Substantive inputs from these institutions covered a wide range of technical areas including: Climate Smart Agriculture, Gender, Nutrition (Biofortification), Public Expenditure Analysis, Overarching growth and poverty goals and country modelling/ Regional trade, Regional trade/ Overarching growth and poverty goals and country modelling, Mutual Accountability, Typology, prioritization, and decentralized performance tracking, Foresight analysis, Agricultural Research and Development, and Value chains.

In complementing the Country CAADP Implementation Guidelines under the Malabo Declaration, the NAIP 2.0 Toolkit is a solid document at the disposal of all experts assigned to support national governments' efforts towards complying with Malabo.

Introduction and context

The CAADP Results Framework 2015-2025 (hereafter, "Results Framework") was developed as a key tool for translating Africa's agricultural development vision and goals into tangible outcomes and for tracking, monitoring and reporting on progress as well as for facilitating mutual learning and accountability. A key challenge for operationalizing the Results Framework is ensuring adequate data is accessed and used, and credible analysis is undertaken, not only in monitoring progress but also in helping to inform future planning and programming. It is of critical importance to ensure that existing National Agricultural Investment Plans (NAIPs) can be effectively appraised and, where new ones are being formulated,

designed in ways that are sufficiently rigorous and consistent with the CAADP goals and commitments in the Malabo Declaration.

Technically, in order to be able to effectively guide member countries in the design and implementation of the institutional, policy, and investment actions required to achieve the Malabo commitments, at least four important elements must be considered:

1. The identification of clear metrics to measure targets, define milestones, and guide progress and performance tracking and review,
2. The definition of a set of key analytical questions that will guide the kind of analysis needed at the country level to inform the NAIPs,
3. The use of a common set of tools and analytical approaches to ensure consistency and alignment among the many Malabo goals and targets, as well as facilitating tracking of progress at the continental level, and
4. The coordination of analytical and other planning activities to ensure the timeliness of delivery, the quality of outputs, and the relevance of findings.

The present report is an input and a contribution to the efforts by the AUC and NPCA to prepare a Technical Guide & Road Map for appraisal and preparation of the next generation of NAIPs and their alignment with the Malabo commitments. It is the outcome of a series of technical meetings facilitated by the AUC and NPCA and supported by IFPRI and ReSAKSS between November 2015 and February 2016. The meetings brought together local and international expertise to identify a common set of analytical tools, metrics, and approaches that can be used to not only inform the development of future NAIPs, but also to help in their appraisal once they are being implemented.

The rest of the report is organized in three parts. The first section of Part I proposes sets of metrics for key goals and targets to be met, commitments to be achieved, milestones to be tracked, and actions to be covered by the investment plans. Then key steps to use the metrics to assess the status and analyze the profile of individual countries in each of the main thematic areas are suggested. The third section describes steps to follow to define country-specific targets and milestones that will guide the design of future investment plans.

Part II presents the list of analytical questions that will be addressed during the NAIP appraisal process. These questions guide country and regional teams on what to focus on, though the questions can further be refined based on the country context. Efforts have been made to distinguish between questions for appraising existing NAIPs and questions for designing upcoming NAIPs. The questions can be different for the status assessment and country profiling and the program milestone and goal setting. They should lead countries to come up with strategic and operational recommendations, which are highlighted immediately after the analytical questions under each overarching and thematic goal.

Part III proposes and describes details of tools that can be used for the country profiling, status assessment, and program design. The purpose here is to list, describe and document available tools/methodologies and databases that can be used for NAIP appraisal. The note presents short explanations on why a particular analysis is needed and explains how the analysis can be done with the

available tools. It also describes when and under what conditions the tools can be used and what types of data are required. The note further provides web-links or other sources for detailed information (see the annex for comprehensive descriptions of the tools). The note will serve as an immediate reference to choose methods, tools or databases.

The major topics covered in this note include overarching and thematic goals that are identified under the Malabo declaration. For each topic, two major types of tools are presented: tools that can be used to carry out the country profiling and status assessment, and tools used for the identification of program milestones and goal setting for future investment plans. While the former mainly focus on measuring metrics used to track achievements of the goals and targets, the latter focus on measuring relationships among these goals, more specifically the links between the different indicators listed in the Results Framework from level one to three. This will ensure consistency and guidance for implementation of NAIPs and help to establish milestones from the appraisals.

The note is primarily developed for local and regional experts who will conduct country level NAIP appraisal with backstopping support from an international NAIP task force. IFPRI has also organized a series of technical clinics to provide the local and regional experts with an in-depth introduction to the tools and methodologies for NAIP appraisal and design. Thus this document is mainly intended as a reference for users who have participated in training and who have access to other guidance on implementing the tools described. The analytical tools presented in this note can be used for ex ante diagnostic, planning, and monitoring as well as for ex post evaluation purposes. While the diagnostic tools serve those countries which are in the early stages of national investment plan development, the evaluation tools are useful to those countries which would like to evaluate their on-going or just-ended investment plans.

This note is not intended to be a how-to manual for appraising and designing NAIPs. Rather it is a repository of information on available tools and methodologies that may be relevant to the NAIP process. Each country will plan its own NAIP reformulation process and define its own roadmap for NAIP-related technical analysis; it is expected that countries will decide to employ a subset of the tools presented here, based on the availability of data and expertise at the country level and on country-specific needs. Since the depth, coverage and importance of the tools are very different, all tools may not be relevant for all country teams. As always, contextualization is needed to fully apply certain tools. Some tools are simple and meant to estimate indexes and associations or causality between metrics and hence they can be used at the national level by most countries conducting the NAIP appraisal. Others are very complex models that require huge datasets and special expertise and hence they should be used at the regional or continental level by a specialized team of experts. However, country teams can access the results generated by the regional team and utilize them for their specific appraisal. As a result, all types of tools and methods are described and their sources are cited.

The analytical questions, tools, and methodologies described can provide essential guidance toward the evaluation and design of NAIPs. Based on this guidance, country NAIP teams will identify the specific programs and policies to be contained in the NAIP and perform cost and risk analysis, including measures of social and environmental sustainability. This document focuses on the analysis required for status assessment and profiling and goal and milestone setting and does not address the operational part of

program design to take place at the country level, which will require additional types of analysis, such as cost-benefit analysis and risk mitigation.

PART I: METRICS, STATUS ASSESSMENTS AND PROGRAM DESIGN

1. Definition of metrics

Two sets of metrics are considered, in line with the above categories of goals and commitments. The first deals with overarching goals and targets such as achieving 6 percent agricultural growth, reaching a 10 percent agricultural expenditure share, eliminating hunger, halving poverty, etc. The second set covers metrics detailing goals and targets that are made under each of the specific thematic areas covered under Malabo. Thematic goals and commitments relate to outcomes in each of the following areas: Inclusive growth and value chain development, Regional trade, Ending hunger, Gender, Climate smart agriculture, and Mutual Accountability. For each of these areas, a non-exhaustive, indicative list of metrics and their definitions are provided in the following sections. In both cases, all relevant indicators in the Results Framework are considered and additional complementary metrics proposed to ensure that status assessments and program and investment plan design are comprehensive enough to meet the vision outlined by Malabo. A complete list of Results Framework indicators and suggested data sources is provided in Annex C.

The metrics defined here deal with goals and commitments at the continental level. Country-specific goals and targets as well as policy and institutional commitments that are defined in existing country investment plans cannot be considered here, but related metrics will need to be defined and added during the status assessment and country profiling exercises.

1.a) Overarching goals, targets and commitments

The original Maputo commitments of achieving a 6 percent annual agricultural growth rate and a 10 percent agricultural expenditure share were upheld by the Malabo Declaration and remain core CAADP commitments. Among the new commitments outlined in the Declaration, the goals of halving poverty and eliminating hunger by 2025 are in the same category. The CAADP Results Framework identifies the following indicators or metrics to quantify key CAADP and Malabo commitments that cut across or are linked to achievement of goals and targets in all thematic areas:

- Poverty headcount ratio, national (% of population)
- Extreme poverty headcount ratio at $1.25/day
- GDP per capita (constant 2005 US$)
- Employment rate (% of population)
- Number of jobs created per annum
- Household income per capita (constant 2005 US$)
- Gini coefficient

- Agriculture value added
- Agriculture production index
- Agriculture value added per agricultural worker
- Agriculture value added per hectare of arable land
- Government agriculture expenditure growth rate
- Share of government agriculture expenditure in total government expenditure
- Government agriculture expenditure as share of agriculture value added

The above list needs to be complemented by metrics and indicators linked to the specific targets and commitments stated by individual countries in their respective NAIPs, New Alliance Cooperation Frameworks and similar documents. These relate to:

- Growth rate of GDP per capita
- Growth rate of agricultural value added per capita
- Yield for individual commodities
- Growth rate of output for individual commodities
- Growth rate of agricultural value added (constant 2005 US$)
- Policy, regulatory, and institutional actions and reforms
    - Quality of planning, execution, and coordination
    - Implementation status
    - Adequacy of coverage
- Government financial commitments
- Private sector investment commitments
- Development partner financial and non-financial commitments
- Non-state actor financial and non-financial commitments
- Any other specified key commitments

1.b) Thematic goals, targets and commitments

i) Inclusive growth and value chain development

Relevant indicators and metrics in the CAADP Results Framework include the following:

- Yields for the top five priority commodities
- Percent share of output of top five priority commodities that is lost post-harvest
- Growth in private sector investment in agriculture and agribusiness

Other indicators to use include:

- Growth in sub-sector value added
- Share of agricultural output that is processed
- Overall employment in agricultural value chains and share of women and youth in total employment
- Number of brands of processed local staples and other food products
- Number of local brands of processed staples and other food products for sale in major supermarket chains

- Number of new seed varieties available annually
- Number of fertilizer blends available
- Number of other agricultural chemicals available

ii) Regional Trade

The CAADP Results Framework includes the following indicators dealing with regional trade:

- Value of intra-African trade
- Domestic food price index volatility

Suggested complementary metrics include:

- Changes in values and volumes of total imports and exports of key agricultural commodities and major inputs
- Changes in values and volumes of intra-regional imports and exports of key agricultural commodities
- Share of formal/informal, registered/non-registered trade
- Share of women-owned businesses and their volume of transactions and cost and profit levels
- Trade performance indicators including trade overlap indicator (TOI), symmetric trade introversion index (STJ), and other indicators listed in Annex B.4, section i
- Nominal and effective rates of assistance for agricultural commodities
- Tariff equivalence of non-tariff barriers to trans-border trade

iii) Ending hunger, reducing food insecurity and improving nutrition

This component lends elements from the SDG2, namely to *end hunger, achieve food security and improved nutrition and promote sustainable agriculture*. The Malabo Declaration commitment to End Hunger by 2025 sets the following targets to:

- At least double productivity (focusing on Inputs, irrigation, mechanization)
- Reduce PHL at least by half
- Nutrition: reduce stunting to 10%

However, a second commitment made at the 2014 Malabo Heads of State Meeting Declaration on *Nutrition Security for Inclusive Economic Growth and Sustainable Development* reaffirmed this commitment to end hunger by 2025 through strengthening of development policies as an effective investment in the human capital in countries and committed to ending child stunting (to below 10%) and reducing child underweight to 5% by 2025 (focusing on the first 1000 Days) and to positioning this goal as a high-level objective in national development plans and strategies, and to establish long-term targets that give all children equal chance for success, by eliminating the additional barriers imposed by child under-nutrition.

For this reason, food security and nutrition are impact-level indicators of achievement of the Malabo efforts, as well as indicators of progress towards specific actions aimed at reducing hunger[1], food insecurity[2] and malnutrition[3].

The core food security and nutrition indicators contained in the CAADP Results Framework overlap with indicators in other components of the framework. These include:

- Access to agricultural inputs and technologies (see section 2b)
- Agricultural productivity (see section 2b)
- Post-harvest losses (see section 1b)
- Social protection (budget lines (%) on social protection as percentage of the total resource requirements for coverage of the vulnerable social groups)
- Food security and nutrition
    - Prevalence of stunting (% of children under 5 years old who are short for their age)
    - Prevalence of underweight (% of children under 5 years old who are of low weight for their age)
    - Prevalence of wasting (% of children under 5 old who are of low weight for their height)
    - Proportion of the population that is undernourished (% of the country's population)
    - Growth rate of the proportion of Minimum Dietary Diversity for Women
    - Proportion of children 6-23 months old who meet the Minimum Acceptable Diet

Complementary metrics that should also be considered include:

- ***For hunger***:
    - Integrated phase classification levels
    - Numbers of people in need of food assistance
    - Proportion of population receiving food assistance
    - Food balance sheet data
    - Cereal import dependency ratio
- ***Food insecurity***:
    - Food Insecurity Experience Scale (FIES) – this is an SDG2 indicator
    - Women's and child body mass index (BMI)
    - Agricultural production diversityContribution of non-staple foods to calorie production, both in amount and monetary value
- ***For nutrition***:
    - Prevalence of anemia in women and children under five years of age

[1] Hunger is a sever manifestation of deprivation of food and can be chronic or acute. At its extreme hunger manifests as wide-spread famine.

[2] Food insecurity exists when individuals, households or communities face difficulties in producing, accessing and consuming enough food to meet their specific nutritional requirements for an active and health life.

[3] Malnutrition includes three forms: underweight, micronutrient deficiencies as well as overweight and obesity due to eating too low energy, too few macro and micronutrients or unbalanced diets.

- Rates of zinc, vitamin A and iodine deficiencies in children under two, children under five and adolescent girls

Biofortification has received wide acceptance on the African continent, leading to a number of countries targeting biofortification among desirable strategies to address selected micronutrient deficiencies such as for iron, zinc and vitamin A. While the HarvestPlus program has been a key driver of biofortification, other development agencies and even the private sector are now engaged in biofortification activities at country level. It has therefore become important to track progress on biofortification at country level as part of the NAIP M&E process. The following five indicators are recommended to help to track progress on production, consumption and investments with respect to biofortification over time:

- Share of [crop] production (quantity) that is biofortified
- Share of dietary energy consumption derived from biofortified crops
- Percent of people consuming biofortified foods
- Percentage of released crop varieties that are biofortified
- Percent of breeding lines that are biofortified

iv) Gender

The Malabo Declaration and Results Framework do not provide specific metrics related to gender in one place. Indeed, gender is relevant to many development outcomes, and it is important to examine how gender issues affect and are affected by conditions and progress under each of the other thematic issues. Hence, several of the thematic issues include gender-specific indicators.

An important and complementary metric to use, in particular as it addresses the gender dimensions of production, welfare, and social engagement, is the Women's Empowerment in Agriculture Index (WEAI), which measures women's empowerment across five domains:

(1) Decisions about agricultural production
(2) Access to and decision making power about productive resources
(3) Control of use of income
(4) Leadership in the community
(5) Time allocation

v) Climate smart agriculture (CSA)

The CAADP Results Framework includes the following indicators dealing with CSA:

- Percent of households that are resilient to climate and weather-related shocks
- Share of agriculture under sustainable land management practices

Other complementary indicators to be added include:

- Share of population exposed to climate risk[4]

[4] The share of population exposed to climate risk can be measured in a variety of ways, for example as the share of population living in areas with a high coefficient of variation of annual rainfall (see S. Benin et al., 2016, *Kenya Agricultural Development Status Assessment*, mimeo, International Food Policy Research Institute).

- Share of land under small-scale irrigation by crop and by region
- Rate of adoption of soil fertility management practices
- Degree of awareness of climate change risk and impact among farming population
- Share of seeds adapted to heat and drought in major crops

vi) Mutual Accountability (MA) and Institutional Architecture

MA indicators in the Results Framework include the following:

- Existence of a new NAIP developed through an inclusive and participatory process
- Existence of inclusive institutionalized mechanisms for mutual accountability and peer review
- Existence of an operational country Strategic Analysis and Knowledge Support System (SAKSS)

Additional metrics on MA include:

- Existence of a comprehensive, inclusive and technically robust agriculture Joint Sector Review (JSR)
- Degree of participation of non-state actors in policy and program formulation and implementation
- Capacity of key institutions to deliver core functions needed for successful policy and program formulation and implementation

2. Country profile and status assessment

Countries will be assessed regarding their status and progress on each of the metrics described above with respect to both the overarching and the thematic goals and commitments. For all quantitative indicators, first a baseline measurement showing average values during a reference period, for example 1995–2003, should be established. Second, the average level during the NAIP period should be compared with the baseline period of 1995–2003. Finally, changes during the period of the NAIP (from the first year to the last year of the NAIP) should be measured. For more qualitative indicators, such as those regarding policy and institutional quality and adequacy, current status will be assessed as well as any available information on progress during the period of the NAIP. In particular, the impact of policy and institutional actions or lack thereof on each of the thematic areas and overarching goals needs to be assessed.

3. Prospective analysis and goal setting for future NAIPs

In addition to assessing the status of progress under existing NAIPs against key metrics and analyzing the profile of individual countries regarding their current standing with respect to all Malabo goals and commitments, it will be necessary to define concrete, measurable targets and milestones to guide the design of future NAIPs. In countries revising existing or beginning the process of designing new NAIPs, prospective analysis can be performed to examine likely future trends in individual core indicators under alternative scenarios that would reflect the realities of each country under the respective thematic groups. The analysis should allow the definition of country-specific targets and milestones that would inform the design of country programs and investments. The analysis should also include the identification of policies and institutional arrangements that are required to ensure that the set goals and milestones

can be achieved efficiently and effectively. Basically, the content of programs and investment plans would be guided by the gaps between: (i) the evidence from the status assessment and profile analysis showing where individual countries stand with respect to key goals and targets and (ii) the findings from the prospective or goal setting analysis showing the possible and desired outcomes to be pursued under the investment plans. The milestones from the prospective analysis help define intermediate program and investment plan outputs and outcomes and thus provide the foundation for effective tracking and implementation stewardship.

PART II: ANALYTICAL QUESTIONS

From an analytical perspective, the broad agenda of the Malabo commitments presents a number of challenges given the greater number of goals and targets. These include achieving economic transformation and growth, attaining 6 percent annual growth in agriculture, doubling productivity (including though climate smart agriculture practices), strengthening 5 agricultural value chains and agribusiness in general (including generating opportunities for women and youth employment), and tripling intra-African trade. Some of these goals may be interrelated or supportive of each other, while others offer many trade-offs or even compete with each other.

Because of the formidable task of assessing the options for a NAIP that account for many of these goals and commitments, the scope of analytical questions will be organized against key thematic areas to help provide more structure and focus.

2a. Overarching goals, targets and commitments

At this level, we are particularly concerned about the national level goals of achieving at least 6 percent agricultural sector growth, halving poverty, and eradicating hunger by 2025. Some key questions to consider include:

i. What is the current state of affairs or initial conditions with respect to growth, poverty and hunger?
ii. For currently existing NAIPs:
    - What have been the lessons and effects of NAIP program development, benchmarking and implementation, as well as progress in achieving outcomes and impact?
    - Is the allocation and level of inputs (e.g. spending, investments, policy interventions) on target? Can the impact of investments be traced to improvements in outputs (e.g. productivity and viability of production systems, food processors, agro-industries, markets, and trade) - and outcomes (e.g. incomes, poverty, jobs and nutrition status)?
    - Are there important lessons on program design, especially the ingredients of success or failure? What factors have shaped (positively and negatively) the level of impact achieved to date? What needs to be altered? What have been the distributional effects on welfare (among smallholders, women, and youth)?
iii. For current and future NAIPs:
    - How much will poverty decline under the current growth path? Is the 6 percent CAADP agricultural growth target achievable and can it halve poverty by 2025?
    - What is the growth and poverty impact of increasing yields and productivity for different crops and sub-sectors (ideally linked to productivity analysis as well)? Which crops and agricultural sub-sectors are best at generating national growth and/or poverty reduction over the next decade? Which one is in line with the 5 value chains identified by CAADP?
    - Are there potential trade-offs in the (intermediary) goals?
    - What level of effort and performance is required to meet the overall growth and poverty reduction targets? Will the 10 percent agricultural spending target be enough to reach 6

percent agricultural growth and, if not, how much is needed? How significant are the impacts and returns of public agricultural expenditure?

- What types of public spending should be prioritized to raise the agricultural growth rate to 6 percent per year?
- What are the trends of public agricultural expenditure in terms of consistency, cost effectiveness and overall performance?
- How should resources be mobilized and allocated for the NAIP across the different economic sectors, welfare concerns, and geographic regions?
- What opportunities are there for leveraging public-private partnership investments and promoting greater private sector investments?

2b. Inclusive growth and value chain development

Here the focus is on identifying the five most promising commodities or value chains that have the greatest potential to drive overall sector and income growth, while also weighing in concerns for agribusiness and value chain development, inclusive of opportunities for women and youth, as well as integrating with growing regional markets. Much of this will build on, and be linked with, the economy-wide analysis above. In some cases, the five value chains may have already been pre-selected by a country based on other criteria.

It will be useful to first determine the current state of affairs among the key commodities / sub-sectors identified in the economy-wide analysis above or pre-selected by the country as priorities. Key questions to ask include:

i. Is value chain development integrated and considered as an important development approach in the existing NAIPs?
ii. What are the key commodities/value chains selected as priority areas for NAIPs?
iii. What are the yield levels and the extent of private agribusiness and the participation of women and youth in these value chains? What is the extent of value addition?
iv. Which are the commodities/value chains which offer the greatest potential for high investment impact among the key sub-sectors and economic activities identified as key sources of growth in the economy-wide analysis above? Which ones (if any) have recently (or in the past) been selected as policy priorities by policy makers?
v. How competitive and efficient are the sub-sectors or value chains selected?
vi. What are the key constraints and/or bottlenecks for commercialization (e.g. high market transaction costs, infrastructure issues, access to technologies and inputs, knowledge and information, poor support institutions and services, etc.)?
vii. How can the issue of post-harvest losses be measured and addressed in value chain analysis?
viii. Which value chains offer the greatest potential for expanding youth employment and gender inclusiveness?
ix. Are there sufficient demand and market opportunities to absorb any rapid increases in supply within the selected sub-sectors at the domestic and regional levels? Which can offer the greatest

comparative advantage for tapping markets in the region? This area of analysis is linked to the regional trade thematic area discussed below.

Based on the analysis above, it is important to highlight areas that require attention for raising productivity, leveraging comparative advantages, accessing markets, employing more youth, empowering women actors, etc.:

i. Identifying investments, e.g. infrastructure (roads, energy), R&D and extension, needed to spur sustainable productivity and income growth along each of the value chains. It is also useful to consider those that relate to industrial development.
ii. Identifying policy and institutional reforms needed to improve the conduct, performance, and competitiveness the value chains (e.g. grades and standards), inclusive of other sectors (e.g. industry and transportation).
iii. Among those most likely to be affected by climate change or other shocks, identifying alternatives for ensuring resilience against future shocks. This is linked to the CSA thematic area discussed below.
iv. Identifying policy and institutional reforms needed to promote greater youth employment and gender inclusiveness. This is linked to the gender thematic area discussed below.

2c. Regional Trade

Trade is quite important not only for ensuring access to regional markets for domestic products, but also for domestic markets to access products from other countries as well. At the continent wide level, such opening up of borders between neighboring countries will help contribute to the Malabo commitment of boosting intra-Africa trade.

It is useful to first determine the current state of affairs with regard to the volume of trade with other African countries in the region. Key questions to be asked include:

i. What is the current state of affairs with regard to the volume of trade with other African countries and other metrics listed above?
ii. What are the commodities for which the country has a comparative advantage? Are any of these among the five value chains selected under the value chain development thematic area discussed above?
iii. What is the trade expansion potential at the regional level for the selected commodities? Is there a preference for intra-regional (within RECs) versus continental integration in the region?
iv. What are current trends in and prospects for cross-border trade, including major products traded, trade volumes, and magnitude of informal trade? Is there any cross-border trade monitoring system and are data on cross-border trade being collected? How should base-year trade levels be defined and how should zero trade observations be dealt with?
v. What are the major bottlenecks (costs, bans) for cross-border trade (infrastructure, institutional, trade policies, etc.?)

vi. Are there major trade corridors which the country has particular strong ties with, and for which major commodities/products traded does the country have a comparative advantage? Are any of these among the five priority value chains?
vii. How efficient and integrated are national and regional markets so as to foster cross border trade and improve the incentive system in a way that transmits effective price signals to local producers?

Based on the analysis above, it is important to highlight areas that require attention for accessing regional markets and boosting exports based on the country's own comparative advantage:

i. Identifying investments for leveraging at the regional level, e.g. infrastructure (inter-country roads and railway systems), to spur greater movements of goods and services across borders, especially along major trade corridors.
ii. Identifying policy and institutional reforms needed to promote exports and trade agreements which could be negotiated at the regional level (e.g. trade bans and restrictions, normalizing tariff and duty rates, establishing product grades and standards).
iii. Determining the degree to which there are existing policies / institutions dealing with industry competition, support services, etc. This is somewhat related to ii. and linked with the inclusive growth and value chains thematic area discussed above.
iv. Improving data and statistics on cross-border trade (linking with any ongoing efforts).

2d. Ending hunger, reducing food insecurity and improving nutrition

In some NIAPs, a specific program area may be included to address food security and nutrition, in others this component may be addressed more broadly as a cross-cutting element of other programs. However, it is important to assess the extent to which hunger, food insecurity and nutrition are addressed, and for current NAIPs, whether nutrition has already been effectively mainstreamed in the agricultural investment plan.

Some key questions can be asked of NAIP design to ensure that three elements of hunger, food insecurity and malnutrition are adequately addressed:

i. Does the NAIP quantify the extent and distribution of hunger and malnutrition across different geographic areas and population groups in the country to establish (i) who the most vulnerable groups are in terms of hunger, food insecurity and malnutrition, (ii) the prevailing challenges and (iii) opportunities as a basis for future monitoring and evaluation? See the above list of possible indicators to support this.
ii. What are the critical underlying determinants of hunger, malnutrition and food insecurity in the country? See the above list of possible indicators to support this.
iii. Does the NAIP refer to and align with the broader development, agriculture, food safety, trade and health policies? Do these support the transformation of current agriculture and food systems in inclusive ways to deliver safe and nutritious food year-round to all people?

iv. What are the current national targets for food security and nutrition for the country? Are they sufficient, desirable and achievable? Do they align with the country's international and African commitments and obligations on SGDs, Malabo, human rights and other conventions etc.? Will the plan help achieve these?
v. Is there an indication of specific budgeting for nutrition in the NAIP or other policy documents relating to agriculture?
vi. What risks (covariate and idiosyncratic) could affect the future state of hunger, malnutrition and food insecurity (for example conflict, migration, climate change etc.). Does the NAIP address these?
vii. What opportunities have been identified to address both nutrition-specific (health) interventions and nutrition-sensitive (broad-based multi-sectoral) policies and interventions? Does the NAIP take these into account for coherence?
viii. To what extent have food security and nutrition been addressed in the current NAIP and how effectively has nutrition been mainstreamed? Do food security considerations go beyond simply focusing on increasing food supply or increasing the supply of staple foods or have (preferably) opportunities for improving the availability, distribution, affordability and safety of nutritious foods been considered? This should go beyond production to looking at opportunities across value chain systems and include nutrition-sensitive post-harvest processing, reduction of food waste, food processing, storage and packaging of foods.
ix. How feasible and effective are current and proposed interventions to address hunger, malnutrition and food insecurity in the given country setting?
x. Does behavior change communication form part of nutrition-sensitive interventions?
xi. Is the prevalent food-related regulatory environment at the national and regional level taken into account? Is it supportive of an enabling environment for ensuring food environments make healthy, safe and nutritious foods available at affordable process to the people who need this the most?
xii. Who are the relevant institutions and stakeholders at the national and regional level? Are they included in the implementation, monitoring and evaluation of the programs?
xiii. Is there adequate provision for multi-sectoral action toward improving food security and nutrition? Are relevant coordinating mechanisms included and operationalized?

Based on the above analyses, identify *food security and* nutrition goals, actions and interventions. Some options include:

i. Improve risk management, for example:
    a. Establishing or strengthening an Early Warning System that allows a country to measure, monitor and track groups who are vulnerable to food insecurity and shocks (e.g. droughts, floods, market and other shocks), their characteristics and where they live?
    b. Developing or strengthening a crisis response system in place including mechanisms, triggers, teams/actors and emergency resources at national and community levels?
    c. Establishing or strengthening national reserves and improving storage facilities and disbursal mechanisms to smooth supply in times of crisis

d. Improved food safety and regulation systems to ensure a stable supply of safe and nutritious food and a health food environment
e. Improve the food system functioning to ensure the supply of diverse and nutritious food year-round, bearing in mind that some vulnerable groups may be net buyers of food rather than producers
f. improve market access and operations in the areas where the vulnerable are located to improve food availability and affordability
g. Identify nutrition-specific and nutrition-sensitive programs to improve the levels of micro-nutrient deficiencies among the vulnerable groups (e.g. iron, vitamin A, iodine)[5]
h. Identify to what extent are bio-fortification, fortification, food processing and safety technologies being applied at all levels of the food chain to improve dietary quality of the target groups. What are the environmental, institutional and policy constraints to food fortification?

ii. Increase the economic opportunities for the vulnerable groups (including women and youth) through:
    a. Identify ways that transformation of the food system can increase the incomes and assets of these targeted groups
    b. Identify where social protection can support nutrition of households and act as a means to stimulate the year-round supply of nutritious foods to vulnerable groups

iii. Identify programs to increase the availability of and access to nutrient-rich foods and diverse diets, including stimulating the demand for healthy foods and diets (e.g. for animal source foods; fruits and vegetables through home gardens; homegrown school feeding programs; biofortification); identify existing policies that discourage diversification of production and the distribution of foods

iv. Can the policies/programs in place promote or lead to education on maintaining healthy foods with nutrition benefits all along the value chain (e.g. enhance nutrient content/prevent losses of nutrients and waste; promote food safety along the value chain, esp. high-value/high-nutrient foods, through information and advertising and food quality standards)

v. Identify policies/policy components that focus on reducing inequalities, especially for women, as they are critically important to ensure that food systems actually deliver on improving nutrition (e.g. linking smallholders to social protection programs and other basic services through WASH, health, and education; increasing access and control by women over assets (e.g. land, livestock), inputs, and resources such as credit; empowering women through agriculture and nutrition training and information, as well as encouraging their use of time- and energy-saving technologies and increasing their decision making power over production, consumption, health and nutrition.

[5] Ruel M, Qunisumbing AR and Balagamwala M. (2018). Nutrition-sensitive agriculture: What have we learned so far? Global Food Policy, Global Food Security, https://doi.org/10.1016/j.gfs.2018.01.002. Available online 1 February 2018.

vi. Identify mechanisms for multi-sectoral and multi-stakeholder coordination of food security and nutrition programs to ensure that the most vulnerable are reached, coverage is increased and actions lead to health food environments.

2e. Gender

It will be useful to first determine the current state of affairs with regard to gender in the country, and one approach is to do so across the five domains of the Women's Empowerment in Agriculture Index (WEAI), which is further elaborated in Part III.

Key questions to be addressed include:

i. How has gender been articulated at the policy level? (Some countries may already have addressed this in their NAIPs.) Are there specific targets? Are objectives reflected in gender sensitive budgeting? Are there lessons learned from first generation NAIPs?
ii. What is the status of women's empowerment in agriculture/agribusiness? What is the status of youth?
iii. What are important drivers of women's and youth empowerment (e.g. production, resources, income, leadership, time), and how do these link to agribusiness?
iv. How strong is the link between gender empowerment and productivity, poverty or nutrition outcomes? What are the potential costs and benefits of not doing anything?
v. Which priority value chains are particularly relevant? These may not necessarily be the five priority value chains identified under the value chain development thematic area described above; the choice would depend on the country context.

Based on the analysis above, it is important to highlight areas that require attention for ensuring gender sensitive interventions and approaches to promote inclusive growth, poverty and hunger reduction:

i. Empowerment: Analysts should think about how agricultural production decisions are taken, describe who can own assets, check who controls the use of income, measure leadership of men and women, and think about time poverty.
ii. Policy: Analysts should examine access to gainful employment (agri-business) opportunities for women and youth. Countries would define what constitutes "gainful and attractive" employment. For example, countries in West Africa may need to think more about options for labor-intensive production, like horticulture.
iii. Regulations: Analysts should think about land ownership as well as land rental markets.
iv. Institutions: Analysts should consider the role of producer organizations, rotating savings schemes, etc.

2f. Climate smart agriculture (CSA)

It will be useful to first determine the current state of affairs with regard to the threats of climate change and resilience to future shocks in the country. Key questions to ask include:

i. What are the current state of affairs and potential future scenarios of climate change vulnerability and socio-economic trade-offs in the country? Is anything being done to deal with the risks and trade-offs?
ii. Which priority value chains face the greatest risks? And where?
iii. What are the broad (aggregate) socio-economic impacts (costs and benefits) associated with climate change?
iv. What are the adaption options in facing these risks and options to mitigate climate risk (as candidate CSA options)?

Based on the analysis above, it is important to highlight areas that require attention for improving productivity and resilience among targeted regions, groups, and specific commodities / sub-sectors:

i. Analysis should inform the type of technologies and interventions needed, plus best fit practices or building blocks for programmatic design for targeted sectors and regions.
ii. A theory of change should be developed to identify key enabling factors and monitoring strategies (e.g. access to extension and land tenure and administration, including water management).
iii. Geospatial targeting and ex-ante impact assessment of investment options should be performed.
iv. Climate change analyses should integrate the policy implications of heterogeneity.
v. Integrating the regional dimension is also very relevant in order give a broader perspective.

PART III: METHODS, TOOLS AND DATABASES

In this section, selected methodologies and tools that can be used for NAIP appraisal are proposed and described. They can be used to carry out both the status assessment and country profiling as well as the evaluation of goals and milestones for future NAIPs. They are organized according to the two categories of goals and commitments, overarching and thematic. The methods and tools described under *status assessment and country profiling* will be used to measure the metrics described in Part I. The methods and tools under *prospect analysis and goal setting* will be used to address the analytical questions stated in Part II.

1. Methodologies and tools to address overarching goals and commitments

1a. Status assessment and profile analysis

Status assessment and profile analysis are straightforward for this category of metrics as they are well defined and their measures widely agreed. The main task here is to obtain the best data to compute the metrics, and based on the results, to describe the status and profile of countries.

However, generating data and estimating the metrics for Public Agriculture Expenditure (PAE) requires formidable tasks. Among the biggest challenges is the classification and definition of public expenditure, which require addressing the question of *what is and what is not counted as agriculture expenditure*. The IMF Classification of the Functions of Government (COFOG) definition of government functions has been a widely used method to classify public expenditures. However, this method lacks specificity regarding the definition of agriculture, government multi-functions and government versus public corporations. For example, if one counts public corporation expenditures as PAE, the figure becomes significantly different from the case where they are not counted. Though how to count PAE is an analysis by itself, countries may follow the COFOG definition and adapt aggregation and disaggregation depending on the government structure and local context. The recent AU Guidance Note on Tracking and Measuring the Levels and Quality of Government Expenditures for Agriculture provides recommendations for classifying government expenditures for agriculture, as well as for monitoring the efficiency and effectiveness of expenditures.[6] Countries may also follow the methodology followed by the Monitoring and Analysing Food and Agricultural Policies (MAFAP)[7] to develop its database using the OECD classification for few countries in Africa. The OECD classification is believed to be more disaggregated than the COFOG classification. An important innovation in the MAFAP database is the classification of public expenditure by commodity, which will help to link public expenditure with value chain specific outcomes. Tools and methodologies for public agricultural expenditure analysis are described in more detail in Annex B.2.

1b. Program milestones and goal setting

Things become complicated when it comes to defining *milestones and goals for new programs and investment plans*. Given their overarching nature, goals and commitments in this area are impacted by

[6] African Union Commission and NEPAD Planning and Coordinating Agency, n.d. The AU Guidance Note on Tracking and Measuring the Levels and Quality of Government Expenditures for Agriculture. Addis Ababa and Midrand: African Union Commission and NEPAD Planning and Coordinating Agency. http://www.nepad.org/resource/au-guidance-note-tracking-and-measuring-levels-and-quality-government-expenditures

[7] http://www.fao.org/in-action/mafap/home/en/

actions and outcomes in all thematic areas and trigger a web of ramifications across the entire economy along complex pathways. The best methodologies and tools to handle them have to be suitable to tackle the various interrelationships and economy-wide dimensions that are involved. Dynamic, economy-wide models, including computable general equilibrium (CGE) models, that allow disaggregated analysis along sectoral, geographic, and socio-economic lines as well as capturing changes over time are leading candidates. Usually, such models are coupled with micro-simulation models to address distributional and disaggregation aspects that cannot be built directly into the economy-wide models. The use of CGE models is described in further detail in Annex B.1.

The more than two dozen country CGEs, related social accounting matrices and micro-simulation models that were developed and used to carry out the first generation of CAADP growth, expenditure and poverty reduction analyses to inform country roundtables can be updated for this purpose. Where they do not exist, similar models and datasets can be developed as needed. The updated and new models and databases can be deployed for the analysis needed to help specify milestones and goals to be pursued by future NAIPs. In particular, they can assess possible and desirable future progress and performance against the set of overarching goals as well as other targets and milestones to be determined for each country. The general economy-wide models can be tailored for specific topical needs by disaggregating the components that are more relevant for the topic. Tailored CGEs can be developed for agriculture by disaggregating factors and institutions, for analyzing female and youth employment by disaggregating factors, and for regional trade by disaggregating external trade.

Economy-wide general equilibrium models are essential to ensure consistency and capture backward and forward linkages. However, partial equilibrium simulation and econometric models are also important to perform prospect analysis on specific overarching issues and develop parameters that can be used in CGE modeling[8]. The following methods/tools can be used for different specific purposes:

- Household Consumption Behavior models can be used to analyze real consumption of agricultural and non-agricultural products based upon real income growth and distribution, and population growth and urbanization. These are agent based models with a theoretical background of maximizing utility for different types of households. The models can also serve to estimate the elasticity of poverty reduction with respect to GDP growth. Data for this analysis can be obtained from household income and expenditure surveys (e.g. LSMS-ISA).
- Farm production models will be used to make optimal crop and technology choices and estimate input requirements to achieve production and productivity targets. The models can be developed for specific regions or homogenous groups of farm households. Data for this type of model are available from agricultural surveys and LSMS-ISA-type surveys.
- Simple graphs and ratios are important for measuring performance and trends of public expenditure using several metrics. Examples include comparison of government agricultural expenditures (GAE) to government total expenditures to assess the commitment to the agricultural sector relative to other sectors; analyses of GAE growth by sub-periods to assess the

[8] Lofgren, H. et al. (2012). A Standard General Equilibrium (CGE) Model in GAMS. Microcomputers in Policy Research 5. IFPRI. Washington DC. http://www.ifpri.org/cdmref/p15738coll2/id/74845/filename/74846.pdf

commitment by different governments or policies; assessment of the ratio of actual expenditure to budgeted expenditure to assess budget execution; comparison of wage to nonwage or recurrent to capital expenditure to assess the relative buildup of productive assets; and estimation of the unit cost, e.g. of training one farmer to examine cost effectiveness of extension.

- The impacts of and returns to public agricultural expenditure are usually analyzed using econometric methods, which estimate the marginal cost of public capital as described in Benin, Mogues and Fan (2012)[9]. This approach estimates the relationship between capital stock and concurrent expenditure with the lagged value of expenditure and other influential factors to capture both the direct and indirect effects of public expenditure on capital stock, which can be linked with growth and productivity in economy-wide models. Similarly, the cost required to achieve stated targets, such as the 6 percent agricultural growth target, can be estimated using the methods described in Benin, Fan, and Johansson (2012)[10].

2. Inclusive growth and value chain development

2a. Status assessment and profiling of value chains

Methodologies and tools should be able to deal with issues related to dynamics in terms of demand patterns, competitiveness, product innovation, market conduct and performance, enterprise creation and growth. While most of the metrics here are standard and well defined, they may not be tracked routinely. Hence, the *status assessment and country profiling* will require a series of structured surveys to quantify the metrics for every country, or specific value chain analysis.

Value chain analysis refers to studying a series of related activities following one commodity from production to consumption, focusing on methods of coordination. It involves a series of steps either to profile the value chain, to identify problems or to track progress. Though all the tools used to analyze or collect data in other thematic areas can be adapted for value chain analysis, a typical value chain assessment framework is required to ensure the inter-linkage of activities and actors involved from production to consumption. So far, despite several efforts (e.g. the sub-sector analysis approach), a standard value chain framework has not yet been developed. However, there is a strong consensus that any value chain assessment shall include at least the following major activities:

- Value chain mapping, which includes identifying actors along the value chain and mapping their modes of relationships. Actors may include primary producers, intermediaries, processors, input dealers, etc., and should be further disaggregated by gender, age and business ownership (private vs.

[9] Benin, S., Mogues, M. and Fan, S. 2012. Agricultural growth and poverty reduction impacts of public investments: assessment concepts and techniques. In Mogues, T. and Benin, S. (Eds.). 2012. *Public Expenditures for Agricultural and Rural Development in Africa*. Routledge, UK.

[10] Benin, S., Fan, S. and Johnson, M. 2012. Estimating public agricultural spending requirements. In Diao, S., Thurlow, J., Benin, S. and Fan. S. (Eds.). 2012. *Strategies and Priorities for African Agriculture: Economywide Perspectives from Country Studies*. IFPRI, Washington, DC.

public). Mapping may also include spatial aspects of product flow to show the movement of the commodity from surplus to deficit areas.

- Decomposition of values and costs, which involves estimating the amount of value created and the cost incurred by each actor to understand the distribution of costs and benefits across the value chain. It includes estimating productivity and identifying innovations created at each stage.
- Analysis of constraints, which includes identifying and analyzing the constraints of each actor in particular and the whole business environment in general. It serves as an entry point to the intervention design phase of value chain development.
- Assessing the gender differentials across the value chain in terms of resource ownership, value appropriation and decision making should also be an important tool to ensure the integration of gender within value chain development.
- Tracking of value chains with respect to more nutrient dense crops, fruits and vegetables and animal source foods, including the extent of involvement of women.

Several tools are available to carry out surveys and conceptualize the above analyses. The ones developed by the CGIAR under the leadership of IFPRI are very comprehensive and diverse. These tools can be used to select value chains, map actors and their linkages in selected value chains, and document constraints along the value chains. While some tools are value chain specific, others are general tools that can be applied under different contexts. The tools can be used not only to assess the status of value chains, but also to design interventions and evaluate the impacts of these interventions. The following are sample tools or tool packs available on the CGIAR's Value Chains Knowledge Clearinghouse website.[11]

- *Pathways out of Poverty: Tools for Value Chain Development Practitioners:* This toolkit aims to equip value chain development programmers to design effective interventions that reach and impact the very poor. It profiles tools that are particularly applicable in the value chain selection and value chain analysis phases of a project, as well as assessment tools that can be used throughout the project cycle. Tools included in this pack are *Sensitivity Analysis, RapAgRisk Assessment, Stakeholder Analysis,* and *Equity of Opportunity Analysi***s.**
- *Livestock and Fish Value Chain Assessment Toolkit:* This tool helps to assess and benchmark livestock and fish value chains. It is used to collect both qualitative and quantitative data. It includes process guidelines, protocols and training manuals. The tool has been applied in Tanzania, Ethiopia and Uganda.
- *Gender Mainstreaming in Value Chain Development*: This guide gives a basic overview of value chain concepts and details why and how to incorporate gender into various parts of value chain analysis, including participatory mapping of the chain, market analysis, and value chain financing.
- *Impact Assessment Primers*: This series of seven primers from USAID details how to properly design and conduct impact assessments of value chain interventions. The lack of properly designed studies has caused many value chain interventions to have inconclusive results.

[11] http://general.tools4valuechains.org/general-tools

- *5Capitals*: This tool facilitates the design and assessment of interventions for value chain development, taking into account the circumstances and needs of upstream-chain actors (namely, smallholder producing households and small and medium enterprises that have direct relations with smallholders). The tool has been tested in over 20 countries in South Asia, Africa, and Latin America and the Caribbean.

2b. Program milestones and goal setting

Program milestones and goal setting in value chain development requires evaluation of the sub-sector (value chain) competitiveness. Competitiveness analysis helps to measure the performance and efficiency of the value chain, which is one of the essential pillars to achieve the goal of inclusive growth and value chain development. Several tools and methods can be used to evaluate the competitiveness of a value chain. One of these is the structure-conduct-performance (SCP) approach, which has been traditionally used for analyzing the industrial organization of markets. The SCP framework is adaptable to a specific context to understand the organization of the sub-sector and the efficiency of the value chain. The basic idea in this approach is that the performance of a value chain depends on the conduct of the actors involved, and the conduct of the actors in turn depends on the structure of the sub-sector. The standard SCP framework consists of several elements under the three major components (i.e. structure, conduct, and performance). While the structure component includes elements of concentration, barriers to entry and product differentiation, the conduct component explains price-setting and coercive polices pursued by the market actors, and the performance component evaluates the efficiency, conservation, employment and income distribution aspects of the value chain (sub-sector). A variety of methods and tools can be applied to analyze and measure the extent of each of the elements so as to identify milestones and interventions and evaluate the feasibility of set goals and targets. For example, the four-firm ratio can be used to review the competitiveness of the sub-sector, and price analysis tools, which will be explained under trade section below, can be used to evaluate the efficiency of the sub-sector in terms of transmitting prices along the value chain.

The SCP analysis can be complemented with agricultural sector models or economy-wide models to assess how the continuation of demand and employment trends and policy and institutional factors, as well as other relevant value chain dynamics that are observed in the status analysis, would impact the overarching goals and targets. Additional analysis would also examine the implications of achieving the latter goals and targets for value chain performance and conduct in terms of market share, employment and wages, policy and regulations, and other relevant country-specific issues. The same CGE and micro-simulation models used in the preceding section could also be applied here.

Strategic analysis may also be required to evaluate existing or proposed strategies and interventions to identify milestones and propose achievable goals. In this case, experimental approaches can be used to pilot innovative institutional and technological interventions for possible scale up and scale out. Standard randomized controlled trials can be used to undertake these experiments. Examples of experiments conducted for improving value chains include the use of ICT for market information, product tracing, certification services, business-to-business contracting, and financial services. In cases in which interventions have already been implemented or are difficult to randomize, the standard impact

evaluation methods of propensity score matching or difference-in-difference methods can be applied. See Annex B.3 for further discussion of tools for value chain analysis.

3. Regional trade

3a. Trade data

Both country profiling and goal setting in regional trade depend on the availability and quality of trade and trade related data. The most commonly used data sources for trade analysis are UN Comrade[12] and BACI. Comtrade is the world's largest database of trade statistics, maintained by the United Nations Statistics Division (UNSD). The BACI database was developed by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) based on COMTRADE data. However, these databases suffer from a problem of reporting with respect to African trade data. This raises an important concern of whether Africa's measured trade performance is low due to data problems or due to structural factors. Another possibility would be to use national and regional databases, though their availability and quality vary across countries and regions. The best option would be to use the international databases and complement them with national sources.

3b. Status assessment and country profiling

Most indicators for trade performance, competitiveness, and related metrics are tracked routinely and can be assembled and analyzed for the *status assessment and country profiling*, although information related to cross-border transactions may pose significant challenges in terms of completeness and accuracy. There are several indices in the ReSAKSS 2013 Annual Trends and Outlook Report (ATOR) dealing with market conduct as well as trade patterns and performance that can be applied here.[13] Standard methods to compute Nominal Rates of Assistance (NRA) can also be used to evaluate the incentive environment for production and trade.[14] Gender-related metrics will require that specialized surveys be developed and carried out.

Changes in the symmetric trade introversion index (STJ) metrics show whether the intensity of intra-regional trade varies at a faster or at a slower pace than that of extra-regional trade (outside the region). The STJ is estimated as the ratio of an intra-regional trade intensity index to its complementary extra-regional trade intensity index. This index is theoretically appealing as well as robust to data limitations. The STJ and other regional trade indicators are described in detail in Annex B.4.i.

An important metric of intra-regional trade performance included in the CAADP Results Framework is price volatility. The idea behind this metric is that an increase in regional and global trade reduces

[12] http://comtrade.un.org/

[13] Badiane, O.; T. Makombe; G. Bahiigwa. 2014. Promoting Agricultural Trade to Enhance Resilience in Africa. ReSAKSS 2013 Annual Trends and Outlook Report. Washington DC. https://www.ifpri.org/cdmref/p15738coll2/id/130121/filename/130332.pdf

[14] See, for example, Anderson, K., M. Kurzweil, W. Martin, D. Sandri, and E. Valenzuela. 2008. Methodology for Measuring Distortions to Agricultural Incentives. Agricultural Distortions Working Paper 2. Washington, DC: World Bank. http://siteresources.worldbank.org/INTTRADERESEARCH/Resources/544824-1146153362267/AgDistortionsMethodology_Rev0108.pdf

domestic price volatility by reducing the variability of domestic supply. Several indexes are available to measure price volatility. The most widely used is the standard deviation of the variation in prices, which can be used to profile and track country performance in price stability. This index assumes homoscedastic price series and measures high-frequency locality. If homoscedasticity does not hold and measures of low-frequency volatility are needed, more sophisticated methods of Generalized Auto-Regressive Conditional Hetroscedasticity (GARCH) and Spline-GARCH can be used. Tools and methodologies to analyze price volatility are described in more detail in Annex B.4.ii.

As a result of increased globalization and increased natural shocks, monitoring and tracking the volatility of food prices has become much more common than in the past, both at the national and global levels. FAO-Global Information Early Warning System (GIEWS)[15] and the IFPRI Food Security Portal[16] provide visual presentation of up-to-date price trends for specified commodities and for most African countries. Since price data are easily available at the country level, countries may use their own sources to profile and track price trends.

3c. Program milestones and goal setting

The 2013 ATOR employs trade simulation models that can be used to assess global and regional trade trends and output under baseline versus alternative policy, regulatory, technological and other relevant scenarios for the identification of *program milestones and goal setting*[17]. Most of the findings in the report will be useful input here as well. Additional tools such as gravity models can also be applied to analyze regional trade in more detail (see Annex B.4.iii). Gender-related goals and milestones can be derived from agreed future changes and outcomes to be pursued under the new NAIPs.

In addition to simulation models, econometric methods can be used to understand the functioning of national and regional markets, the extent of regional market integration and intra-Africa trade performance.

The efficiency of national and regional markets is essential for effective external trade, implying that evaluating the efficiency of these markets is required to identify milestones and goals that will be achieved through NAIPs. Price analysis is a widely used approach to measure the efficiency and performance of markets. In this approach the behavior and transmission of prices across spatial markets, commodities and value chains are analyzed. The assumption behind the price approach is that prices are the final outcomes of market operations and hence if prices behave efficiently, markets do perform competitively. This approach is easier than others due to the availability of price series across time and space. In the

[15] http://www.fao.org/giews/pricetool/

[16] http://www.foodsecurityportal.org/policy-analysis-tools/excessive-food-price-variability-early-warning-system

[17] Badiane, O. and S. Odjo (2014). More Resilient Domestic Food Markets through Regional Trade. In Badiane, O., T. Makombe and G. Bahiigwa. Promoting Trade to Enhance Resilience. ReSAKSS Annual Trends and Outlook Report 2013. Expanded version published as Badiane, O. and S. Odjo (2016). Regional Trade and Volatility in Staple Food Markets in Africa. In Kalkuhl, M. et al. (Eds.). Food Price Volatility and its Implications for Food Security and Policy. Springer.

price transmission approach, product flow is not a necessary condition for prices to transmit as long as information is shared among markets.

Price analysis to measure market performance can take either of the following approaches:

- Analysis of individual prices, including seasonality, changes in levels, and volatility
- Analysis of relationships between prices, including relationships between prices of spatially separated markets, producer and consumer prices, prices of raw and processed products, prices of related commodities, local and international prices, prices and shocks (e.g. drought or export bans), and prices and marketing institutions.

The methods used to measure price relationships have evolved over time. In the 1970s, simple correlations between prices had been the major methods of estimating price relationships. However, this measurement did not take into account the effects of lagged prices, which led to the use of econometric analysis including lagged prices in the 1980s. Since then, ARIMA and ARDL models have been utilized to a wider extent to explain and forecast price trends and movements. However, these models are very sensitive to the problem of non-stationary price series, which leads to spurious regression results. As a result of this problem, unit root testing, first differencing, vector error correlation models and co-integration analysis emerged as methods in the 1990s. These models still assume that prices affect each other, but if the gap is small, prices will not affect each other no matter how efficient the markets are.

The recent approach to deal with the non-stationarity problem is Threshold Auto-Regression (TAR)-based co-integration analysis. The assumption behind TAR is that prices move together if the difference between the two prices is beyond a certain threshold. The threshold can be interpreted as the full cost of transferring the product between markets. TAR can also be used for analyzing asymmetric price relationships or behaviors under different regimes, such as high and low price regimes and increasing and decreasing price regimes.

Regional market analysis will be done using an approach similar to that described above for price relationship analysis. Depending on the physical proximity of countries and the spatial distribution of markets, several types of market integration analyses can be done to evaluate how neighboring countries are integrated through formal and informal channels. The analysis will also measure how national and regional markets are functioning by estimating price transmission. See Annex B.4.iv for further discussion of tools to analyze market integration.

An econometric application of the standard gravity model can be used to identify domestic, regional and global factors that affect regional and continental trade. This approach provides insight into the relative importance of tariffs, non-tariff barriers, domestic agricultural policies, and institutional and infrastructural factors that determine the cost of trade. In this case, the logarithms of bilateral intra-regional trade values will be regressed against the leaner form of these determinants using a variety of econometric specifications. Since zero trade is rather common in bilateral trades, the use of Tobit or Heckman two-stage models are preferred over simple OLS estimations. In this approach, the analysis is usually done at the regional or continental level using bilateral trade flows. However, it is possible to conduct country-specific gravity analysis for aggregate or commodity-specific trade flows.

4. Ending hunger, reducing food insecurity and improving nutrition

4a. Status assessment and country profiling

While data on national stocks and flows and trade balances for the staple food commodities and level of hunger are often tracked by international agencies and are often readily available in most countries, the availability for up-to-date food security and nutrition data is not always available. Recent Demographic and Health surveys have helped improve the availability of food security and nutrition-related data. However, the collection of detailed nutrition data is expensive and irregular. The assessment should include both qualitative (based on the analytical questions in part II) and quantitative components, with the quantitative components providing the state of the situation with respect to hunger, food security and nutrition-related indicators.

Country status and profile regarding hunger, food insecurity and nutrition indicators can, in most cases, be assessed using the presented methodologies and data sources. For instance, undernourishment rates can be tracked using FAO food balance sheets and local consumption surveys (where available). Anthropometric indicators including underweight, stunting and wasting in children under five can be calculated using the WHO Anthro software and data sources such as DHS surveys and other country-level nutrition surveys related to SUN and other initiatives, as well as UNICEF data. Methodologies developed under FANTA[18] and by WHO can be applied to quantify metrics related to diet diversity and quality as well as body mass index (BMI) using the same data sources.

The prevalence of key micronutrient deficiencies for women and children under five years, including anemia, iron, zinc, and vitamin A, will be measured using standard methods and tools depending on the specific micronutrient. Data sources will include national micronutrient surveys as well as DHS surveys and food balance sheets.

Hunger, food insecurity and malnutrition levels can vary widely sub-nationally. It will therefore be useful for projects at the sub-national level to also adopt the given indicators to be able to inform decisions at that level.

Several indicators on biofortification can be measured using household production and consumption surveys that include a line item of biofortified foods. The public sector indicators on biofortified crop varieties and breeding lines could be informed by data collected from government ministries, NARS, and other public and private institutions that develop and release crop varieties. For all indicators, it is encouraged to take the given measurements at sub-national program/project levels.

Since food security and nutrition are a cross-cutting issues that require multi-sectoral and multi-stakeholder action, the assessment should include a review of existing structures and coordination among sectors that directly and indirectly contribute to improving food security and nutrition outcomes. This

[18] See http://www.fantaproject.org/monitoring-and-evaluation/minimum-dietary-diversity-women-indicator-mddw

could be done in line with the Mutual Accountability (MA) procedure of the Joint Sector Review (JSR). A detailed description of nutrition-related indicators is provided in Annex B.5.

4b. Program milestones and goal setting

The above assessment should be done against set country and continental targets. The country level targets will be informed by country level strategic documents and policies. The continental targets should be judged against the Malabo, Africa Region Nutrition Strategy (ARNS) 2015-2025, and Sustainable Development Goals (SDG) targets. To identify underlying determinants of the different forms of malnutrition, regression analyses can be done exploring links between malnutrition variables, poverty, food insecurity indicators, gender, education, water and sanitation, and agriculture-informed indicators. Time series data for a country or cross-sectional data across countries or regions can be generated over time to track progress. Consumption elasticities and agricultural growth multipliers[19] can predict the potential changes in food consumption behavior if incomes increase and the impact of broad-based economic growth on consumption behavior. This is an important consideration in investigating if potential programs will have positive or negative effects on dietary composition and diversity. In contrast, new, simple tools will have to be developed to measure metrics such as agricultural production diversity as well as the share of staple food production that is biofortified. Recent experimentation with consumption elasticities and multipliers have shown potential for identifying the GDP-growth, productivity-growth and dietary-diversity growth potential of investment in various commodities[20].

Experimental approaches including quasi-experimental methods can be adopted at the country level to explore the effectiveness of current and proposed nutrition-specific and nutrition-sensitive interventions. It is important at the country level to incorporate data collection on nutrition-related indicators and on their determinants in order to track the impact of nutrition-sensitive agriculture interventions on nutrition.

5. Gender

5a. Status assessment and country profiling

Several gender-related metrics are to be quantified as part of the *status assessment and country profiling* under the other thematic areas. Since gender, like nutrition, is a cross-cutting issue, one has to make sure that dialogue between the different actors takes place in order to reflect the priority of agriculture in the different agendas.

A key question in the status assessment and country profiling is how gender is mainstreamed in NAIPs. The assessment should include a review of the gender strategy designed and implemented by countries to mainstream gender in NAIPs, and examine whether they have adopted a gender institutionalization approach needed for gender integration in programmes, projects, and the governance system for NAIP implementation. The gender strategy for appraisal and development of NAIPs shall include the following major activities and milestones:

[19] Delgado C. (1998). Agricultural Growth Linkages in Sub-Saharan Africa. IFPRI: Washington DC.
[20] Ulimwengu, Roberts and Randrianmamonjy (2012). Resource-Rich Yet Malnourished: Analysis of the Demand for Food Nutrients in the Democratic Republic of Congo. IFPRI Discussion Paper 1154. Washington DC

▪ Gender integration in the National Agricultural Policy, and development and implementation of a Gender Action Plan with specific and clear gender activities, specific gender indicators, means and source of verification, outputs, timeframe, risks and assumptions, and the estimated cost for each activity.

▪ Development and/or use of relevant gender screening, analysis, and assessment tools, involving the assessment of tools that are used for gender analysis and assessment of NAIP projects and interventions. This includes project gender screening, which helps to identify the gaps and needed corrective actions for gender integration into project objectives, activities, methodology, results frameworks, and impacts.

▪ Definition of a target (%) for women and youth beneficiaries of NAIP resources, opportunities and benefits: There should be a clear target for vulnerable groups such as women and youth in access to the needed agricultural productive resources to enable their socio-economic empowerment in agriculture, particularly access to land as a major agricultural asset.

▪ Gender institutional capacity building for stakeholders and NAIP implementing agencies involves specific trainings (not business as usual – i.e. training that can really tap the needs of NAIPs on gender) to provide them with knowledge, skills and tools to mainstream gender in NAIP activities.

▪ Building a Monitoring and Evaluation system is linked to gender inclusion in the Results Framework, with collection of gender and /or sex disaggregated indicators, and a monitoring mechanism to track progress and impacts of gender inclusion in NAIPs.

▪ Building a gender responsive communication system involves advocacy and awareness on gender consideration in NAIPs, but also requires developing gender-responsive communication means such as rural TV and radio broadcasts, translation of some NAIP documentation into local languages, etc. Such efforts would enable socially-marginalized groups to access and adopt innovations and technologies. NAIP gender activities should be advertised and diffused on TV, radio, and the written press, as well as through policy briefs and flyers; public imaging and branding of the NAIP implementing institutions should be gender responsive.

▪ Building partnerships and collaborations with Regional Economic Communities and national decision-makers, international, regional and national agricultural research and development institutions, civil society, particularly women and youth-led organizations and networks, and private sector stakeholders at the regional and country levels is needed to pool synergies for achieving NAIP gender strategy objectives.

▪ Development of an accountability framework involves the designation of a gender focal person with clear criteria including the scope of his/her expertise and knowledge on gender and the scope of his/her involvement in project design, implementation, and M&E. It also involves the commitment of decision-makers towards the development, implementation and assessment of the NAIP gender strategy, and to ensure that appropriate mechanisms are developed to foster a gender-friendly private sector and civil society and to minimize gender inequalities in agriculture.

▪ Setting and meeting financial targets for resource allocation to the NAIP gender strategy: the NAIPs should allocate financial resources from the operational work budget at AUC headquarters and at the country level to interventions targeted to women and youth (for example agripreuneurship), with priority given to supporting organizations and activities that advance the access of women and youth to appropriate agricultural productive resources.

Several tools are available to carry out surveys and conceptualize the above analyses. The tools can be used not only to assess the status of gender integration in projects, but also to design interventions and evaluate the impacts of these interventions. The following are sample available tools or tool packs:

▪ The *Gender institutionalization Web* developed by Caren Levy from the University College London can be used to assess the policy and institutional framework, the actions, and the monitoring and evaluation of NAIPs. The Web is used as a diagnostic and operational tool. As such, it can be used not only to assess the status of gender integration in policy, planning, and projects, but also to design interventions and evaluate impacts of these interventions.

▪ *ACDI – VOCA Gender Analysis, Assessment and Audit Manual and Toolkits (I); the USAID Guide to Gender Integration and Analysis (II); and the Bill & Melinda Gates Gender Toolkits and Checklist (III)* are tools that help to learn about the required stages for gender analysis, assessment, and audit, i.e. for conducting a desk review and field work and for analyzing findings and making recommendations for gender responsive agricultural projects. The gender checklist presents overarching questions to identify the socially-marginalized groups as project target populations, women's and men's roles in household production systems, roles that smallholder women and men play in the development of innovations, access to productive resources and services, access to new technologies, impact of new technologies, incomes benefits and market access, farmer organization, institutional capacity, Monitoring and Evaluation, advocacy, risks and opportunities, and the budget.

▪ *Gender screening tools* developed by the World Bank and CORAF/WECARD are more specific to project level diagnostics and can be used to identify gaps and needed corrective actions for gender integration in project objectives, activities, methodology, results frameworks, and impacts.

▪ The *Gender integration in Monitoring and Evaluation in agriculture toolkit* developed by the World Bank is very comprehensive and useful in designing a gender-informed results framework, but also to track progress and impacts of agricultural projects with gender and sex disaggregated indicators.

▪ The *FAO gender toolkits* include the Socio-Economic Gender Analysis (SEAGA), the Agri–Gender Statistics Toolkits, and the Gender and Land Rights Database, and provides a set of tools for gender analysis and assessment for each agricultural sector, i.e. forestry, fisheries, aquaculture, livestock, and Natural Resources Management. In addition, DIMITRA, a participatory information and communication gender tool, offers resources for agricultural communication for development (http://www.fao.org/gender/gender-home/gender-resources/gender-toolkits/en/).

As a complement, countries can implement the WEAI survey to compute the overall index and related sub-components. WEAI data already exists for some African countries, but countries can further update existing data using their own national WEAI surveys. The WEAI represents the first comprehensive and standardized measure to directly capture women's empowerment and inclusion . It presents an aggregate index, reported at the country or regional level, based on individual-level data on men and women within the same household. The two sub-indices of the WEAI are (1) the five domains of empowerment (5DE) and (2) the Gender Parity Index (GPI). The 5DE sub-index measures how empowered women and men are in five domains: (1) decisions over agricultural production, (2) access to and decision-making power over

productive resources, (3) control over use of income, (4) leadership in the community, and (5) time use. 5DE assesses the degree to which women and men are empowered in these domains, and for those who are not empowered, the percentage of domains in which they are empowered.

The GPI reflects the percentage of women who are as empowered as the men in their households. For those households that have not achieved gender parity, the GPI shows the empowerment gap that needs to be closed for women to reach the same level of empowerment as men. The aggregate index (0.9 x 5DE + 0.1 x GPI) shows the degree to which women are empowered in their households and communities and the degree of inequality between women and men in their households.

Standardized survey tools as well as a shorter A-WEAI option have been developed and both survey tools are publicly available, as well as STATA do-files for computation. These tools in addition to papers describing the calculation of the index and empirical applications are available from IFPRI[21]. A detailed description of the WEAI is also provided in Annex B.6.

5b. Program milestones and goal setting

The gender strategy outlines steps to follow to have a gender responsive NAIP that can enable socio-economic empowerment of socially marginalized groups such as women and youth in agriculture. The strategy describes steps with milestones that will guide the design of future investment plans, and should be used in addition to the WEAI to analyze the enabling conditions with regard to gender consideration in agriculture in the countries, to uphold women's empowerment on key targets including productivity, poverty, and nutrition. Therefore, one may consider the presented gender strategy as a pathway to empower women in agriculture, for sustainable food security and nutrition in the continent, to achieve the Malabo commitments.

Econometric models can be applied to analyze the impact of women's empowerment on key targets. The results can, in turn, be fed into country economy-wide models to evaluate the implications for overarching goals and commitments and identify future outcomes to be pursued. The WEAI score is an endogenous variable that can be explained by policy and institutional factors. Thus, the primary analyses will be estimations of econometric models that can help to explain differentials in the WEAI across households, sub-countries and rural-urban divides. This estimation should capture technological and institutional variables as explanatory variables so that intervention areas can be identified. Since the WEAI is bounded between zero and one, appropriate econometric models may include lower and upper bound truncated regression models.

More challenging from the modeling perspective is linking the WEAI with outcome variables such as productivity, nutrition and poverty, due to the endogenity of the WEAI. The simplest model to handle this is an IV regression, provided that an appropriate instrument is in place. The impact of the WEAI may not only be an average effect; it may also produce a structural effect by changing the relationship between, for example, inputs and outputs in production analysis. In this case, one may consider the WEAI as a state

[21] http://www.ifpri.org/publication/womens-empowerment-agriculture-index

variable and conduct analyses for empowered and less empowered groups separately. Switching regression could be an appropriate method to apply under such circumstances.

6. Climate smart agriculture

6a. Status assessment and country profiling

This area is related to the Malabo Declaration commitment number VI that aims to enhance the resilience of livelihoods and production systems to climate variability and other related risks.

Biophysical and production data produced routinely by global and national organizations using standard methodologies can be accessed to inform country CSA *status assessment and profiling*. The HarvestChoice website (www.harvestchoice.org) already has a large number of relevant metrics that can be used to inform the current state of affairs with regard to climate change and resilience. Integrating heterogeneity of the livestock and agricultural systems will also be important in order to see how farmers respond to climate change (adaption and mitigation options) and to the increasing demand for animal products. Livestock systems in pastoralist areas will require special emphasis where relevant. Livestock demand, production and markets should be brought out within the different quantitative modeling approaches that will be used.

5b. Program milestones and goal setting

Many of the methodologies and tools that can be used for identification of *program milestones and goal setting* are also available from the HarvestChoice website. They include tools for geospatial policy analysis and simulation; commodity priority-setting; rainfall and temperature variability projections; the rapid yield gap assessment method; simulation of impacts on yields and productivity at the district and region levels; and multimarket models for ex ante climate shock impact assessment and models for technology potential evaluations and choices. The yield-related methods can help to assess country profiles and guide in setting the NAIP's crop productivity goals. The HarvestChoice platform includes many tools (a tool dedicated to rainfall and drought history, the CELL5M tool, the commodity priority setting tool, and the Agritech Toolbox) that help decision makers and researchers to assess how agricultural practices and technologies can impact outcomes like farm yields, food prices, hunger, malnutrition, land use, global trade, etc. in the long term and taking into account climate change.

The rainfall and drought history tool provides a visual presentation of the long-term (1960-2014) gridded data on monthly precipitation, near-surface temperature, and Palmer Drought Severity Index time series for sub-Saharan Africa available at the district level based on FAO/GAUL 2008. The data are available in Stata, CV or GIS-related formats and can be download for the different countries. They are from monthly estimates from the Climatic Research Unit (CRU)[22] and the Climate and Global Dynamics Laboratory (CDG) of the University of East Anglia and University Corporation for Atmospheric Research (NCAR)[23].

[22] https://crudata.uea.ac.uk
[23] http://www2.cgd.ucar.edu

CELL5M is a geospatial database of harmonized multidisciplinary agricultural indicators for Africa South of the Sahara on 10 km grids. CELL5M includes biophysical and socioeconomic indicators covering four broad research domains: food production, agro-ecology, demographics, and market accessibility.

The commodity priority tool and the geospatial targeting tool are based on interactive data queries and can help to set economic priorities at the country level and build development programs that efficiently target the poorest and other needy and marginalized individuals. The prioritization of the value chains will depend on criteria like the linkage to the poor, the nutritional value, the impacts on natural resources, and the attractiveness to the private sector, while the targeting tool will is used to clearly identify the regions with more potential for scalable impact, based on criteria including climate, elevation, market accessibility, and linkage to other socioeconomic factors. The targeting will help to set goals and priorities at the local level. The data used are based on household surveys and inputs from the available literature[24].

The potential impacts of technology can be assessed by using the Agritech Toolbox. The Toolbox analyzes the impact of agricultural technology on productivity in 2050 while incorporating changes in climate conditions. The tool also focus on other issues like trade, environment, food prices, malnutrition, etc. [25]

The effects of technology on productivity are estimated by combining a biophysical crop modeling tool (DSSAT model) with an economic model (IMPACT model). The former shows how crop yields respond to the adoption of technologies while the latter ultimately shows the corresponding effects on production, trade and food security through a multi-market equilibrium model. The multimarket models belong to the class of partial equilibrium models and can be used to assess the combined impacts of climate shocks and national policies that affect prices and outputs for a selected group of products. Partial equilibrium models require less data than the computable general equilibrium model and provide a detailed description of the agricultural sector. Disaggregated data on income or consumption distribution across households are needed in order to consider heterogeneity issues when assessing the impacts of technology. Both traditional and advanced technologies are included in the Agritech Toolbox, namely no-till, integrated soil fertility management, precision agriculture, water harvesting, drip irrigation, sprinkler irrigation, heat tolerance, drought tolerance, nitrogen-use efficiency and crop protection.

Other tools and methods like DREAM (Dynamic Research Evaluation for Management), the Crop Investment Analytics Framework, and pseudo panel analysis can be used to support planning investments for the Malabo resilience goal and monitoring their progress. A detailed description of most of the above-mentioned tools is provided in Annex B.7.

7. Mutual Accountability

Accountability is commonly understood as a process through which people entrusted with responsibilities are kept under check when carrying out functions or tasks assigned to them [26]. Three core elements can

[24] See more details with the example for Tanzania and Ghana in HarvestChoice, 2013a, 2013b
[25] For more details see http://apps.harvestchoice.org/agritech-toolbox/
[26] Overseas Development Institute, 2009, Mutual Accountability at country level: Emerging good practice.

be identified in a mutual accountability process: generating a shared agenda, monitoring and reviewing mutual commitments, and providing space for dialogue and negotiation.

The methodology followed by the national and regional JSR assessments will be used to assess the existence and adequacy of policy and review processes ensuring mutual accountability. For subjective indicators such as the quality of policy planning and implementation, traffic light ratings from JSR assessment reports will be used as the main data source. In cases where a JSR assessment has not been performed, ratings will be assigned for each indicator using the methodology followed by the assessments, relying on expert interviews and public record as well as other available data, as outlined in the country JSR concept note.[27]

Program milestones and goal setting can be performed on the basis of the JSR Best Practice Table that is part of the validated JSR report. The table defines key building blocks of a comprehensive, inclusive and technically robust JSR that is well coordinated and includes adequate follow up mechanisms to ensure that conclusions and findings are acted upon. The summary of actions required to achieve JSR best practices—available at http://www.resakss.org/node/37#JSR-BEST-PRACTICES—shows the experience from the first round of JSR assessments and demonstrates how JSR-related milestones and goals were identified by participating countries. Annex B.8 also provides further details on JSR principles, methodology and best practices.

For countries that have established a SAKSS platform, the *status assessment and country profiling* focuses on the quality of governance and operational performance of the platform, as reflected in the existence and operation of an inclusive steering committee or similar oversight body with clear terms of reference and coordination modalities; the existence of a functioning local analysis network mobilizing local centers of expertise to produce relevant policy analysis and research output; and the existence of an operational IT-based knowledge platform and tools to store and disseminate data, analytical findings and other knowledge products required to support evidence-based policy planning and implementation. The *program milestones and goal setting* will be informed by the identified gaps in the above areas and agreed future improvements that need to be undertaken.

For countries without a SAKSS, the best approach is to carry out a capacity needs assessment (CNA) for which methodologies and tools as well as a number of published country reports are available on the ReSAKSS website (www.resakss.org). The CNA reports will serve the purposes both of status assessment and profiling as well as identification of program milestones and goal setting.

Agricultural JSRs and country SAKSS are key elements for evaluating and promoting Mutual Accountability in the agricultural sector; however, many additional tools are relevant to assessing the status of Mutual Accountability. The following section provides introductions to additional sets of tools that can provide insight on countries' broader institutional and policy environments.

[27] See http://www.resakss.org/2014conference/docs/JSR%20Concept%20Note.pdf.

8. Institutional Architectural Assessment Process

Africa Lead's Institutional Architecture Assessment

Africa Lead[28]'s Institutional Architecture Assessment (IAA) approach can be used to assess the institutional capacity aspect of mutual accountability. Africa Lead's institutional assessment approach might be an additional useful tool for *status assessment and profiling* and *program milestones/goal setting.* Africa Lead promotes and enhances the adoption and the improvement of mutual accountability frameworks and other key elements[29] of the institutional architecture assessment process in order to help the countries and RECs to assess and upgrade the quality of their systems and their policy processes, and ultimately positively influence agricultural and food security policies.

Mutual accountability like the other five components is analyzed though a set of indicators (assessed using a three-tier rating system) related to the existence of the following elements[30]:

- ✓ A Forum Exists for Regularly Scheduled Donor-Government Meetings
- ✓ Joint Policy Priorities Developed
- ✓ Monitoring System Exists
- ✓ Donor Coordination – Alignment and Harmonization
- ✓ Private Sector Accountability
- ✓ Civil Society Organizations (CSO) Sector Accountability

Mapping the relationship between stakeholders/actors involved in the policy process should be done prior to the application of the rating system. The assessment ends with recommendations for future priorities and actions based on findings.

More specific details about the Institutional Architecture Assessment for Agriculture and Food Security Policy are presented in Annex B.9.

Agricultural Science and Technology Indicators (ASTI)

The ASTI program provides a platform that collects and presents data on agricultural R&D expenditures, including from the private sector. Data from ASTI can be used to measure resources R&D into agriculture and assess the impacts of research and development on productivity for each country[31]. Evidence demonstrates that long-term investments in agricultural research have significantly enhanced agricultural productivity around the world. By raising the quantity and quality of agricultural outputs, agricultural technologies and varieties developed through agricultural research have led to higher incomes, greater food security, and better nutrition. It is not surprising, therefore, that the United Nation's post-2015

[28] Africa Lead II is USAID's primary capacity building program in sub Saharan Africa. See http://africaleadftf.org.
[29] Institutional Architecture assessments look at six components of the policy making process: Guiding Policy Framework, Policy Development and Coordination, Inclusivity and Stakeholder Consultation, Evidence-based Analysis, Policy Implementation and Mutual Accountability.
[30] See https://agrilinks.org/sites/default/files/resource/files/Day%202%20Institutional%20Architechture%20and%20Mutual%20Accountability.pdf

[31] http://www.asti.cgiar.org/

development agenda stresses the key role of R&D in increasing food production in the face of rapid population growth, climate change, and volatile food prices.

Nevertheless, in spite of well-documented evidence of the payoffs to investing in agricultural R&D, many developing countries continue to underinvest. One explanation is the length of time required to reap the rewards of investments in research—which can typically involve decades, not just years. Agricultural R&D requires the long-term commitment of sufficient and sustained levels of funding, appropriate levels and allocations of research staff, and the necessary supporting institutional infrastructure.

Given the competing demands on national budgets, shorter-term goals often take priority over longer-term agricultural R&D investments. This is why quantitative data are essential to an informed decision-making process. Agricultural R&D stakeholders require such data to analyze investment and capacity trends, identify key gaps, set future priorities, promote efficient resource use, and ensure effective coordination and coherence of agricultural research initiatives. R&D indicators are also vital in assessing the contribution of agricultural R&D to development goals, such as agricultural and economic growth, food security, poverty reduction, and climate change mitigation. See Annex B.10 for a detailed description of the ASTI program and data.

9. Performance tracking and investment targeting tools

Achieving the CAADP goals and targets will not be easy without efficient and understandable monitoring systems to help countries to stay on track. The mutual accountability framework of the joint sector review is a primary tool to monitor progress and design institutional interventions. This tool will be complemented by other tools that can estimate and visualize quantitative indicators and their spatial distributions. One such tool is an eAtlas developed by IFPRI through ReSAKSS[32] that can serve countries to monitor progress in an interactive and user-friendly way. The eAtlas presents relevant and meaningful information quickly and accessibly. Statistics presented in the eAtlas tool are highly disaggregated by location and time as well as by gender, age and other socio-economic status indicators.

Countries can also use the eAtlas tools to generate data, which is the major core element of the tool. Most of the information presented in the eAtlas tool is based on geographic information systems and remote sensing data. The eAtlas tool also presents agricultural economic accounts. Country experts are in charge of ensuring data availability and providing the kind of data they find relevant for the eAtlas. The data has to be validated, used and managed by the countries, particularly analysts and policy makers. In fact, the long term goal is to release the eAtlas to the country experts, who will have the possibility of adding new data. See Annex B.11 for a more detailed description of the eAtlas.

NAIPs involve investment targeting of sectors, functions and geographic locations. While the methods and tools that can be used for sectorial and functional choices are described above under the overarching goals section, the methods and tools for spatial choice need to be further explored. For this purpose, a rural typology tool developed by IFPRI researchers is a relatively simple and well-conceptualized method.

[32] http://www.resakss.org

This typology tool helps to identify regions with high rural poverty rates and significant gaps between their current agricultural performance and their potential. The tool estimates a stochastic frontier in order to measure the agricultural potential and efficiency in different regions. Then a typology is constructed by combining potential, efficiency, accessibility and poverty maps. The aim is to identify and direct investment toward the regions with high marginal return or high priority. This can help to target the poor in terms of supporting the NAIPs and see how to efficiently set development interventions (long-term investments in agriculture such as R&D activities, assistance programs such as conditional cash transfers, road improvements and price information systems, access to inputs and extension services, mini-irrigation projects and land management projects, orientation to high values and export markets, certification and organic production, etc.).

The econometric model used for the classification requires the following data: Living Standards Survey, Land Cover Type, GIS data on inland water, roads, railroads, elevation, population, and climate (DIVA-GIS), GIS data on district boundaries (ArcGIS, ESRI), and poverty map[33].

The challenge is also to extend the tool to increase countries' involvement beyond simply being consumers of the tool. It will require working with different ministries in order to train local researchers and government officers so that they can participate in the construction of the tool and in the modeling process. The typology tool should also be mastered by many researchers (through training) and should be accessible. The tool can be used for many purposes beyond the NAIPs.

10. Foresight tools

Quantitative foresight models inform on the direction and magnitude of future changes. These models will be useful for *Program milestones and goal setting*. This helps to know longer term trends based on the results of forward-looking modeling for agricultural and food security futures. It is very useful to look at the changes at the global level to 2050 in Africa. Global Futures and Strategic Foresight includes improved tools for biophysical and economic modeling. This integrates a complete recoding of the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), disaggregation geographically and by commodity, improved water and crop models, a new data management system, a modular framework, and training for users of the model[34].

As explained earlier, IMPACT is a widely used partial equilibrium agricultural sector model that is designed to examine alternative futures for global food supply, demand, trade, prices, and food security. Modeling the long run climate impacts on agriculture through biophysical and economic effects can be useful for

[33] See Torero and Maruyama (2009), Targeting investments in rural development using typologies of micro-regions.

[34] See www.ifpri.org/program/impact-model; globalfutures.cgiar.org

global projections on agricultural supply and demand. See Annex B.12 for a more detailed description of IMPACT.

The following lessons learned from the first generation of NAIPs can be used to inform NAIP appraisal and design:

- ✓ There is strong interest and opportunity to inform decision making in many different policy bodies (AU, regional organizations, donors, development organizations, etc.).
- ✓ Multiple geographic scales of analysis are critical.
- ✓ Expertise that connects on-the-ground realities with modeling efforts at scale is invaluable.
- ✓ Beyond understanding global trends, the tools might be tailored for use at the country level.
- ✓ The possibility of combining the global-level IMPACT model with general equilibrium models constructed at the country level in order to look at specific development issues should be explored.
- ✓ Data and model driven work requires:

- Collective efforts to build and collect consistent databases of drivers of change (both historical and projected)

- A strong community of practice engaged at both regional and international levels for both data and modeling.

Annex A: CAADP Results Framework Indicators

Table 1. Priority Indicators for CAADP Results Framework

Level 1 - Agriculture's Contribution to Economic Growth and Inclusive Development

Results Area	Indicators	Data Sources	Contribution to measurement of Malabo targets
1.1. Wealth creation	1.1.1 GDP per capita (constant 2005 US$)	WDI, national source	
	1.1.2 Household final consumption expenditure (constant 2005 US$)	HIES	
1.2. Food security and nutrition	1.2.1 Prevalence of undernourishment (%)	FAO	IIId)
	1.2.2 Status of malnutrition: a) Prevalence of underweight b) Prevalence of stunting c) Prevalence of wasting d) Minimum dietary diversity - women e) Minimum acceptable diet for 6-23 months old infants	DHS/WDI, UNICEF, WHO	IIId)
	1.2.5 Cereal import dependency ratio	FAO	Ia)
1.3. Economic opportunities, poverty eradication and shared prosperity	1.3.1 Employment rate (% of population)	ILO/WDI, National sources	
	1.3.2 Number of jobs created per annum by age category and sex	ILO/WDI, National sources	
	1.3.3 Poverty gap at national line	WDI/HIES	
	1.3.4 Extreme Poverty headcount ratio at $1.25/day	WDI/HIES	
	1.3.5 Gini coefficient	HIES	
1.4. Resilience and sustainability	1.4.1 Percent of households that are resilient to climate and weather related shocks	RIMA (Resilience Index Measurement and Analysis)	Via)
	1.4.2 Human sustainable development index	HSDI UNDP	

Table 1. Priority Indicators for CAADP Results Framework (continued)

Level 2: Agricultural Transformation and Sustained Inclusive Agricultural Growth

Results Area	Indicators	Data Sources	Contribution to measurement of Malabo targets
2.1. Increased agriculture production and productivity	2.1.1 Agriculture value added (absolute values)	WDI	Ia) and IVa)
	2.1.2 Agriculture production index (2004-2006=100)	FAOStat and WDI	IIIa)
	2.1.3 Agriculture value added per agricultural worker (constant 2005 USD)	WDI, FAOStat	IIIa)
	2.1.4 Agriculture value added per hectare of arable land (constant 2005 USD)	WDI, FAOStat	IIIa)
	2.1.5 Yields for the five most commodities	FAOStat, National sources	IIIa)
2.2. Increased intra-African regional trade and better functioning of national & regional markets	2.2.1. Value of intra-African trade (constant 2005 US$)	UNCTAD, FAOStat, RECs	Va)
	2.2.2 Domestic food price index volatility	ILO/FAO	Vb) and VIc)
2.3. Expanded local agro-industry and value chain development inclusive of women and youth	2.3.1 Percent of agricultural five priority products that is lost post-harvest	FAO, APHLIS, national source	IIIb)
	2.3.2 Activity and inclusive employment in industries related to agriculture value chains	UNIDO, ILO, national sources	IVc) and IVd)
2.4. Increased resilience of livelihoods and improved management of risks in the agriculture sector	2.4.1. Coverage of social assistance, social protection, social insurance and labour programs	ASPIRE Database (WB)	IIIc) and VIb)
	2.4.2 Existence of food reserves, local purchases for relief programmes, early warning systems and food feeding programmes	National sources	IIIc)
2.5. Improved management of natural resources for sustainable agriculture	2.5.1. Share of agriculture under sustainable land management practices	Terrafrica, national data	VIc)

Table 1. Priority Indicators for CAADP Results Framework (continued)

Level 3: Strengthening Systemic capacity to deliver results

Results Area	Indicators	Data Sources	Contribution to measurement of Malabo targets
3.1 Effective and inclusive policy design and implementation processes	3.1.1 Existence of a new NAIP/NAFSIP developed through an inclusive and participatory process	National sources	Id)
3.2 Effective and accountable institutions including assessing implementation of policies and commitments	3.2.1 Existence of inclusive institutionalized mechanisms for mutual accountability and peer review	National sources	VIIa) and VIIb)
3.3 Strengthened capacity for evidence based planning, implementation & review	3.3.1 Existence of and quality in the implementation of evidence-informed policies and corresponding human resources	National sources	Ic)
3.4 Improved multi-sectorial coordination, partnerships and mutual accountability in sectors related to agriculture	3.4.1 Existence of a functional multi-sectorial and multi-stakeholder coordination body	National sources	VIIb) and Id)
	3.4.2. Cumulative number of agriculture-related Public Private Partnerships (PPPs) that are successfully undertaken	National sources	Id) and IVb)
	3.4.3 Cumulative value of investments in the PPPs	National sources	IIa)
3.5 Increased public and private investments in agriculture	3.5.1 Government agriculture expenditure growth rate (%)	ReSAKSS, national sources	IIa)
	3.5.2 Share government agriculture expenditure (% of total government expenditure)	ReSAKSS, national sources	IIa)
	3.5.3 Government agriculture expenditure as % of agriculture value added	ReSAKSS, WB, national sources	IIa)
	3.5.4 Growth in Private sector investment in agriculture and agribusiness	IFPRI FAO	IIb)
3.6 Increased capacity to generate, analyze and use data, information, knowledge and innovations	3.6.1 Index of capacity to generate and use statistical data and information (ASDI)	AfDB, UNECA	VIIc)
	3.6.2 Existence of an operational country SAKSS	IFPRI	VIIc)

Source: CAADP Results Framework 2015-2025

Annex B:

Description of Methods, Tools, and Databases for NAIPs Design, Appraisal, and Tracking

Annex B.1: Macro-Micro Models to Assess the CAADP Overarching Commitments and Goals

Computable General Equilibrium (CGE) models are frequently used to assess the growth and poverty goals and targets of programs or policies. Two CGE models are widely used by the community of modelers: the IFPRI (International Food Policy Research Institute) model and the PEP (Partnership for Economic Policy) model. The IFPRI standard model is a result of a joint work undertaken in 2002 by a team of researchers at the Institute. It is a standard static general equilibrium model built with the aim of analyzing trade and food policy issues in developing countries. The PEP model is an extension of the widely used EXTER model resulting from collaborative work by the PEP team.

Methodology

CGE models are grounded in the Walrasian general equilibrium theory. That is, relative prices simultaneously equalize the quantity produced to the quantity demanded in each commodity market as a result of profit and utility maximization behaviors of price-taker producers and consumers, respectively. Country models build equations to capture the behavior of producers and consumers through interactions between three main components of the economy: domestic supply (including external trade), domestic demand (including income generation and savings), and institutional or macroeconomic constraints.

Domestic Supply

Price taker producers maximize their profit under a given technology. An industry-specific representative producer specifies a nested Constant Elasticity of Substitution (CES) between output supplies and input demands, including services provided by productive factors (labor and capital). Export supply and import demand are specified for each individual commodity. Commodities produced in different regions of the world are imperfect substitutes. Imports and exports can be distinguished by region of origin, i.e. ECOWAS countries, other African countries, and the rest of the world.

Domestic Demand

Aggregate demand or absorption consists of demand for final consumption from consumers (households and the government), demand for investment, i.e. fixed capital formation and changes in inventories from producers, and demand for intermediate consumption from producers.

Institutional Constraints

Institutional or macroeconomic constraints condition purchasing prices and factor rewards, which in turn affect income, saving, and consumption. Institutional constraints specify the macro closure rules that equilibrate domestic commodity and factor markets. They also define the mechanisms that govern foreign commodity markets and prices, as well as equilibrate the foreign exchange market. The rule to reconcile government income and expenses (fiscal policy) affects prices through indirect (activities and commodities) and direct (consumers and producers) taxation, and government saving. Finally, the choice of the saving-investment equilibrium mechanism affects consumption and saving behaviours, and in turn domestic commodities markets.

Data

CGE models are operationalized through the calibration procedure which consists of finding model parameters that permit to reproduce the benchmark situation given by the Social Accounting Matrix (SAM). The SAM is the presentation of the national accounts in a condensed matrix. It is a consistent quantitative macroeconomic data framework representing the flows between different sectors and institutional units within an economy during a given period of time, in general, one year. The choice of the initial conditions of the economy is an important step of the analysis. In case the SAM no longer reflects the initial conditions of the economy at the time the study is undertaken (due to its being too old or to the occurrence of a major shock) and it is not possible to build a new SAM, updating the SAM can be a reasonable solution.

Access

https://www.ifpri.org/publication/standard-computable-general-equilibrium-cge-model-gams-0

https://www.pep-net.org/pep-standard-cge-models

Annex B.2: Analyses of Public Expenditure in Agriculture

i. Public Agriculture Expenditure Analysis

1. Introduction

Public spending in general is a powerful instrument to address economic inefficiencies due to market failures and inequality in the distribution of goods and services due to differences in initial allocation of resources across different groups and members of society. In the agricultural sector, market failure hinges on, for example, imperfect markets and information asymmetries in agricultural technology generation and adoption. In terms of social inequities, the distribution of goods and services is often biased against the majority of people who live in rural areas, depend on agriculture for their livelihoods, and are poor. Thus, public agriculture expenditure (PAE) has critical role to play in Africa's agriculture-led development agenda.

The literature shows that the effect of PAE on different development outcomes (e.g. agricultural productivity and growth, income, poverty, and food security and nutrition) may materialize through various channels, that the effects are not the same for all types of PAE or in all locations, and that the effects often materialize with a lag rather than contemporaneously. The effects may also vary depending on the source of financing the expenditures. See Mogues, Fan and Benin (2015) for a recent review of the literature.

Therefore, the PAE analysis tool aims to address three main issues:

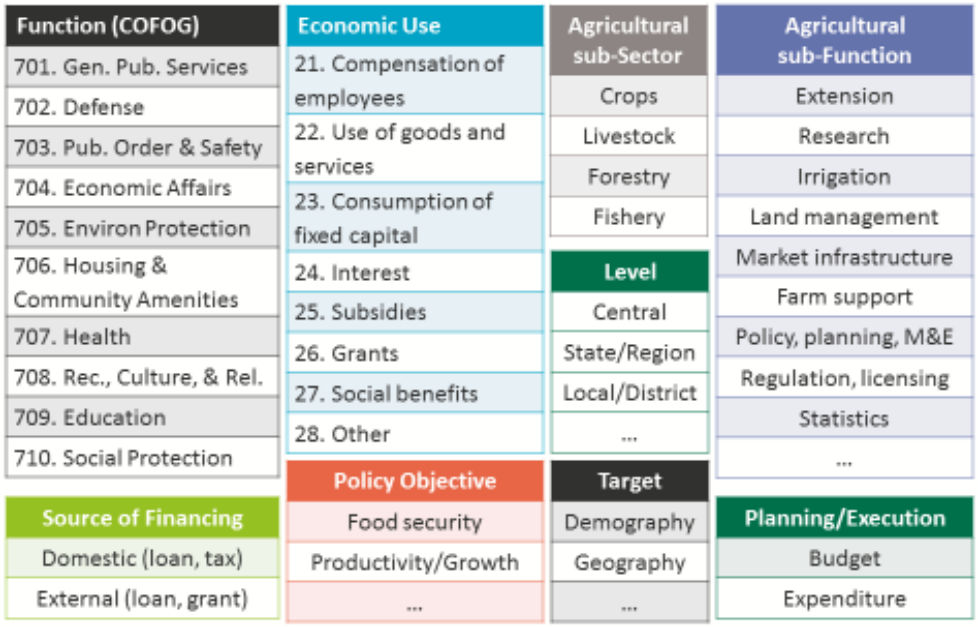
1. Consistency of PAE with policy objectives
2. Effectiveness and efficiency of PAE
3. PAE requirements to achieve stated development objectives

2. Data Requirements and Sources

Due to differential effects of different types of PAE that often materialize with different lags, addressing the above three issues requires a large panel dataset on PAE and relevant outputs and outcomes that are adequately disaggregated. There is no shortcut. Focusing on PAE, the main aspects of disaggregating PAE data, starting with a disaggregation of total public expenditure (TPE) according to the classification of the functions of government (COFOG), are shown in Figure 1. The issue of what to count as PAE has been continuously debated. The African Union has issued a guidance note for this purpose (AUC-NEPAD 2015), which follows the UN COFOG. The other data required, similarly disaggregated, include: public capital (which is the immediate physical manifestation of the expenditures, e.g. technologies for research expenditure); intermediate outputs (e.g. production and productivity); outcomes or impact indicators (e.g. income, poverty, and food security and nutrition); and conditioning factors, such as those that influence PAE (e.g. governance and political economy factors) and those that influence the outcomes (e.g. sociodemographic characteristics and agro-ecological conditions). See for example Benin, Mogues and Fan (2012) for a list of the data required.

PAE data may be compiled from various government sources including: ministries of finance, agriculture, and local government; accountant general's office; statistics bureau; central banks; and chambers of commerce. The other data may be compiled from the above sources, in addition to different types of national household, sector, industry or firm, and labor surveys.

Figure B.2.1. Main aspects of disaggregating total expenditure and PAE data



Notes: COFOG = classification of functions of government. PAE is typically under Economic Affairs (COFOG 704).

3. Methods

Different methodological approaches can be used to address the issues raised in the introduction.

3.1. Consistency of PAE with policy objectives

This will involve trends and comparative analysis of PAE against different indicators on the policy objectives or strategic direction of the government:

- Budget execution:
  - Ratio of actual expenditure to budget
  - Sources of financing: relative taxation of agriculture; timing of releases; public-private partnerships
- Commitment to the agricultural sector, CAADP, and AU targets:
  - Compare PAE growth to TPE or agricultural GDP growth to assess commitment to agricultural sector relative to others
  - Analyze PAE growth by sub-periods to assess commitment by different governments or policies over time
  - Compare PAE/TPE vis-à-vis to CAADP 10 percent target
  - Compare research expenditure as share of agricultural GDP vis-à-vis AU 1 percent target
- Consistency with policies and strategies based on different classifications of PAE (see Figure 1):
  - **Economic inductive analysis**: compare e.g. wage vs. non-wage expenditure or recurrent vs. capital expenditure to assess relative buildup of productive assets

- **Sub-sector and sub-function analysis**: compare shares of PAE in the different areas to assess consistency with investment plan or strategic direction of spending
- **Deconcentration of PAE**: compare shares of PAE at different levels of government to assess deconcentration of fiscal policy
- **Policy objectives**: compare shares of PAE for different outcomes (e.g. growth, nutrition, poverty) to assess consistency with policy objectives
- **Demographic targeting**: calculate for example per capita expenditures for different socio-demographic groups (or benefit incidence analysis) to assess e.g. gender focus of expenditures

3.2. Effectiveness and efficiency of PAE

Effectiveness refers to the capability of PAE to achieve an objective, whereas efficiency includes the cost of achieving it. Assessing these will require econometric and simultaneous equations modeling, involving four fundamental sets of equations: outcomes (O_i); intermediate outputs (Y_j); public capital (PC_s) formation; and allocation decisions of different types of public agricultural expenditure (PAE_s). This is represented by the following general form of simultaneous equations:

$$O_{it} = f^{O}(PC_{st}, PAE_{st}, Y_{jt}, Z_{it}^{O}) \quad 1$$

$$Y_{jt} = f^{Y}(PC_{ht}, PAE_{st}, O_{it}, Z_{jt}^{Y}) \quad 2$$

$$PC_{ht} = f^{PC}(PAE_{st}, PAE_{st-1}, \dots, PAE_{st-k}, Z_{st}^{PC}) \quad 3$$

$$PAE_{st} = f^{PAE}(PC_{ht}, PAE_{st-1}, Y_{jt}, O_{it}, Z_{st}^{PAE}) \quad 4$$

Where f^m and Z^m are used to represent function and exogenous factors for the respective equations. The subscripts *i*, *j*, *h*, and *s* are used to represent the different types of outcomes, intermediate outputs, public capital, and public agricultural expenditures, respectively, and *t-k* reflects the lag of PAE. The main issues to deal with in the estimation include: endogeneity (which derives from the simultaneity of the dependent variables included in the right hand side of the equations or from omitted explanatory variables and measurement errors); optimal lag length of *PAE* in equation 3; serial correlation that is typically associated with the use of time-series data; and heteroscedasticity that is typically associated with the use of cross-sectional data. Any standard econometric textbook is a good resource on these issues and how to address them. Benin, Mogues and Fan (2012) discuss these with respect to PAE analysis.

The estimated parameters, typically elasticities, from the different equations can then be combined to obtain the total effect (i.e. direct and indirect effects) of any type of PAE_s on any outcome according to (dropping the subscripts *i*, *j*, *h*, and *s* for simplicity):

$$\frac{dO}{dPAE} = \frac{\partial f^{O}}{\partial PC}\sum_{k=0}^{\mathrm{N}}\frac{\partial f^{PC}}{\partial PAE_{t-k}} + \frac{\partial f^{O}}{\partial PAE} + \frac{\partial f^{O}}{\partial Y}\left[\frac{\partial f^{Y}}{\partial PC}\sum_{k=0}^{\mathrm{N}}\frac{\partial f^{PC}}{\partial PAE_{t-k}} + \frac{\partial f^{Y}}{\partial PAE}\right]$$

Let $\hat{\beta}_{PAE}^{m}$ represent the estimated elasticity with respect to *PAE* from the respective equation *m* (i.e. for *O*, *Y*, and *PC*), then the total effect of the elasticity outcome with respect to PAE, ε_{PAE}^{O}, is given by:

$$\varepsilon_{PAE}^{O} = \hat{\beta}_{PC}^{O} * \sum_{k=0}^{\mathrm{N}}\hat{\beta}_{PAE_{t-k}}^{PC} + \hat{\beta}_{PAE}^{O} + \hat{\beta}_{Y}^{O} * \left[\hat{\beta}_{PC}^{Y} * \sum_{k=0}^{\mathrm{N}}\hat{\beta}_{PAE_{t-k}}^{PC} + \hat{\beta}_{PAE}^{Y}\right]$$

Effectiveness of PAE ($\varepsilon_{PAE_s}^{O}$): as elasticity is a unitless concept defined as the ratio of the percentage change in the outcome to the percentage change in PAE, the estimates can be compared for different

types of PAE_s to assess their relative effectiveness in achieving different outcomes over specific periods of time. PAEs with larger and statistically significant elasticities can be classified as the more effective ones, whereas those with smaller and statistically insignificant elasticities can be classified as the less effective or ineffective ones.

Efficiency of PAE ($\eta^{O}_{PAE_s}$): An indication of the efficiency can be obtained by multiplying the elasticity with the ratio of the mean value of the outcome ($\bar{O} = \sum_t O_t/\mathrm{N}$) to the mean value of the relevant PAE ($\overline{PAE_s} = \sum_t PAE_{st}/\mathrm{N}$): where $\eta^{O}_{PAE_s} = \varepsilon^{O}_{PAE_s} * (\bar{O}/\overline{PAE_s})$, which can be interpreted as the amount of outcome per unit of PAE type, evaluated over specific periods of time. As above, PAEs with larger and statistically significant η can be classified as more efficient, whereas those with smaller and statistically insignificant η can be classified as less efficient or inefficient. See Table B.2.1 at the end of Part i. of this annex for an example on India.

3.3. PAE requirements to achieve stated development objectives

Addressing this issues involves answering two interrelated questions: what amount of different types of PAE is needed to achieve stated development objectives (e.g. achieving a 6 percent agricultural growth rate or reducing poverty by half); and how much should be allocated to different types of PAE to maximize outcomes (e.g. increasing the agricultural growth rate or reducing poverty). Answering these will involve a simulation model based on equations 1 through 4 and the estimated elasticities or relationships for all the factors. As this is an ex-ante analysis, it will involve making some assumptions on how the past and current conditions that influenced the estimated parameters may be expected to change over time. Based on these assumptions and the desired outcomes, the impacts and costs of the different types of PAE can be simulated, using the principle of equal marginal returns to the different types of PAE. Typically, a baseline or business-as-usual scenario, representing the status quo where all factors and their effects are assumed to evolve as observed for the past, is estimated as described above. Then, different assumptions and scenarios can be simulated and the results compared with the business-as-usual results to assess the relative costs of achieving the objectives under the different scenarios. See Benin, Fan and Johnson (2012) and Diao et al. (2012) for detailed methods and examples on several African countries.

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Cross-Country Datasets on Public Expenditures

Anson, R. and Mogues, T. 2016. A Systematic Review of Cross-Country Data Initiatives on Agricultural Public Expenditures in Developing Countries. IFPRI Discussion Paper 1541. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130452.

Agricultural Science and Technology Indicators (ASTI). www.asti.cgiar.org/data/. ASTI provides data on expenditures for agricultural research for 44 African countries, as well as analyses and reports.

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Regional Strategic Analysis and Knowledge Support System (ReSAKSS). www.resakss.org/map.

Statistics on Public Expenditures for Economic Development (SPEED). https://www.ifpri.org/program/statistics-public-expenditures-economic-development-speed.

Other Initiatives to Track Public Expenditures

Monitoring and Analysing Food and Agricultural Policies (MAFAP): FAO's MAFAP initiative tracks public agricultural expenditures as well as strengthening country-level capacity to track and analyze public agricultural expenditures. See Annex B.2., part ii below for further details. Also see http://www.fao.org/in-action/mafap/home/en/.

ReSAKSS: In addition to tracking and disseminating cross-country data on public agricultural expenditures, ReSAKSS analyzes public expenditures at the country, regional and continental levels and collects country agricultural public expenditure reviews. See http://www.resakss.org/node/43?key=&type=0&country=0&topic=Public+Expenditures.

World Bank Agricultural Public Expenditure Reviews: The World Bank has produced detailed agricultural public expenditure reviews for a number of African countries. See https://openknowledge.worldbank.org/discover?scope=%2F&query=agricultural+public+expenditure+review&submit=

World Bank BOOST initiative: The Boost initiative provides detailed data and reports on government expenditures for several African countries. See http://wbi.worldbank.org/boost/boost-initiative.

For further information on initiatives to track and analyze public agricultural expenditures, see: Mas Aparisi, A., L. Ghins, and J. Bailé. 2015. *Initiatives for the Monitoring and Analysis of Agricultural Public Expenditures in Africa: A Comparative Review and Analysis*. MAFAP. Rome: FAO. http://www.fao.org/3/a-i4461e.pdf.

Table B.2.1: Returns in growth and poverty reduction to different types of spending in agricultural and rural sectors in India by different time periods, 1951-1993

	Return in agricultural GDP (RPS per RPS)								
	1960s–1970s			1980s			1990s		
	Return	R1	R2	Return	R1	R2	Return	R1	R2
Agricultural sector									
Research and dev't	8.65	2	5	7.93	1	2	9.50	1	1
Irrigation investment	8.00	3	6	4.71	2	4	4.37	2	4
Irrigation subsidies	5.22	4	7	2.25	4	6	2.47	4	6
Fertilizer subsidies	1.79	5	8	1.94	5	8	0.85	5	8
Credit subsidies	18.77	1	2	3.00	3	5	4.26	3	5
Rural sector									
Roads	19.99	1	1	8.89	1	1	7.66	1	2
Education	14.66	2	3	7.58	2	3	5.46	2	3
Power subsidies	12.06	3	4	2.25	3	6	1.19	3	7
	Return in number of rural poor reduced per million RPS								
	1960s–1970s			1980s			1990s		
	Return	R1	R2	Return	R1	R2	Return	R1	R2
Agricultural sector									
Research and dev't	642.69	2	5	409.00	1	3	436.12	1	2
Irrigation investment	630.37	3	6	267.01	2	4	193.21	3	5
Irrigation subsidies	393.70	4	7	116.05	4	7	113.47	4	6
Fertilizer subsidies	90.07	5	8	109.99	5	8	37.41	5	8
Credit subsidies	1448.51	1	3	154.59	3	5	195.66	2	4
Rural sector									
Roads	4124.15	1	1	1311.64	1	1	881.49	1	1
Education	1955.56	2	2	651.40	2	2	335.86	2	3
Power subsidies	998.42	3	4	125.50	3	6	59.15	3	7

Source: Based on Fan, Gulati, and Thorat (2008).

RPS = Retention Pricing Scheme. R1 = rank of return within sector, where 1 is the highest rank. R2 = rank of return across sectors, where 1 is the highest rank.

ii. MAFAP Public Expenditure Analysis

The Monitoring and Analyzing Food and Agricultural Policies (MAFAP) programme is an initiative of FAO to support the development of country-owned, sustainable systems to monitor, analyze and reform food and agricultural policies. This contributes to more effective, efficient and inclusive policy frameworks in a growing number of developing and emerging economies, and supports implementation of the CAADP Results Framework, assessment of National Agricultural Investment Plans (NAIPs) and progress towards the targets of the Malabo Declaration.

MAFAP works with government institutions, research organizations and other partners to carry out analysis of the effect of policies on the food and agricultural sector, particularly farmers. Public expenditure analysis is one of the three core areas of MAFAP, which are:

- Public expenditure analysis
- Price incentives and disincentives
- Policy coherence

As of June 2016, MAFAP operates in the following countries:

MAFAP Partner Countries in Africa		
Benin	Kenya	Rwanda
Burkina Faso	Malawi	Senegal
Burundi	Mali	Tanzania
Ethiopia	Mozambique	Uganda
Ghana	Nigeria	

Scope of the Public Expenditure Analysis

Public Expenditure Analysis is a core component of MAFAP. With support from FAO, national teams of policy analysts produce sets of PEA (PEA) indicators that include the following:

- Total level of agricultural public expenditure
- Share of agricultural public expenditure within total national public expenditures
- Disaggregation of agricultural public expenditure according to MAFAP/OECD classification categories.
- Share of recurrent and capital expenditure within each classification category and in total agricultural public expenditure
- Budgeted and actual amounts for each category
- Budget support to specific commodities
- Overviews of qualitative information for all expenditure items, including: name of expenditure measure, data source, responsible ministry, etc.

The indicators are updated on a bi-yearly basis and published in the public expenditure database on the FAO MAFAP website (http://www.fao.org/in-action/mafap). Due to MAFAP's universal methodology, indicators can be compared between countries and years. In addition, MAFAP teams also produce technical notes and policy briefs that provide interpretation of the indicators and policy recommendations. As such, the MAFAP methodology is particularly well-placed to track policy effects and budget support to the agricultural sector before, during and after NAIP formulation and implementation.

Methodology

The MAFAP tool for public expenditure analysis forms part of a broader methodology for monitoring and analyzing how the public sector supports the food and agricultural sector. It is based on the OECD methodology of Producer Support Estimates, which has been applied for over 30 years across OECD

countries and a large number of emerging economies in Asia and Latin America to measure how policy affects agricultural producers and consumers.

The methodology proposes to capture all public expenditures in support of food and agricultural sector development, ideally going back a minimum of nine years. That includes expenditures from the national budget undertaken by either a central or regional government, regardless of the ministry or agency that implements the policy, and external aid provided either through local governments or specific projects and programmes conducted by development partners.

Public expenditures considered in the MAFAP-PE methodology are those of the food and agricultural sector, including forestry and fisheries. In addition, the MAFAP-PE methodology includes all public expenditures in rural areas, as they may also play an important role in agricultural sector development, even if they are not specific to the sector.

The MAFAP/OECD methodology is unique in that it allows the user to measure coherence between budget support (e.g. subsidies) and price support (import tariffs, pricing policies).

The MAFAP public expenditure indicators track both the level and composition of expenditures in support of food and agricultural sector development. This helps to measure progress towards the Malabo targets and to assess whether resources are being allocated to priority areas, whether they address investment needs, and whether they are consistent with government policy objectives.

The full details of the methodology are described in the MAFAP Methodology Working Paper: Volume II: Analysis of Public Expenditure on Food and Agriculture.

Why Use MAFAP?

- MAFAP's Public Expenditure Analysis is part of a broader support package that also looks at coherence between budget execution and other policies of the government to support the agricultural sector.
- MAFAP can carry out impact analyses of possible policy reforms and budget re-allocations, for example assessing the effects on prices or productivity. These impact analyses can be particularly useful during NAIP implementation.
- The MAFAP public expenditure tool strengthens systematic expenditure monitoring (in contrast to one-off studies or reviews).
- MAFAP expenditure analysis is disaggregated, and indicators are checked and verified by FAO.
- Because of its disaggregation, MAFAP expenditure analysis may be used by policy-makers to report on the quality of expenditure, as per the commitment undertaken by AU Member States in the Malabo Declaration.

More Information

Overall information about MAFAP:
http://www.fao.org/in-action/mafap
MAFAP PE Methodology Guide
http://www.fao.org/in-action/mafap/resources/detail/en/c/386924/
Other publications are available on the MAFAP website, including technical notes on public expenditures in support of food and agriculture in Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Tanzania and Uganda.

Annex B.3: Inclusive growth and value chain development

Value-chain analysis refers to the study of the marketing channels for one commodity from production to consumption, focusing on the types of actors (including farmers, traders, and processors) and their competitive relationships with each other. One important aspect of the analysis of a marketing channel is understanding the spatial dimension, including the geographic distribution of production, processing, and consumption, as well as the spatial flows of the commodity between production and consumption.

Information on the geographic distribution of production and consumption is available in many developing countries. However, it is not common to have direct estimates of the flows of agricultural commodities from one region to another. Interviews with traders can provide a general idea of the main flows, but it is difficult to obtain quantitative estimates of the flows between regions of the country. Too often, it is simply assumed that agricultural commodities are transported from the main surplus zones to the largest cities or to the port in the case of export commodities.

This note describes a method for estimating the likely flows of the commodity between surplus and deficit zones using information on the geographic distribution of production and consumption and some plausible assumptions.

Methods

The key assumption in this analysis is that the surpluses in the main production zones are distributed to the deficit zones in a way that minimizes the transportation costs. Linear programming is a mathematical technique to minimize (or maximize) a linear objective function subject to a set of linear constraints, which can take the form of equalities or inequalities. In this case, we search for a set of flows from region i to region j (F_{ij}) that minimize the cost of transportation:

$$\sum_{i=1}^{n}\sum_{j=1}^{n} C_{ij}F_{ij}$$

where C_{ij} is the cost of transporting one ton of the commodity from zone i to zone j, F_{ij} is the volume of the commodity shipped from zone i to zone j, and n is the number of zones. The constraints are that supply (S_i) plus inflows must be equal to demand (D_i) plus outflows for each zone:

$$S_i + \sum_{j=1}^{n} F_{ji} = D_i + \sum_{j=1}^{n} F_{ij} \; for\ all\ i$$

and all flows must be positive:

$$F_{ij} \geq 0 \; for\ all\ i,j$$

The data needed to solve the problem are:

- S_i a vector of production estimates for each zone,
- D_i a vector of utilization estimates for each zone, and
- C_{ij} a matrix of the cost of transporting the commodity from zone i to zone j.

The output of the linear programming analysis will be the value of Fij, the flows from zone I to zone j that make supply and demand equilibrate in each zone in a cost-minimizing way.

Linear programming problems can be solved using the Excel Solver or using GAMS. The details of the implementation are beyond the scope of this short note, but are available from the author.

Data requirements

Three types of information are required to estimate the spatial flows of an agricultural commodity in the absence of direct measurements. First, spatially disaggregated production information is needed. This may be available from nationally representative surveys that include crop production estimates, or it may be available from administrative data collection systems carried out by the Ministry of Agriculture. In most countries, production estimates are available from at least ten sub-national regions, but in larger countries with good statistical systems, estimates may be available for 50-100 regions.

Second, it is necessary to have spatially disaggregated information on the utilization of the crop, including consumption, seed, feed, and industrial use. Spatial patterns in human consumption are available from household income and consumption surveys. Seed use can be obtained from farm surveys or assumed to have the same spatial distribution as production. Feed use may be estimated from direct measurement in farm surveys or assumed to be distributed in the same proportions that livestock are distributed. Industrial use can be estimated based on the spatial distribution of the main industries that use the crop as a raw material. Of course, the more important the utilization, the more important it is to locate reliable information on its spatial distribution.

The definition of zones for the analysis depends on the least disaggregated data. For example, if production is available for each sub-district, but utilization is only available at the district level, then production will need to be aggregated to the district and the analysis carried out at that level. If possible, the major cities should be separated as distinct zones for the purpose of the analysis.

Third, it is necessary to obtain information on the transportation cost of moving the commodity from each zone to each other zone. In many cases, a market or city is used to represent each region for the purpose of these calculations. The implicit assumption is that shipments from one region to another go from the main market of one region to the main market of the other region. If 20 regions are being used in the analysis, the number of market pairs is 20*(20-1)/2 = 190. Because of the large number of market pairs, it will often be necessary to estimate travel cost based on the distance and some estimate of the cost of transportation per kilometer-ton. GIS data or even Google Maps can be used to estimate the distance between the markets representing each zone.

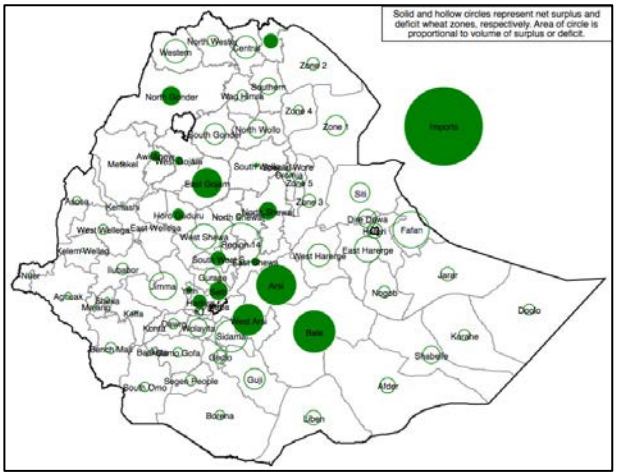
Example from Ethiopia

This method was applied to map the spatial flows of wheat in Ethiopia. Production data were obtained from the 2013 Agricultural Sample Survey, while consumption data were obtained from the 2011 Household Income, Consumption, and Expenditure (HICE) survey. Because the estimates of wheat production and imports significantly exceeded the survey-based estimates of consumption, we scaled the consumption estimates up proportionately in each zone to achieve an equilibrium at the national level. The analysis was carried out at the zone level, of which there are 75.

The results indicated that of the 74 zones, just 19 of them had a wheat surplus. Just four zones accounted for two-thirds of the national surplus. Among the 55 wheat-deficit zones, the largest deficit was in Addis Ababa, not surprisingly. Somewhat surprising were the large deficits in the semi-arid zones of southern and eastern Ethiopia. Although the population density is low, their diet is heavily dependent on wheat products with virtually no production in these zones. Although Addis Ababa is the largest demand sink, it represents just 12 percent of the total deficit.

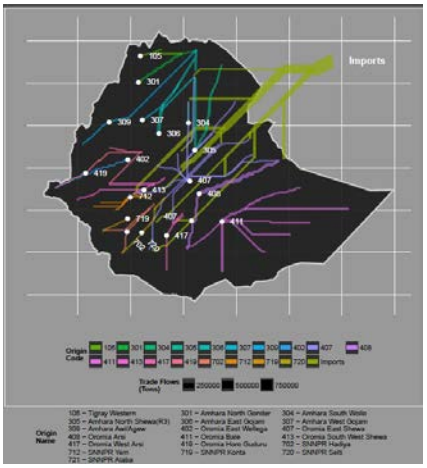
Based on the results of the linear programming model, more than one quarter of the imported wheat is shipped to Addis Ababa, satisfying almost all the requirements of the capital city. Arsi (Oromia) generates 267 thousand tonnes of wheat surplus, the largest in the country. According to the linear programming model, these are shipped to three rural zones near Arsi. This suggests that wheat flows do not represent a hub-and-spoke pattern in which wheat flows from different surplus zones into Addis Ababa and other cities. Instead, the flows follow a complex pattern in which most of the volume is shipped from rural surplus zones to rural deficit zones.

Figure B.3.1. Map of wheat surplus and wheat deficit zones



Source: Analysis based on data from 2011 HICE and 2013 Agricultural Sample Survey.

Figure B.3.2. Estimated flows of wheat among zones in Ethiopia



Source: Linear programming analysis based on production and consumption data from CSA (2014) and FAO (2015).

These results should be interpreted with caution. The distance between zones is only an approximation of the cost of transporting wheat between them. The model does not take into account seasonality, in which imported wheat is more widely distributed during the off-season and domestic wheat becomes more important after the main harvest. Furthermore, the model assumes wheat is perfectly homogeneous, but differences in the characteristics of imported and domestic wheat undoubtedly have some influence on the flows. As a result, actual flows may differ from the flows estimated by the model, and the model should not be considered a guide for how wheat "should" be marketed. Nonetheless, in the absence of direct measurements, it may be considered an approximation of the flows of wheat between markets.

Annex B.4: Regional Trade

i. Regional Trade Indicators

Value of intra-African trade of individual countries

- Changes in values and volumes of total imports and exports of key agricultural commodities
- Changes in values and volumes of intra-regional imports and exports of key agricultural commodities

Regional trade expansion possibilities

Production and export similarity indices are calculated in order to explore the possibilities of expanding cross-border trade between countries under current production and trade patterns. These two indices are calculated for pairwise comparison of agricultural production and trading patterns across countries with the following formulas:

- **Production Similarity Index**

$SQ_{ij} = 100 \sum_k Min(q_{ik}, q_{jk})$

where q_{ik} and q_{jk} are the shares of a product k in the total agricultural production of countries i and j, respectively.

- **Export Similarity Index**

$SE_{ij} = 100 \sum_k Min(e_{ik}, e_{jk})$

where e_{ik} and e_{jk} are the shares of a product k in the total exports of countries i and j, respectively.

The indices have a maximum value of 100, which would reflect complete similarity of patterns between the considered pair of countries. The more the value of the indices tends towards zero, the greater the degree of specialization between the two countries. Index values of around 50 and below are interpreted as indicating patterns of specialization that are compatible with higher degrees of trade expansion.

Degree of specialization in agricultural production and trade

The following three indices are used to assess for individual countries their actual degree of specialization in agricultural production and trade and whether or not there is real scope for trans-border trade expansion as a strategy to exploit the dissimilarities among countries.

- **Comparative Production Performance**

$$CQP_{ik} = \frac{Q_{ik}/Q_{wk}}{\sum_{k=1}^{K} Q_{ik} / \sum_{k=1}^{K} Q_{wk}}$$

where i and w stand for a country and the world, and Q_{ik} and Q_{wk} represent the quantity produced of an agricultural product k in the country and the world, respectively. An index value of more than unity means that the particular commodity has a larger share in total agricultural production of the individual country than it has in world production. If all countries in a region have similar resources and climates, the CQP coefficients for individual products of the countries will vary only a little, if at all.

- **Comparative Export Performance**

$$CEP_{ik} = \frac{X_{ik}/X_{wk}}{\sum_{k=1}^{K} X_{ik} / \sum_{k=1}^{K} X_{wk}}$$

where i and w stand for a country and the world, and X_{ik} and X_{wk} represent export values of an agricultural product k from the country and the world, respectively. An index of more than unity indicates that the particular product has a larger share in total agricultural exports of the individual country than it has in world agricultural exports.

- **Revealed Comparative Advantage Index**

The revealed comparative advantage (RCA) index is a measure of a country's relative advantage or disadvantage in a specific sector as evidenced by trade flows. It is calculated according to the following formulae:

$$RCA_{ijk} = \frac{\frac{x_{ijk}}{X_{ij}}}{\frac{x_{wjk}}{X_{wj}}}$$

where x_{ijk} is the value of exports of an agricultural product k from country i to destination j, and $X_{ij} = \sum_k x_{ijk}$ is the country's total exports to that destination; $x_{wjk} = \sum_i x_{ijk}$ and $X_{wj} = \sum_i \sum_k x_{ijk}$ are similarly defined for world exports.

A value of the RCA index above one indicates that a country's share of exports in a sector to a particular destination exceeds the global export share of the same sector to the same destination. If this is the case, we infer that the country has a comparative advantage in that sector and in that destination.

A disadvantage of the RCA index is that it is asymmetric, i.e. unbounded for those sectors with a revealed comparative advantage, but it has a zero lower bound for those sectors with a comparative disadvantage. One alternative is to rely on a simple normalization proposed by Laursen (2000). The normalized RCA index (NRCA) becomes:

$$NRCA_{ijk} = \frac{RCA_{ijk}-1}{RCA_{ijk}+1}$$

The interpretation of the NRCA index is similar to the standard RCA measure except that the critical value is 0 instead of 1 and the lower (–1) and upper (+1) bounds are now symmetric.

Scope of non-exploited regional trade possibilities

The extent to which cross-border trade possibilities and current specialization patterns have not been exploited so far is revealed by the trade overlap and trade expansion indicators. The trade overlap indicator (TOI) is defined as follows:

- **Trade Overlap Indicator**

$$TOI_i = \frac{2\left(\sum_{k=1}^{K} Min(X_{ik}, M_{ik})\right)}{\sum_{k}^{K}(X_{ik}+M_{ik})}$$

where X_{ik}, M_{ik} denote export and import values of an agricultural product k for a country i.

The coefficient varies between 0 and 1. It will be zero if the country only exports or imports any individual products. It will be 1 if the country both exports and imports any products by an equal amount.

- **Trade Expansion Indicator**

The trade expansion indicator (TEI) is more disaggregated than the TOI in order to specify those products for which intra-regional trade can be expected to expand the most. It is defined as follows:

$TEI_{ik} = [Min(X_{ik}, M_{ik})/Max(X_{ik}, M_{ik})] \cdot 100$

where X_{ik}, M_{ik} denote export and import values of a product k for a country i.

The coefficient indicates the percentage of the region's exports that are matched by imports from the region.

- **Symmetric trade introversion index (STJ)**

Changes in the index show whether the intensity of intra-regional trade varies at a faster or at a slower pace than that of extra-regional trade. The index is based on the ratio of an intra-regional trade intensity index to its complementary extra-regional trade intensity index.

$$STJ_{i,t} = \frac{\frac{HITI_{i,t}}{HETI_{i,t}} - 1}{\frac{HITI_{i,t}}{HETI_{i,t}} + 1} = \frac{(HITI_{i,t} - HETI_{i,t})}{(HITI_{i,t} + HETI_{i,t})}$$

$$HITI_{i,t} = \frac{\left(\frac{IT_{i,t}}{T_{i,t}}\right)}{\left(\frac{ET_{i,t}}{T_{w,t}-IT_{i,t}}\right)} \quad \text{and} \quad HETI_{i,t} = \frac{1-\left(\frac{IT_{i,t}}{T_{i,t}}\right)}{1-\left(\frac{ET_{i,t}}{T_{w,t}-IT_{i,t}}\right)}$$

$HITI_{i,t}$: modified version of the intra-regional trade intensity index (maximum value is independent from region *i*'s trade size)

$HETI_{i,t}$: extra-regional trade intensity index

Varies from -1 (no intra-regional trade) to 1 (no extra-regional trade)

Suggested readings

Online trade outcomes indicators:

http://wits.worldbank.org/trade_outcomes.html

A Practical Guide to trade Policy Analysis:

https://www.wto.org/english/res_e/publications_e/wto_unctad12_e.pdf

ii. Tools to measure food price volatility

Volatility is a complex concept important for consumers, producers and investors, and measuring it is not an easy task. Its measurement has given rise to several debates which are still ongoing (Just and Pope, 2002). In particular, the nature of the data generating process of the time series is of great importance when it comes to measuring and modeling volatility. In addition, making a distinction between the predictable and unpredictable components of prices is paramount when the underlying concept in mind is risk. Finally, a distinction between historic volatility (which is our focus) and implicit volatility is important.

There are two families of methods that deal with the measurement of volatility: descriptive methods and econometric ones.

Descriptive statistics methods

Standard deviation

Probably the most common measure of volatility which comes to mind is the standard deviation of the underlying price series. This measure represents the amount of variation (dispersion) of the variable around its mean. With a sample $(P_1, P_2, \cdots, P_T)$ of prices, the standard deviation is given by:

$$\boldsymbol{\sigma = \sqrt{\frac{\sum_{t=1}^{T}(P_t - \overline{P})^2}{T-1}}}$$

Where $\overline{\boldsymbol{P}}$ represents the mean of the prices.

Coefficient of variation: Since the standard deviation depends on the unit of measurement, it is not comparable between different series. For that, one needs a unit free measure. The coefficient of variation or relative standard deviation is such a measure. It is a standardized measure and is given by:

$$CV = \frac{\sigma}{\overline{P}}$$

Price Variation

When prices follow a complex stochastic process, in particular when they are not stationary, price variation is better indicated to work with for studying volatility. In particular, working with price variation generally makes the price variables stationary (Enders, 2014). As a consequence one could focus on the standard deviation of the variation in prices instead of the level of prices. Furthermore, variation is unit free. The two most common measures of price variation are:

Net variation: $R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$

Log variation: $r_t = log\frac{P_t}{P_{t-1}}$

Both measures allow the user to track price volatility, and the choice of one measure is a matter of convenience as long as estimation is not involved. Also, both measures give similar results for small variations.

Econometric methods

Economists are sometimes interested in volatility as a synonym for risk. In general this notion of risk is more oriented towards producers and investors, rather than consumers and market integration. As a consequence, a distinction is usually made between the predictable and the unpredictable component of volatility and only the latter is taken into account (Moledina et al., 2003; Jordaan et al., 2007). Thus the volatility of prices is given by either the standard error of the price process (such as an ARIMA process) or the conditional standard deviation in an ARCH/GARCH type estimation process.

The ARCH/GARCH implies that the volatility is not constant over time. If prices follow a standard AR (p) process: $P_t = a_o + \sum_{i=1}^{p} a_i P_{t-1} + \varepsilon_t$ with $\varepsilon_t \sim N(0, \sigma_t^2)$

the ARCH (p) model (Engle, 1982) assumes that : $\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2$

while the GARCH (p,q) model () assumes that: $\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2$

In that approach, the volatility is given by conditional standard deviations[35].

Useful links

FAOSTAT provides useful food price indices that can be complemented by national data. The volatility of these indices can be used as metrics.

The Food security portal provides estimates of world price volatility for selected commodities using a sophisticated (nonparametric) model. It shows periods of low and high volatility in a rigorous manner.

[35]Instead of using ARCH/GARCH type models, one can also adopt a nonparametric approach to studying price variation and volatility (Martins-Filho, Torero and Yao, 2010). See the Food security portal for an application to world prices and how to distinguish between periods of high and low volatility.

iii. Uses of gravity models for trade analysis

Gravity models have now become a standard tool in international trade since the work of Anderson (1979) building on the seminal approach of Tinbergen (1962). They are now among the most successful empirical models in economics and can be used to assess different trade issues such as customs unions, border effects (McCallum 1995; Anderson and Van Wincoop, 2003), evaluating missing trade (Villoria, 2008) or the tariff equivalent of non-tariff barriers (Head and Ries, 2001; Jacks et al., 2008).

The model

The gravity approach assumes that bilateral trade flows between two countries can be approximated by a "gravity equation" in a way similar to the Newtonian theory of gravitation. As planets are mutually attracted in proportion to their sizes and proximity, it is assumed that countries trade in proportion to their respective GDPs and proximity (distance). Anderson and van Wincoop (2003) proposed a convincing microeconomic foundation for structural gravity models by especially emphasizing the importance of price endogeneity issues (multilateral resistance), an element neglected in previous atheoretical gravity models. The theoretical model, which is now accepted as the best starting point, assumes N countries and a variety of goods differentiated by the country of origin and is formulated as follows:

$$X_{ij} = \frac{Y_i Y_j}{Y_W} \frac{{t_{ij}}^{1-\sigma}}{{P_i}^{1-\sigma} {P_j}^{1-\sigma}} \qquad (1)$$

$$P_i^{1-\sigma} = \sum_{j=1}^{N} \frac{Y_j \, {t_{ij}}^{1-\sigma}}{Y_W \, {P_j}^{1-\sigma}} \qquad (2)$$

Where X_{ij} is exports from *i* to *j* ; Y_i, Y_j et Y_W is GDP of *i*, *j* and *w* (*w* stands for World) ; t_{ij} is overall trade costs ; σ is the intra-sectorial elasticity of substitution (between varieties); and P_i and P_j are the multilateral resistance terms. The multilateral resistance terms capture the fact that trade between *i* and *j* depends on trade costs across all possible export and import markets (Anderson and Van Wincoop, 2003). As a consequence, trade between two partners is determined by relative trade barriers (the bilateral barrier between them relative to average trade barriers that both face with all their trading partners).

Estimation methods

In the literature, (1) is commonly estimated in its log-linear form as:

$$\ln x_{ij} = \lambda + (1-\sigma) \ln t_{ij} + \eta_i + \zeta_j + u_{ij} \qquad (3)$$

where $x_{ij} = \frac{X_{ij} Y_w}{Y_i Y_j}$, η_i, ζ_j are importers and exporters fixed effects, which are approximations of multilateral resistance terms[36]. Commonly, trade costs have the following form:

$$\ln t_{ij} = \rho \ln dist_{ij} + \sum_k \beta_k Z_k \qquad (4)$$

Where $dist_{ij}$ is distance between trading partners, and $Z = (Z_1, Z_2 \ \ldots)$ stand for all other trade cost variables such as tariffs, contiguity, colonial relationship, regional trade agreements, common official language, etc.

[36] "Remoteness variables" can also be computed and used.

Equation (3) can be estimated by the Ordinary Least Squares method (OLS). However, the log linearization procedure raises at least two issues:

- The existence of zero flows in international trade data makes the estimation impossible for these observations. Dealing with these zero trade flows has given rise to many debates in the empirical literature: while truncating the sample or adding a small constant have been questionable, using a selection model à la Heckman seems preferable given that the probability of having positive (nonzero) trade between two countries may be correlated with unobserved characteristics of the countries (Bacchetta et al. 2012).
- In addition to the zero trade flow issue, due to the Jensen Inequality, the interpretation of the coefficients of the log-linearized model can be misleading in the presence of heteroskedasticity (Santos Silva and Tenreyro, 2006). Instead, a Pseudo Poisson Maximum Likelihood (PPML) estimator is used. This estimator also allows the user to circumvent the zero flow problems mentioned above. The estimated model in this context is:

$$x_{ij} = \exp\left[\lambda + (1-\sigma)\ln t_{ij} + \eta_i + \zeta_j\right]\epsilon_{ij} \qquad (5)$$

As mentioned in the introduction, once the model has been estimated, it can be used to evaluate missing trade (Villoria, 2008) or to convert the impact of trade costs in ad valorem tariff equivalents (Head and Ries, 2001; Jacks et al., 2008) and other trade issues.

Data requirements and sources

The estimation of gravity equations requires a lot of data that need to be gathered. In particular, it requires data on bilateral trade, distances, GDPs, tariffs and other determinants of bilateral trade flows. Trade data can be found in the COMTRADE or BACI databases. Other databases exist, but COMTRADE and particularly BACI are the more disaggregated ones. Data on tariffs and non-tariff barriers (NTBs) can be found in TRAINS or in World Bank WITS. GDP data can be found in the World Bank's World Development Indicators or in IMF's International Financial Statistics (IFS).

Useful links

UNCTAD and WTO have published a Practical guide to trade policy analysis (Bacchetta et al. 2012) which contains useful examples of gravity modeling and computer codes to reproduce them.

AGRODEP has published a Technical Note giving several examples of hands-on gravity estimation with Stata.

iv. Tools to measure market integration

The past twenty years have registered a growing literature on market integration, and the 2008 food crisis gave rise to questions on price signal transmission. It is assumed that more integrated markets yield lower price variability and more welfare gains as local markets become protected from idiosyncratic shocks. Surplus areas are then linked to deficit ones (Ravallion, 1997; Sen, 1981).

Market integration involves the free movement of goods and information (prices) in spatially distinct places. However, the literature on testing market integration has focused on prices (e.g. the law of one price) rather than trade flows, particularly in developing countries. This is due to the fact that it is easier to get data on prices at a relatively high frequencies than data on trade flows (Araujo Bonjean and Combes, 2010). The second reason is that markets are places where equilibrium prices are set, once transaction costs have been taken into account (Stigler and Sherwin, 1985). If two marketplaces are integrated, a shock to the price in one market should be transmitted to the other market's price. As a consequence price transmission and comovement of prices tend to be synonymous with market integration (Barrett, 1996).

While price variables are used to test market integration, one important caveat is that it is almost impossible to fully reject market integration, as the hypothesis on integration comes along with many auxiliary ones (background assumptions) such as the nature of transaction costs and the market structure (Araujo, Bonjean and Combes, 2010).

Two methods have been developed to test market integration. The first one is based on descriptive statistics while the second one builds upon econometric models.

Descriptive statistic methods

Early descriptive statistic methods are based on price correlation analysis and go back to Cummings (1967) and Lele (1971). Markets are integrated if there is a strong (significant) correlation between prices. Person's correlation coefficient is a natural candidate for this type of analysis. If P_{it} (P_{jt}) denotes prices for market i (market j), we do not reject market integration if

$\rho = \frac{cov(P_{it},P_{jt})}{\sigma_{P_{it}}\sigma_{P_{jt}}}$ is statistically different from zero. A t-test can be used for that perspective.

For a sample of size T from a joint distribution, the coefficient is given by:

$$\rho = \frac{\sum_{t=1}^{T}(P_{it} - \bar{P}_i)\left(P_{jt} - \bar{P}_j\right)}{\sqrt{\sum_{t=1}^{T}(P_{it} - \bar{P}_i)^2\left(P_{jt} - \bar{P}_j\right)^2}}$$

The t-statistic associated with the test $\rho = 0$ is given by:

$$t = \frac{\rho}{S_\rho} = \frac{\rho}{\sqrt{\frac{1-\rho^2}{n-2}}}.$$

For large samples a normal approximation is possible with $U = \frac{\rho}{\sqrt{\frac{1}{n-1}}} = \rho \cdot \sqrt{n-1}$.

Since Pearson's coefficient assumes a linear relationship between the two variables, when the test is rejected, it should be complemented by a non-parametric test such as the Spearman rank correlation coefficient. Price variables are first converted to ranks $rg_{P_{it}}$ and $rg_{P_{jt}}$ and Spearman's (ρ_S) coefficient is just Pearson's ρ applied to ranks. This yields: $\rho_S = \frac{cov\left(rg_{P_{it}}, rg_{P_{jt}}\right)}{\sigma rg_{P_{it}} \sigma_{rgP_{jt}}}$. A t-test can be used here as well to test the significance of the relationship, which can be non-linear. Spearman's coefficient is also robust to outliers.

Econometric methods

Econometric methods have been widely used to test market integration since the seminal work of Ravallion (1986). Econometric methods allow to circumvent most of the limitations of simple bivariate analysis such as the lags in information that may overestimate segmentation, heteroskedasticity when high frequency data are used, or spurious integration due to common exogenous trends (e.g. inflation).

The general econometric model used to test for market integration builds upon Ravallion (1986):

$$P_{it} = a_0 + \sum_{j=1}^{n} a_{ij} P_{it-j} + \sum_{j=0}^{n} b_{ij} P_{ct-j} + d_i X_{it} + \epsilon_{it} \qquad \text{(E)}$$

Where P_c represents the price in a central market, P_i the price in the ith local market and X a vector of other variables (seasonal dummies, inflation, etc.). It is supposed that prices in the central market are weakly exogenous. If not, they should be instrumented. A Granger causality test can also be used to detect anteriority of price movements (see Granger, 1969).

Following Ravallion (1986), the following hypotheses can be tested:

Market segmentation: central (leader) market prices do not influence the ith market prices: $b_{ij} = 0, j = 0,1, \dots n$

Short run market integration: immediate transmission of price increases in the central market to the ith market and no lagged effects on prices in the future: $b_{i0} = 1, a_{ij} = b_{ij} = 0, j = 1,2, \dots n$

Long run market integration: given by the long run equilibrium of (E): $\sum_{j=1}^{n} a_{ij} + \sum_{j=0}^{n} b_{ij} = 1$

The model (E) can also be transformed into an error correction model, representing a cointegration relationship. The cointegration (stable long run) relationship is interpreted as market integration (Palaskas and Harriss, 1993; Dercon, 1995). Since the Ravallion model and its extensions have an Autoregressive Distributed Lag structure, the ARDL bounds tests approach developed by Pesaran Shin and Smith (2001) is particularly indicated here when testing for cointegration. Once cointegration cannot be rejected, the long run market integration hypothesis of Ravallion (1986) can then be tested.[37]

Two caveats have to be mentioned when testing market integration with cointegration relationships. First, the nature of transaction costs is important. Indeed, when transaction costs are non-stationary, the test is biased towards market segmentation (Barrett, 1996). Second, threshold effects may be present; price adjustments take place only for large changes for which the magnitude exceed transaction costs (Balke and Fomby, 1997; Goodwin and Pigott, 2001).

[37] In 1986, the literature on cointegration had hardly begun.

v. Regional Economy-wide Multi-Market Models for COMESA, ECOWAS, SADC and ECCAS

An economy-wide multi-market (EMM) model is made available for each Regional Economic Community (REC) following the template described in Diao et al. (2007) and Nin-Pratt et al. (2010). EMM is a regional model in the sense that the national economies of all member countries of a REC are modeled individually and solved simultaneously, which allows for the possibility to create a regional market. The EMM model is based on neoclassical microeconomic theory. For tradable goods, domestic producer and consumer prices are functions of exogenous world prices, taking into account exogenous marketing margins. For non-traded good, domestic prices are endogenously determined by national market-clearing conditions, taking into consideration marketing margins on both the production and the consumption sides. EMM is a recursive dynamic model with exogenous growth in income, cultivated area, yields, and rural and urban population. The model is built as a Mixed Complementarity Problem and allows for shifts from non-traded to net import or net export market positions. Apart from optimal levels of domestic supply and demand variables, the EMM model solves for net trade positions of different commodities for individual member countries of the modelled region.

Cross-border trade analytical features

These general features of a standard multimarket model are augmented in the EMM constructed for each REC with a differentiation of national trade outcomes in terms of intra- versus extra-regional trade sources and destinations (see Badiane and Odjo, 2016). Specifically, the net export of any commodity is modelled as an aggregate of two output varieties differentiated according to their market outlets (regional and extra-regional) while assuming imperfect transformability between the two export varieties. Similarly, the net import of any commodity is modelled as a composite of two varieties differentiated by their origins (regional and extra-regional) while assuming imperfect substitutability between the two import varieties. As such the model allows for the analysis of the impacts of changes in production and trading conditions. It is well suited for exploring alternative ways through which individual countries can contribute to achieving the Maputo Declaration target of tripling regional trade by 2025.

Four different scenarios are constructed in the current versions of the different regional EMM models. (Other scenarios may be designed and implemented with the models.) The first is the baseline scenario described above, which assumes a continuation of current trends in cultivated areas, yields and population growth up to 2025. It serves as a reference to evaluate the impact of changes under the remaining three scenarios. The latter scenarios introduce the following three different sets of changes to examine their impacts on regional trade levels: a reduction of 10 percent in the overall cost of trading across the economy; a removal of all cross-border trade barriers, that is a reduction of their tariff equivalent to zero; and an across the board 10 percent increase in yields. These changes are to take place between 2008, the base year, and 2025.

Country coverage by region

COMESA EMM model encompasses: Burundi, Comoros, The Democratic Republic of the Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Libyan Arab Jamahiriya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia and Zimbabwe. Note that Tanzania is also included in this regional EMM but it can be removed for an analysis restricted to COMESA members only.

ECOWAS EMM model includes: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Note that Chad and Mauritania are also included in this model in order to allow for analyses covering member countries of the Permanent Interstates Committee for Drought Control in the Sahel (CILSS), with differentiation

between Sahelian and coastal countries. However, these two countries can be easily removed for analyses strictly limited to the ECOWAS region.

SADC EMM model covers: Angola, Botswana, The Democratic Republic of the Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

ECCAS EMM model (under construction) encompasses: Angola, Burundi, Cameroon, Central African Republic, Chad, Congo, The Democratic Republic of the Congo, Equatorial Guinea, Gabon, Rwanda, and Sao Tome and Principe.

Product coverage

The following 51 products are individually considered in each regional EMM model:

Cereals: Maize, rice, millet, sorghum, wheat, other cereals (grouped).

Roots & Tubers: Cassava, yam, sweet potato, potato, cocoyam.

Oilseeds: Groundnuts, soybeans, oil palm, sesame seed, and other oilseeds (grouped).

Other crops: Pulses, cotton, sugar, cocoa, coffee, tea, tobacco, vegetables, plantain, other fruits (grouped), spices (grouped), nuts.

Livestock: Cattle, chickens, sheep and goats, pigs, other live animals (grouped).

Meats: Cattle meat, chicken meat, sheep and goat meat, pig meat, other meat (grouped).

Other animal products: Milk, eggs, skin.

Fisheries: Sea fish, fresh water fish.

Edible oils: Cottonseed oil, groundnut oil, soybean oil, sesame oil, palm oil, other edible oils (grouped).

Nonagricultural sectors: Traded nonagricultural goods, non-traded nonagricultural goods.

vi. Technical Note on the ECOWAS Simulation Model[38]

The ECOWAS Simulation Model (ECOSIM) is an integrated multi-country computable general equilibrium (CGE) framework developed for the ECOWAS countries. The framework interconnects fifteen single-country models through trade flows and factor mobility. ECOSIM is therefore a useful tool that contributes to assessing the socioeconomic impact of regional integration policies implemented by the ECOWAS Commission and its Member States.

ECOSIM follows the tradition of multi-country CGE models developed to evaluate regional integration policies. Similar models have been developed by, among others, Hinojosa-Ojeda, Lewis and Robinson (1995) for the analysis of the North America Free Trade Agreement (NAFTA) and Robinson and Lewis (1996) to assess the impact of regional trade liberalization in Indonesia. ECOSIM is different from previous multi-country CGE models in three main ways:

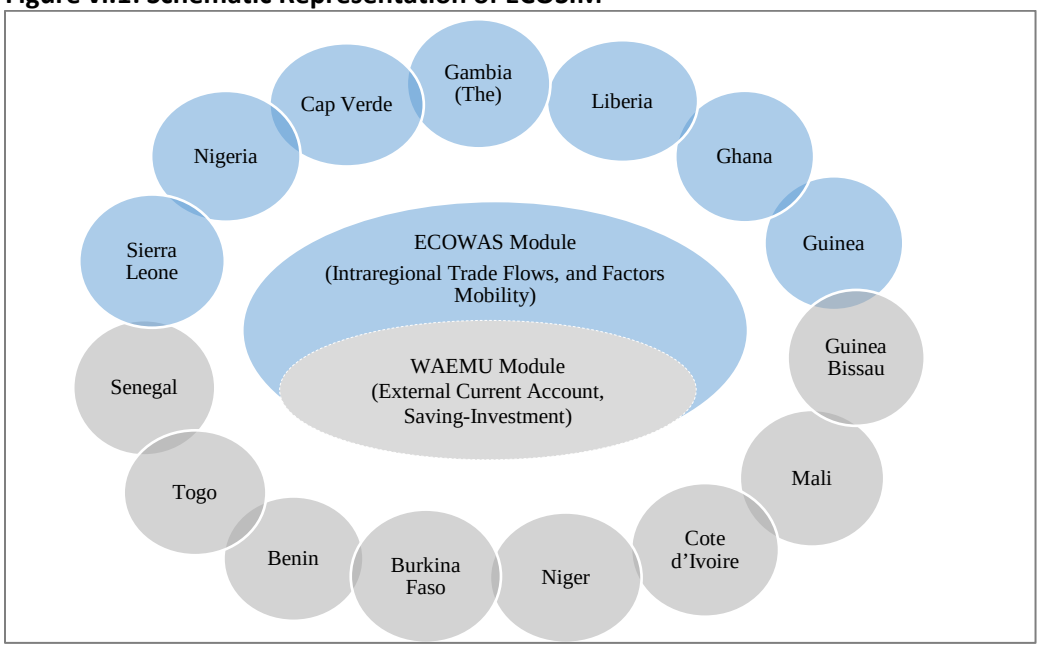
- It integrates two blocks of countries with different degrees of integration: the West African Economic and Monetary Union (WAEMU) formed by eight countries,[39] and the Economic Community of West African States (ECOWAS) grouping fifteen countries, including the eight WAEMU countries. On the one hand, WAEMU member countries have abolished internal tariffs on goods and services (free trade area), adopted a common external tariff (CET) against the rest of the world (customs union), extended the free movement of goods and services to labor and capital (common market), and adopted a single currency and a set of fiscal and monetary rules (economic and monetary union). On the other hand, ECOWAS is a free trade area and has recently adopted a customs union which is an extension of the WAEMU CET.
- An interesting feature of the model, not ordinarily incorporated in multi-country CGE models, is the flexibility of including different level of detail in each economy in terms of number of industries, products, factors and institutions.
- The framework can be converted into fifteen single-country models, i.e. with no interconnection among ECOWAS Member States; it can also consider only a sub-group of ECOWAS countries (e.g. WAEMU countries) in simulating policy changes.

The ECOWAS Simulation Model consists in two building blocks: the country modules which follow the standard single-country CGE archetype; and the regional modules which lay out interactions among single-country models. The fifteen single-country CGE models are grounded in the Walrasian general equilibrium theory. That is, relative prices simultaneously equalize the quantity produced to the quantity demanded in each commodity market as a result of profit and utility maximization behaviors of price-taker producers and consumers, respectively. Country models build equations to capture the behavior of producers and consumers through interactions between three main components of the economy: domestic supply (including external trade), domestic demand (including income generation and savings), and institutional or macroeconomic constraints.

[38] Fofana, Goundan, and Magne used the ECOSIM model to simulate the Impact of ECOWAS rice self-sufficiency policy (Fofana, Goundan, Magne, 2014). Correspondence to I. Fofana: i.fofana@cgiar.org

[39] The West African Economic and Monetary Union (WAEMU) is an organization of eight West African states that share the CFA franc as a common currency.

Figure vi.1: Schematic Representation of ECOSIM



Although country models are the cornerstone of the ECOSIM framework, the latter integrates additional features which are meant to capture the relationships among the fifteen ECOWAS economies, on the one hand, and the eight WAEMU economies, on the other. Regional specificities that apply to the ECOWAS region include the following:

- Multiple trading partners exchange goods and services among themselves through imports and exports; the standard small country assumption does not apply to the regional trading of goods and services, and the openness of countries to regional trade is lower than their openness to trade with the rest of the world due to multiple cross-country barriers.
- Labor mobility is greater within a country than between countries and there is a mismatch between the place of factor employment and payment, and the place of expenditure of factor income.

The WAEMU countries, as well as being member states of ECOWAS, have succeeded in promoting economic integration through the adoption of a common external tariff and customs union, and joint regulatory measures and policies. The following specificities are implemented for the WAEMU member countries:

- One interesting feature of the WAEMU common currency is the pooling of 65 percent of the Member States' reserves and an overdraft facility on the central bank operations account maintained with the French Treasury (Zafar, 2005). This has major implications for the current account constraint of the economies of the Union.
- Domestic savings and investments are less likely to move across countries than within countries, and there is a positive relationship between flows of foreign investment and economic performance.

vii. A short presentation of MIRAGRODEP

MIRAGRODEP is a Computable General Equilibrium (CGE) model based on MIRAGE (Modelling International Relations Under Applied General Equilibrium). This model has already been utilized to study issues related to international trade and trade policy in Africa[40]. It is a recursive dynamic multi-region, multi-sector model. MIRAGE was initially developed at CEPII and devoted to trade policy analysis. As opposed to a single country CGE model, a multi-country CGE model allows for a detailed and consistent representation of economic and trade relations with the rest of the world. International economic linkages are captured through the international trade of goods and foreign direct investment (FDI). The regional and sectoral aggregation of the model can be adapted to fit the modeler's need. A dynamic version of the model is used by solving the model sequentially and moving the equilibrium from one period (year) to another. We assume perfect competition in all sectors, which enables us to have a detailed geographic and sector decomposition. For each country/region, the model includes three domestic agents: households, firms, and the government.

Unlike MIRAGE, in MIRAGRODEP, the government is explicitly modelled as a different agent from the private sector. Government income consists of taxes collected on production, on factors of production, on exports, on imports, on consumption, and on households' income. The government maximizes a Cobb-Douglass utility function: government spending on each commodity is a fixed share, in value, of total public expenditure in goods and services. Government purchases are subject to taxes.

Firms operate under perfect competition in all sectors and minimize their costs subject to the technology constraint. On the production side, the model uses five factors of production (capital, skilled labor, unskilled labor, land, and natural resources). These factors are assumed to be fully employed and grow at exogenous rates. The production function has a nesting structure: at the top level, the model assumes perfect complementarity between value added and total intermediate consumption. At the intermediate level, value added is a CES aggregate of unskilled labor, land, natural resources, and a capital-skilled labor bundle. The latter bundle is a CES function of capital and skilled labor. This allows the modeler to have lower elasticities of substitution (more complementarity) between capital and skilled labor. It is assumed that land is imperfectly immobile across sectors. Installed capital and natural resources are sector-specific, and total intermediate consumption is a combination of intermediate inputs through a CES function.

Households maximize their utility subject to their budget constraints. Their demand is given by a LES-CES (Linear Expenditure System - Constant Elasticity of Substitution) function. With this specification, the evolution of the demand structure of each country/region can be accounted for as its income changes. The elasticity of substitution is constant only among sectoral consumption goods above a minimum level, and this level may vary across countries/regions.

Regarding international trade, MIRAGRODEP is a bilateral trade model consistent with the Armington (1969) assumption. Commodities are assumed to be imperfect substitutes according to their origin. The consumer preference for varieties originating from different regions is reflected by nested CES functions.

[40] Bouët, Deason, and Laborde (2014), in particular, study the potential evolution of international trade in Africa, depending on various trade liberalization scenarios, either regional or multilateral. Bouët, Laborde, and Traoré (2014) evaluate the impact of the EPA between West Africa and the EU, with different model closures and theoretical assumptions.

With this specification, one can observe two-way trade: countries/regions can export and import the same commodity depending on consumers' preferences for different varieties.

MIRAGRODEP includes three important assumptions that will drive its results and that should be taken into account in the simulation process: the external account closure assumption, the government account closure assumption, and the private account closure assumption.

This last assumption concerns the savings-investment closure. We usually adopt the so-called Neo-Classical closure: the marginal propensity to save is constant such that variations in income lead to variations in savings, which lead to variations in investment. Thus, investment is "savings driven."

Regarding the external account closure, we usually assume in the simulations that the current account balance is fixed (in the model, this is expressed as a percent of global GDP). The fixed level of the current account balance is maintained through an adjustment of the real exchange rate that takes place via an adjustment of the nominal exchange rate (devaluation, depreciation) or through different evolutions of domestic prices in the different regions (i.e., competitive disinflation). With this specification, there is no "free lunch"; if a country needs to increase its imports, it will have to increase its exports as well through a depreciation of its real exchange rate. The main advantage of this assumption is that it allows us to conduct a thorough welfare analysis. The alternative assumption (flexible foreign savings) means that the country's consumption, and welfare, are "subsidized" through transfers from the rest of the world (capital inflows). However, our model, similar to the GTAP and Linkage models, does not incorporate international capital flows (reallocation of the capital flows at the global level). Finally, the fixed current account assumption with an adjustment of the real exchange rate is the only consistent assumption in the long run, as only the US has managed to have a recurrent current account deficit due to its privileged position as issuer of the international currency.

The last important assumption is the government or public account closure, which concerns how the public balance is affected when taxes are changed by a reform. We usually assume that each government maintains the public balance constant and also keeps real public expenses per capita constant; after a shock that reduces for example custom duties, a new public tax is levied to offset this loss of public revenues. Therefore, for all the specifications, we do not allow for the so-called "crowding-out effect" of raising public deficits when it is the private sector that will need to finance the public sector.

viii. References

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Annex B.5: Nutrition

Table B.5.1. Summary of the methods, tools and data sources to measure nutrition indicators

Result Area	1.2 food security and nutrition
Performance Target (Malabo Target)	Improve nutritional status, and in particular, the elimination of child under-nutrition in Africa with a view to bringing down stunting to 10% and underweight to 5% by 2025. (IIId)
Performance Indicator	
Indicator	Definition/explanation
1.2.1 Prevalence of undernourishment	The proportion of the population in the country with a level of Dietary Energy Consumption (DEC) lower than the Dietary Energy Requirements (DER). This indicator is used to monitor evolution of hunger over time (at the world, regional and, since 1999, national level, through publication of the State of Food Insecurity). In particular the indicator was used to monitor achievement of the Millennium Development Goal target.
Indicator computing	The prevalence of undernourishment (PoU) indicator is defined as the probability that a randomly selected individual from the reference population is found to consume less than his/her calorie requirement for an active and healthy life. It is written as: $$PoU = \int_{x<MDER} f(x)dx$$ where f(x) is the probability density function of per capita calorie consumption. The parameters needed for the calculation of the indicator are: the mean level of dietary energy consumption (DEC); a cut-off point defined as the Minimum Dietary Energy Requirement (MDER); the coefficient of variation (CV) as a parameter accounting for inequality in food consumption; and a skewness (SK) parameter accounting for asymmetry in the distribution. The DEC as well as the MDER are updated annually, with the former calculated from the FAO Food Balance Sheets. The MDER is calculated as a weighted average of energy requirements according to sex and age class, and is updated each year from UN population ratio data. The inequality in food consumption parameters are derived from national household survey data when such data is available and reliable. Due to the limited number of available household surveys, the inequality in food access parameters are updated much less frequently over time than the DEC and MDER parameters. Source: Refinements to the FAO Methodology for Estimating the Prevalence of Undernourishment Indicator ESS Working Paper No. 14-05, September 2014 http://www.fao.org/3/a-i4046e.pdf

Table B.5.1. Summary of the methods, tools and data sources to measure nutrition indicators (cont.)

Result Area	1.2 food security and nutrition			
Performance Target (Malabo Target)	Improve nutritional status, and in particular, the elimination of child under-nutrition in Africa with a view to bringing down stunting to 10% and underweight to 5% by 2025. (IIId)			
Performance Indicator				
Indicator	Definition/explanation			
1.2.2 Prevalence of underweight (% of children under 5 years old)	Underweight is a weight-for-age measurement. Underweight is a reflection of acute and/or chronic undernutrition. This indicator measures the percent of children 0-59 months who are underweight, as defined by a weight-for-age Z score < -2. Although different levels of severity of underweight can be measured, this indicator measures the prevalence of all underweight, i.e. both moderate and severe underweight combined. Based on the WHO Anthro tool: http://www.who.int/growthref/tools/who_anthroplus_manual.pdf			
Disaggregation				
Parameter	Definition	Data required	Computing methods	Possible source
Percent of children 0-59 months of age in the sample that are underweight (**Uw**)	Percent of children 0-59 months of age in the sample with a weight-for-age Z-score of < -2 SD	Total number of children 0-59 months of age in the sample (**T**) Number of children 0-59 months of age in the sample that are underweight (**U**)	**Uw** = **U**/**T***100	WHO, UNICEF
Percent of male children 0-59 months of age in the sample that are underweight ($\mathbf{Uw_m}$)	Percent of male children 0-59 months of age in the sample with a weight-for-age Z-score of < -2 SD	Total number of male children 0-59 months of age in the sample ($\mathbf{T_m}$) Number of male children 0-59 months of age in the sample that are underweight ($\mathbf{U_m}$)	$\mathbf{Uw_m}$ = $\mathbf{U_m}/\mathbf{T_m}$*100	WHO, UNICEF
Percent of female children 0-59 months of age in the sample that are underweight ($\mathbf{Uw_f}$)	Percent of female children 0-59 months of age in the sample with a weight-for-age Z-score of < -2 SD	Total number of female children 0-59 months of age in the sample ($\mathbf{T_f}$) Number of female children 0-59 months of age in the sample that are underweight ($\mathbf{U_f}$)	$\mathbf{Uw_f}$ = $\mathbf{U_f}/\mathbf{T_f}$*100	WHO, UNICEF
Indicator computing	The numerator for this indicator is the total number of children 0-59 months in the sample with a weight-for-age Z score < -2. The denominator is the total number of children 0-59 months in the sample with weight-for-age Z score data.			

Table B.5.1. Summary of the methods, tools and data sources to measure nutrition indicators (cont.)

Result Area	1.2 food security and nutrition			
Performance Target (Malabo Target)	Improve nutritional status, and in particular, the elimination of child under-nutrition in Africa with a view to bringing down stunting to 10% and underweight to 5% by 2025. (IIId)			
Performance Indicator				
Indicator	Definition/explanation			
1.2.3 Prevalence of stunting (% of children under 5 years old)	Stunting is a height-for-age measurement that is a reflection of chronic undernutrition. It measures the percent of children 0-59 months who are stunted, as defined by a height-for-age Z score < -2. Although different levels of severity of stunting can be measured, this indicator measures the prevalence of all stunting, i.e. both moderate and severe stunting combined. While stunting is difficult to measure in children 0-6 months and most stunting occurs in the -9-23 month range (1,000 days), this indicator reports on all children under 59 months to capture the impact of interventions over time and to align with DHS data. Based on the WHO Anthro tool.			
Disaggregation				
Parameter	Definition	Data required	Computing methods	Possible source
Percent of children 0-59 months of age in the sample that are stunted (**St**)	Percent of children 0-59 months of age in the sample with a height-for-age Z-score of < -2 SD	Total number of children 0-59 months of age in the sample (**T**) Number of children 0-59 months of age in the sample that are stunted (**S**)	**St** = **S**/**T***100	WHO, UNICEF
Percent of male children 0-59 months of age in the sample that are stunted ($\mathbf{H_m}$)	Percent of male children 0-59 months of age in the sample with a height-for-age Z-score of < -2SD	Total number of male children 0-59 months of age in the sample ($\mathbf{T_m}$) Number of male children 0-59 months of age in the sample that are stunted ($\mathbf{S_m}$)	$\mathbf{St_m} = \mathbf{S_m}/\mathbf{T_m}*100$	WHO, UNICEF
Percent of female children 0-59 months of age in the sample that are stunted ($\mathbf{H_w}$)	Percent of female children 0-59 months of age in the sample with a height-for-age Z-score of < -2 SD	Total number of male children 0-59 months of age in the sample ($\mathbf{T_f}$) Number of male children 0-59 months of age in the sample that are stunted ($\mathbf{S_f}$)	$\mathbf{St_f} = \mathbf{S_f}/\mathbf{T_f}*100$	WHO, UNICEF
Indicator computing	The numerator for this indicator is the total number of children 0-59 months in the sample with a height-for-age Z score < -2. The denominator is the total number of children 0-59 months in the sample with height-for-age Z score data. Based on the WHO Anthro tool.			

Table B.5.1. Summary of the methods, tools and data sources to measure nutrition indicators (cont.)

Result Area	1.2 food security and nutrition			
Performance Target (Malabo Target)	Improve nutritional status, and in particular, the elimination of child under-nutrition in Africa with a view to bringing down stunting to 10% and underweight to 5% by 2025. (IIId)			
Performance Indicator				
Indicator	Definition/explanation			
1.2.4 Prevalence of wasting (% of children under 5 years old)	This indicator measures the percent of children 0-59 months who are acutely malnourished, as defined by a weight-for-height Z score < -2. Although different levels of severity of wasting can be measured, this indicator measures the prevalence of all wasting, i.e. both moderate and severe wasting combined. Based on the WHO Anthro tool.			
Disaggregation				
Parameter	Definition	Data required	Computing methods	Possible source
Percent of children 0-59 months of age in the sample that are wasted	Percent of children 0-59 months of age in the sample with a weight-for-height Z-score of < -2 SD	Total number of children 0-59 months of age in the sample (**T**) Number of children 0-59 months of age in the sample that are stunted (**W**)	**Wa** = **W**/**T***100	WHO, UNICEF
Percent of male children 0-59 months of age in the sample that are wasted	Percent of male children 0-59 months of age in the sample with a weight-for-height Z-score of < -2 SD	Total number of male children 0-59 months of age in the sample ($\mathbf{T_m}$) Number of male children 0-59 months of age in the sample that are stunted ($\mathbf{W_m}$)	$\mathbf{Wa_m} = \mathbf{W_m}/\mathbf{T_m}$*100	WHO, UNICEF
Percent of female children 0-59 months of age in the sample that are wasted	Percent of female children 0-59 months of age in the sample with a weight-for-height Z-score of < -2 SD	Total number of male children 0-59 months of age in the sample ($\mathbf{T_f}$) Number of male children 0-59 months of age in the sample that are stunted ($\mathbf{W_f}$)	$\mathbf{Wa_f} = \mathbf{W_f}/\mathbf{T_f}$*100	WHO, UNICEF
Indicator computing	The numerator for the indicator is the total number of children 0-59 months in the sample with a weight-for-height Z score < -2. The denominator is the total number of children 0-59 months in the sample with weight-for-height Z score data. Based on the WHO Anthro tool.			

Table B.5.1. Summary of the methods, tools and data sources to measure nutrition indicators (cont.)

Result Area	1.2 Food Security and Nutrition			
Performance Target (Malabo Target)	Improve nutritional status, and in particular, the elimination of child under-nutrition in Africa with a view to bringing down stunting to 10% and underweight to 5% by 2025. (IIId) The pursuit of agriculture-led growth as a main strategy to achieve targets on food security and nutrition and shared prosperity.			
Performance indicator				
Indicator	Definition/explanation			
Percent of women 15-49 years old who consumed a Minimum Dietary Diversity (MDD-W) in the previous 24 hours	Percent of women of child bearing age (15-49 years) in the survey sample who consumed the MDD-W. The indicator reflects the proportion attaining a minimum dietary diversity, an indication of diet quality and a proxy indicator for micronutrient adequacy. The indicator is useful to reflect if agricultural programmes in place are influencing dietary patterns towards better nutrition status and thus useful for linking nutrition outcomes to the CAADP process.			
Disaggregation				
Indicator	Definition	Data required	Computing methods	Possible source
Percent of women of child bearing age (15-49 years) who consumed food from at least 5 food groups	The minimum dietary diversity required to meet adequate nutrition is consumption of food from at least 5 food groups from the given 10 food groups as defined by FAO. At least 15g must be consumed for the group to count. The groups are 1. All starchy staple foods 2. Beans and peas 3. Nuts and seeds 4. Dairy 5. Flesh foods 6. Eggs 7. Vitamin A-rich dark green leafy vegetables 8. Vitamin A-rich vegetables and fruits 9. Other vegetables 10. Other fruits	Total number of possible groups =10 Total number of women (15-49 years) in the sample whose MDD-W was determined for the previous 24hrs (T) Number of women (15-49 years) in the sample who consumed at least 5 food groups (X_{MDD-W}) in the previous 24 hours	(X_{MDD-W} / T) * 100	USAID FAO To be determined within CAADP nutrition process

Table B.5.1. Summary of the methods, tools and data sources to measure nutrition indicators (cont.)

Result Area	1.2 Food Security and Nutrition			
Performance Target (Malabo Target)	Improve nutritional status, and in particular, the elimination of child under-nutrition in Africa with a view to bringing down stunting to 10% and underweight to 5% by 2025. (IIId) The pursuit of agriculture-led growth as a main strategy to achieve targets on food security and nutrition and shared prosperity.			
Performance indicator				
Indicator	**Definition/explanation**			
Percent of children 6-23 months old who consumed the Minimum Acceptable Diet	Percent in the age group 6-23 months consuming the minimum acceptable diet (MAD). This age group is critical to reducing stunting in the first 1000 days. The indicator will serve as a process indicator of improvements in diet quality and feeding practices towards better nutrition. Because its computation includes dietary diversity and meal frequency in the age group, it will be possible to use it to link agriculture programmes to observed changes in feeding practices and nutrition status indicators; where relevant, negative impacts on these variables may need to be mitigated. This is important because agriculture is a key strategy targeted by the Malabo Declaration for nutrition impact.			
Disaggregation				
Indicator	Definition	Data required	Computing methods	Possible source
Percent children 6-23 months of age consuming a minimum acceptable diet.	The minimum acceptable diet is a composite indicator of feeding practices reflecting both dietary diversity and meal frequency, both of which are necessary for adequate nutrient intake and are prerequisites for optimal nutritional status. Minimum acceptable dietary diversity requires consumption from at least 4 of the following 7 groups in the previous 24 hours: 1. Grains, roots, tubers 2. Legumes and nuts 3. Dairy products (milk, yoghurt, cheese) 4. Flesh foods (meat, fish, poultry and liver/organ meats) 5. Eggs 6. Vitamin A-rich fruits and vegetables 7. Other fruits and vegetables Minimum meal frequency is disaggregated according to age category: - 2 times for breastfed infants 6-8 months (excluding breastmilk feeds) - 3 times for breastfed children 9-23 months - 4 times for non-breastfed children 6-23 months - Meals include meals and snacks - No minimum amount consumed is specified thus any amount consumed counts.	Total number of possible groups=7 Total number in the sample surveyed on food consumption the previous 24 hours of breastfed children (TBF) or non-breastfed children (TNBF) The number consuming from at least 4 food groups in the previous 24 hours, i.e. the minimum dietary diversity (MDD) for breastfed (TBF_{MDD}) and for non-breastfed ($TNBF_{MDD}$) children The numbers consuming the minimum acceptable meal frequencies (MMF) according to age category and whether breastfed (TBF_{MMF}) or not ($TNBF_{MMF}$) The numbers consuming BOTH at least the minimum dietary diversity (MDD) AND at least the minimum meal frequency (MMF) are those with the minimum acceptable diet, for breastfed (BFMAD) and non-breastfed (NBFMAD), respectively.	**For breastfed children** BFMAD = (BFMAD/TBF)*100 **For non-breastfed children** NBFMAD = (NBFMAD/TNBF)*100	UNICEF WHO DHS

Table B.5.2. Additional indicators currently not in the CAADP Results Framework

Indicator	Method/tool	Possible source of data
Women's BMI	WHO standards for calculation based on height and weight measurements	DHS; other national nutrition surveys related to SUN and other initiatives; UNICEF
Under five year old overweight	WHO Anthro	DHS; other national nutrition surveys related to SUN and other initiatives; UNICEF
Agricultural production diversity	New tool/method to be explored	Ulimwengu, Roberts and Randrianmamonjy (2012). Resource-Rich Yet Malnourished: Analysis of the Demand for Food Nutrients in the Democratic Republic of Congo
Contribution of non-staple foods to calorie production, both in amount and monetary value	FAOSTAT	FAO Balance sheets
Micronutrient status: prevalence of iron, zinc, vitamin A deficiency	Standard methods and tools depending on the specific micronutrients.	National micronutrient surveys

Table B.5.3. Proposed biofortification indicators

Indicator	Possible sources	Data collection and notes
Share of [crop] production that is biofortified	Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) (WorldBank), FAOSTAT, Household Consumption and Expenditure Surveys, National Agricultural Sample Surveys (NASS), National agricultural census data, etc.	1. National household surveys (e.g. LSMS-ISA, HCES) which include a line item for biofortified crops in the crop production module. Actual names used to distinguish biofortified crops should be context/country specific to ensure proper identification of biofortified varieties. Countries may consider including a commonly known local name given to the specific biofortified variety. For visible trait vitamin A crops (i.e. vitamin A cassava or maize), crop color may be used to distinguish biofortified varieties from other varieties of the staple crop. For invisible trait crops (iron and zinc), respondent perceptions/subjectivity can be relied on to identify biofortified crop varieties. 2. National agricultural crop production census. Secondary data derived from commercial farmers, market data etc.
Share of dietary energy consumption derived from biofortified crops	FAO food balance sheets; national agricultural statistics	1. National Food Balance Sheets (FAOSTAT) and other household surveys that can estimate intake or consumption (e.g. LSMS-ISA, HCES), which include a line item for biofortified crops in the household food consumption module. Actual names used to distinguish biofortified crops should be context/country specific to ensure proper identification of biofortified varieties. Countries may consider including a commonly known local name given to specific biofortified variety. For visible trait vitamin A crops (i.e. vitamin A cassava or maize), crop color may be used to distinguish biofortified varieties from other varieties of the staple crop. For invisible trait crops (iron and zinc), respondent perceptions/subjectivity can be relied on to identify biofortified crop varieties. 2. Consumption data are combined with food composition data that provide the amount of energy (kcal) per 100 g of edible portion of food.
Percent of people consuming biofortified foods	Demographic and Health Surveys (DHS); UNICEF, MICS	--Indicator should be disaggregated by population category and target micronutrient. All population groups should have access to biofortified foods, but it is recommended to track consumption among women of childbearing age (15-49 years) and children under five. --Line item to be included for biofortified foods in DHS survey module on groups of food consumed during the previous 24 hours --Data will be collected for target groups within the household but reporting can focus on the population group(s) of interest. The respondent for these surveys is usually the main care provider and the one who prepares meals for children in the household (often the mother). --Actual names used to distinguish biofortified foods should be context/country specific to ensure proper identification of food made with biofortified varieties of crops. Countries may consider including a commonly known local name given to food made with a specific biofortified variety. For visible trait vitamin A crops (i.e. vitamin A cassava or maize), food color may be used to distinguish biofortified foods from other food made with the staple crop. For invisible trait crops (iron and zinc), respondent perceptions/subjectivity can be relied on to identify biofortified crop varieties.

Table B.5.3. Proposed biofortification indicators (cont.)

Percent of released crop varieties that are biofortified	Government agencies (Ministry of Agriculture) and NARS; Other national institutions (such as universities) that release crop varieties (may include private seed companies)	--National records (secondary data) --Records from private seed companies and other institutions that release crop varieties
Percent of breeding lines that are biofortified	NARS; international crop research/breeding centers (e.g. IITA, CIMMYT, CIAT, CIP, ICRISAT, IRRI etc.), private seed companies (especially for hybrid crops)	--National records (secondary data) --Records from international and national research/breeding centers --Records from private seed companies

Annex B.6: Gender

Introduction to the Women's Empowerment in Agriculture Index (WEAI)

The fifth Sustainable Development Goal on gender has as its objective to "Achieve gender equality and empower all women and girls." Gender is relevant to many development outcomes, and it is important to examine how gender issues affect and are affected by conditions and progress under each of the other thematic issues defined in the NAIPs. Empowerment can be defined as the expansion of people's ability to make strategic life choices, particularly in contexts where this ability had been denied them. When thinking about empowerment in agriculture, it is important to consider the ability to make decisions as well as access to the material and social resources needed to carry out those decisions.

The Women's Empowerment in Agriculture Index (WEAI) addresses the gender dimensions of production, welfare, and social engagement of rural households. In particular, it is an index calculated on the basis of data collected on five domains of empowerment (production, resources, income, leadership and time) through the administration of an individual-level survey to adult male and female household members. The resulting gender-disaggregated data can be used to set gender-related goals and targets and institute accountability mechanisms.

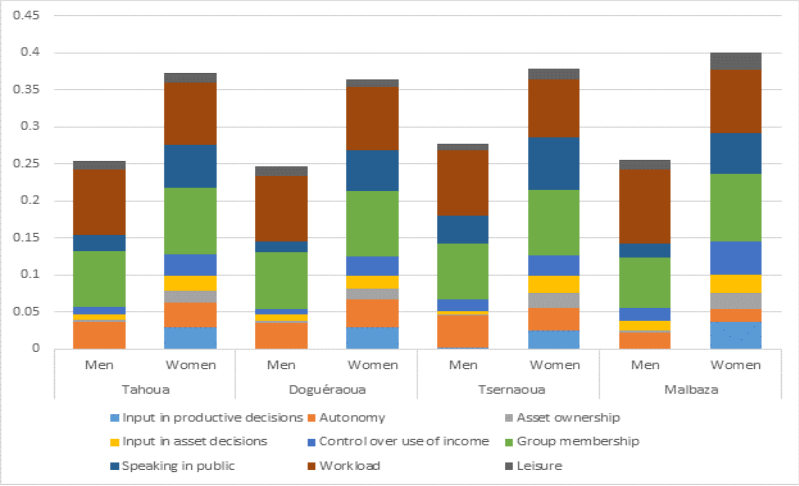
Key questions that can be addressed with the WEAI are:

- What is the status of women's empowerment in agriculture/agribusiness?
- What are important drivers of women's empowerment (production, resources, income, leadership, time), and how do these link to agribusiness?
- How strong is the link between gender empowerment and productivity, poverty or nutrition outcomes? What are the potential costs and benefits of not doing anything?

An example for the WEAI in Niger

Data were collected by IFPRI during April–May 2015 for 500 randomly sampled households (and 769 adult individuals in these households) in 35 villages situated in three communes (Doguéraoua, Malbaza, and Tsernaoua) in the Maggia valley of the Birni N'Konni department in the Tahoua region of Niger. Individual-level data were collected using the Women's Empowerment in Agriculture Index (WEAI) survey tool and household-level data were collected using a standard agricultural household survey. Figure 1 shows overall disempowerment and the contributions of the various domains.

Figure B.6.1: WEAI findings from Niger



Empowerment and agricultural productivity

Wouterse, F. 2016. Empowerment and Agricultural Production Evidence from Rural Households in Niger. IFPRI Discussion Paper 01509. Washington DC: IFPRI

http://ebrary.ifpri.org/cdm/singleitem/collection/p15738coll2/id/130167

Empowerment and nutrition

Sraboni, E., H. Malapit, A. Quisumbing, and A. Ahmed. 2014. Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh? *World Development* 61: 11–52.

http://www.sciencedirect.com/science/article/pii/S0305750X14000989

Description of the tool

The Women's Empowerment in Agriculture Index is an innovative tool composed of two sub-indexes: one measures the five domains of empowerment for women (5DE), and the other measures gender parity in empowerment (GPI) within the household. It is an aggregate index reported at the country or regional level that is based on individual-level data on men and women within the same households.

Five domains of empowerment (5DE): This sub-index assesses whether women are empowered across the five domains examined in the WEAI (see Figure 1 for an illustration). For the women who are disempowered, it also shows the percentage of domains in which they meet the required threshold and thus experience "sufficiency." The 5DE sub-index captures women's empowerment within their households and communities.

Gender Parity Index (GPI): This sub-index reflects the percentage of women who are as empowered as the men in their households. For those households that have not achieved gender parity, the GPI sub-index shows the gap that needs to be closed for women to reach the same level of empowerment as men. Using a survey method that goes beyond the traditional practice of interviewing only a household "head" (often a male) to interview both a principal male and a principal female, the GPI allows for a comparison of the agricultural empowerment of men and women living in the same household.

Based on both sub-indexes, the WEAI is thus an aggregate index that shows the degree to which women are empowered in their households and communities and the degree of inequality between women and men within the household. Computation details are as follows: Measuring the 5DE results in a number ranging to from zero to unity, where higher values indicate greater empowerment. The score has two components. First, it reflects the percentage of women who are empowered (H_e). Second, it reflects the percentage of domains in which those women who are not yet empowered (H_n) already have adequate achievements. In the 5DE formula, A_a is the percentage of dimensions in which disempowered women have adequate achievements: $5DE = H_e + H_n(A_a)$, where $H_e + H_n = 100\%$ and $0 < A_a < 100\%$. Table B.6.1 shows the various computations for the Niger data.

Table B.6.1 Weighted inadequacy scores for Niger

Indices	Women	Men
Disempowered headcount (H)	0.835	0.503
Empowered headcount (1-H)	0.165	0.497
Average inadequacy score (A)	0.410	0.338
Average adequacy score (1-A)	0.590	0.662
Disempowerment index (M0=H x A)	0.342	0.170
5DE index (1-M0)	0.658	0.830
Number of observations used	262	158
Total observations	401	357
% of data used	39	73
% of women without gender parity (H_{GPI})	81.8	
% of women with gender parity (1-H_{GPI})	18.2	
Average empowerment gap (I_{GPI})	31.5	
GPI (1- H_{GPI}x I_{GPI})	74.2	
Number of observations used	128	
Total number of dual households	64	
% of data used	0.168	
WEAI (0.9 x 5DE + 0.1 x GPI)	0.666	

Table B.6.1 shows that the women's disempowerment index (M0) is 83.5 percent × 41 percent = 0.342 and 5DE is 1 – 0.835 = 16.5 percent + (83.5 percent × [1 – 41 percent]) = 0.658. In the Tahoua region of Niger, 50 percent of men are not yet empowered, and the average inadequacy score among these men is 34 percent. So the men's disempowerment index (M0) is 50.3 percent × 33.8 percent = 0.170, and men's 5DE is 1 – 0.170 = 0.830. The second subindex (the Gender Parity Index [GPI]) measures gender parity within surveyed households. Table B.6.1 shows that 18.2 percent of women are equally empowered as the men in their households. For those 81.8 percent of households that have not achieved gender parity, GPI shows that empowerment gap that needs to be closed for women to reach the same level of empowerment as men, is quite large at 31.5 percent. Thus the overall GPI in the Tahoua region of Niger is 74.2 percent.

Accessing the WEAI

A WEAI resource centre exists and can be accessed through:
http://www.ifpri.org/topic/weai-resource-center
The following link leads to the instructional guide:
http://www.ifpri.org/file/45658/download
Data to construct the WEAI are obtained through the administration of an individual level-survey to adult male and female household members. The survey is available at:
http://www.ifpri.org/file/45617/download
Although the recommendation is to collect the full WEAI, the website provides the survey for the abbreviated WEAI at:
http://www.ifpri.org/file/64493/download
Following data collection and transfer of data to STATA, data are cleaned and organized and the index and its components are computed using pre-existing STATA do-files available through the resource center on
http://www.ophi.org.uk/wp-content/uploads/WEAI-dataprep.do
http://www.ophi.org.uk/wp-content/uploads/Calculating-the-WEAI.do

Annex B.7 CSA Analysis Tools for the NAIP Toolbox: Synthesis Notes

i. CELL5M: A geospatial database of agricultural indicators for Africa South of the Sahara on 10 km grids

What is it?

CELL5M is a geospatial database of harmonized multidisciplinary agricultural indicators for Africa South of the Sahara on 10 km grids. CELL5M includes biophysical and socioeconomic indicators covering four broad research domains: food production, agro-ecology, demographics, and market accessibility. CELL5M currently consists of over 750 data layers, providing a unique platform for multi-faceted analysis and fine-grain visualization at the nexus of agriculture and economic development.

What is this for?

The database serves as the core to a decision-support system enabling development practitioners and analysts to explore complex relationships between major agro-ecological challenges (e.g., soil and land degradation) and socioeconomic trends (e.g., poverty, health, and nutrition).

Relevance to the NAIP appraisal

CELL5M can provide spatially-disaggregated baseline information of multi-disciplinary indicators for the analytical tools.

How was it developed?

All indicators are referenced to a uniform GIS grid: a flat table populated by over 300,000 grid cells overlaying SSA at 5 arc-minute spatial resolution. Each grid cell (or pixel) is about 100 (10 km x 10 km) square kilometers at the equator and holds a stack of georeferenced data layers. The structure of CELL5M allows for simplified numerical aggregations of gridded data along specific geographic domains, either sub-nationally (e.g., across administrative boundaries, agro-ecological zones or watersheds) or across country borders for regional analyses — all readily possible without GIS software. CELL5M indicators originate from a variety of sources and partnerships, including CGIAR, World Bank, and FAO. Raw datasets are provided in multiple spatio-temporal resolutions, geographical extents, and formats (e.g., tabular, vector and raster). They undergo harmonization routines that aim to generate standardized, cross-regional comparable statistics at uniform scale. Raster datasets of finer resolution are aggregated using weights (e.g., land or population weights) or summarized (e.g., population headcounts). Conversely, coarser datasets, such as most socioeconomic datasets represented at administrative units, are disaggregated. Where applicable, care is taken to ensure that country totals within the disaggregated data in CELL5M are consistent with official national statistics. To maximize coverage across SSA, missing data are imputed using coarser statistics and prior information. The result is a stack of harmonized, interoperable datasets based on a standardized grid system.

Examples of uses

As of this writing (May 2016), CELL5M datasets were found in over 100 studies published from various institutions globally. Recent examples range from using CELL5M as a data framework (e.g., Kwon et al., 2016) to using it to define and characterize study areas (e.g., van Wart et al., 2013), to estimate travel times (e.g., Damania et al., 2016), to explore crop production geography changes (e.g., Beddow and Pardey, 2015), to estimate local agricultural commodity prices (e.g., Fjelde, 2015), to map the threat of potential plant diseases (e.g., Kriticos et al., 2015), and to model climate change adaptations in agriculture (e.g., Robinson et al., 2015). Beyond the published studies, CELL5M datasets have also been widely used

to develop training on GIS in academic institutions (e.g., Deshazor, 2014), research grant proposals, and institution-wide strategies.

Where to access?

Users can visualize CELL5M indicators through HarvestChoice tools, such as Mappr (http://harvestchoice.org/mappr) and Tablr (http://harvestchoice.org/tablr), or download them directly from HarvestChoice Dataverse (http://dx.doi.org/10.7910/DVN/G4TBLF). CELL5M complies with the Data Packages open-data standards by the Open Knowledge Foundation (http://data.okfn.org/doc/data-package).

ii. Climate Projection Data Visualization Tool

What is it?

Climate change data is essential for countries to understand what types of climate shifts are being projected from General Circulation Models (GCM). Many of such data from the climate research community are publicly available, but they are provided in scientific formats in large volumes that require advanced data analysis skills and software to analyze. This tool provides an easy interface to interact with the climate projection data on a monthly basis, aggregated at the 2nd administrative level.

What is this for?

Agricultural policy analysts and practitioners with no advanced skills can easily visualize and download the climate change data and enhance their understanding on the extent of changing climates projected in climate science.

Relevance to the NAIP appraisal

This tool will provide basic contextual information to understand how agro-climatic conditions will change up to 2025 (e.g., shifting cropping seasons, increased rainfall variability, and rising temperature) and help guide the development of climate-smart investment plans accordingly.

How was it developed?

The tool was developed in collaboration with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Underlying climate change datasets for five climate models were derived from the IPCC-CMIP5 (Intergovernmental Panel on Climate Change – Coupled Model Intercomparison Project phase 5) with the RCP (Representative Concentration Pathways) 8.5 scenario. Data were overlaid with 2nd level administrative boundary data and aggregated to a tabular format, which was then imported to Tableau software to develop an online data visualization.

Examples of uses

A customized tool was developed for Tanzania and used in the CSA Technical Workshop.

Where to access?

The customized tool for Tanzania is accessible at the Platform for Agricultural Policy Analysis and Coordination (PAPAC) Knowledge Base at http://papac.info/knowledgebase/climate-projection-data-for-tanzania-2050-monthly-district. For further development in new countries, contact Evan Givertz (e.girvetz@cgiar.org) for the underlying data and Jawoo Koo (j.koo@cgiar.org) for the interactive data visualization tool.

iii. Rapid Yield Gap Assessment Method

What is it?

This method uses spatially-explicit, disaggregated crop production data from HarvestChoice and FAO to estimate the gap between actual and potential yields.

What is this for?

This method can provide estimates of the current level of yield gaps of crops for any geography, fixed (e.g., administrative units such as country or district) or flexible (e.g., agro-ecological zones or Zone of Influences), using the grid-based underlying datasets at the spatial resolution of 10 km.

Relevance to the NAIP appraisal

This method can contextualize the NAIP's crop productivity goals by quantifying the current level of yield gaps across space and provide a benchmark for prioritizing investment options for each crop.

How was it developed?

This method uses two input datasets: HarvestChoice's SPAM (Spatial Production Allocation Model), a spatially-disaggregated crop production statistics database (You, Wood, Wood-Sichra, and Wu, 2014), and FAO's Global Agro-Ecological Zones database (GAEZ; http://gaez.fao.org). The yield gap was defined as the percentage difference between the actual yield estimated from SPAM and the potential yield retrieved from GAEZ, both at the 10 km pixel level. When the geography of interest is larger than pixel-level (e.g., country-level), the actual and potential yield data are first aggregated to the target geography before the difference is taken. Depending on the scope of the question, the attainable potential yield gap can be further discounted and broken down when the complete closure of the yield gap is not deemed economically sensible.

Examples of uses

In January 2016, the HarvestChoice team used the method to assess yield gaps for nine priority commodities of the African Development Bank and reported the aggregated yield gaps at two levels across the African continent: 1) agro-ecological zones and 2) agro-ecological zones by country. Data and analysis results are publicly available on the IFPRI Dataverse at http://dx.doi.org/10.7910/DVN/U03ZET.

Where to access?

HarvestChoice's SPAM database is downloadable from the IFPRI Dataverse at http://dx.doi.org/10.7910/DVN/DHXBJX and the dedicated SPAM website at http://mapspam.info. FAO's GAEZ database can be downloaded from http://gaez.fao.org.

iv. Toucan: Grid-based crop modeling framework

What it is?

HarvestChoice's grid-based crop modeling framework, Toucan, uses the DSSAT Cropping System Model to simulate crop growth and yields on 5 arc-minute (10 km) grids over the Africa South of the Sahara (SSA) region and 30 arc-minute (60 km) grids globally.

What is this for?

The framework integrates HarvestChoice's multidisciplinary geospatial data layers (e.g., weather/climate, soil properties, market accessibility, use of agricultural inputs, baseline varieties) to simulate crop productivity changes under various what-if scenarios of changes in agroecological conditions and farmers' management practices.

Relevance to the NAIP appraisal

This modeling framework can estimate the potential biophysical impacts of interventions on the farmers' management practices interacting with climate change scenarios. Daily weather data used in the simulation can generate temporally disaggregated crop productivity data for the yield and climate variability and investment risk assessment.

Framework functionalities

The DSSAT includes models of 28 crops, but the degree of model validation varies widely amongst the models. To date, Toucan has been primarily used to model the following crops: maize, rice, wheat, soybean, sorghum, millet, groundnut, cowpea, and cassava. Toucan has been used to simulate cropping systems in SSA on 5 arc-minute grids (10 km) and globally on 30 arc-minute grids (60 km). Most simulations are being done on crop-specifically defined area extents using SPAM2005 (spatially-disaggregated sub-national production statistics; http://mapspam.info), but it is feasible to cover all land areas, as long as soil profile data exists. DSSAT allows users to simulate the following management practices: inorganic fertilizer application, organic amendment (manure/residue), supplementary irrigation, residue management, tillage, and crop rotation. The following additional agricultural technologies were implemented in the DSSAT framework to show the potential food security impact of climate-smart agriculture practices: alternate wetting and drying (rice only), no-till/reduced tillage, drought tolerance, heat tolerance, integrated soil fertility management, urea deep placement (rice only), nitrogen-use efficiency, precision agriculture, sprinkler irrigation, drip irrigation, and water harvesting technology.

Examples of uses

HarvestChoice's modeling capacity has also supported ex-ante impact assessments of climate change (Nelson et al., 2009), agricultural technologies (Rosegrant et al., 2014), and climate variability associated with regional drought (Cervigni and Morris, 2016); these assessments have been used in technical consultations with various stakeholders. For example, last year the team developed a series of modeling analyses for the prioritization of CSA practices and climate change scenarios for Tanzania and presented them to stakeholders in the government's Ministry of Agriculture at the country SAKSS-organized workshop in Dar es Salaam (see http://papac.info/knowledgebase/technical-workshop-on-climate-smart-agriculture-new-tools-and-technologies-in-tanzania-sep-2015).

Where to access?

The DSSAT model can be freely downloaded from the DSSAT Foundation website at http://dssat.net. Toucan's underlying datasets can be retrieved from the HarvestChoice CELL5M database publicly available at http://dx.doi.org/10.7910/DVN/G4TBLF. The Toucan framework is being operated within IFPRI's Linux cluster (80 CPUs); contact Jawoo Koo (j.koo@cgiar.org) for further information about access.

v. Dynamic Research Evaluation for Management

What is it?

DREAM (Dynamic Research Evaluation for Management) is a menu-driven software package for evaluating the economic impacts of agricultural research and development (R&D). Users can simulate a range of market, technology adoption, research spillover, and trade policy scenarios based on a flexible, multi-market, partial equilibrium model.

What is this for?

With DREAM the user can define a range of technology investment, development, and adoption scenarios and save them in an integrated database. Scenarios are described using market, R&D, and adoption information for any number of separate "regions." Some factors, such as taxes, subsidies, growth rates, and price elasticities, can be specified as constant or as changing over the analysis period. Each region in which production takes place may have its own pattern of technology adoption. After specifying the initial conditions for each region, the user can simulate the likely effects of technology development and adoption on price; on quantities produced, consumed, and traded; and on the flow of economic benefits to producers, consumers, and government (if taxes or subsidies are specified).

Relevance to the NAIP appraisal

Ex-ante impact assessments using DREAM can help in selecting priority value chains and assessing tradeoffs amongst technology investment options for the country-level targets.

Model functionalities

DREAM handles simple to relatively complex evaluation problems using a standardized interface. A number of market assumptions are possible: small open economy, closed economy, vertically integrated farm and post-harvest sectors in a single economy, or multiple trading regions. The software also accommodates technology-driven shifts in supply or demand, and users may specify constant or variable shift effects over time in farmers' fields. Importantly, DREAM's multiple region specification can simulate various technology "spillover" scenarios wherein a technology may be adopted in more than one region. Changes in the pattern of technology spillovers can significantly alter the size and distribution of R&D benefits.

Examples of uses

DREAM has been applied to the evaluation of individual projects in a national context as well as to entire commodity sectors at a subcontinental or continental scale. And while it was designed primarily to evaluate options for R&D that is yet to be undertaken (ex-ante assessments), DREAM has also been successfully applied to analyzing the effects of past research (ex-post assessments). DREAM was also used to calculate the size and distribution of the economic benefits from the agricultural research and development activities of the Australian Centre for International Agricultural Research (ACIAR) using a range of market model options (http://aciar.gov.au/article/methodology-quantifying-impacts). The model has been used in a wide range of projects on technology priority setting (e.g. http://www.asareca.org/~asareca/sites/default/files/ASARECA%20%20Strategies_%20IFRI%20REPORT.pdf), on the impact of climate change on agriculture (e.g. https://www.ifpri.org/publication/climate-change-food-security-and-socioeconomic-livelihood-pacific-islands; Rosegrant, Valmonte-Santos, Thomas, You, and Chiang, 2015), and on irrigation potential and investment return (e.g. http://ilssi.tamu.edu, http://www.fao.org/nr/water/projects_agwatermanagement.html; Xie, You, Wielgosz, and Ringler, 2014).

Where to access?

The DREAM model and documentation are freely downloadable from the HarvestChoice website at https://harvestchoice.org/tools/dream-dynamic-research-evaluation-management-31

vi. Pseudo-Panel Analysis

What is it?

Pseudo-panel analysis is an econometric technique that can be used in the absence of real panel data to analyze the effect of a particular policy or intervention on the dynamics of an outcome variable, controlling for possible confounding factors that affect the relationship between the dependent and independent variables in a multivariate regression framework (Verbeek, 2007).

What is this for?

The technique has been developed to analyze how households and individuals dynamically react to shocks, when nationally-representative data on a panel of individuals or households followed over time are unavailable (Collado, 1997). The absence of panel data makes it unfeasible to follow the same individuals over time, but the pseudo-panel technique allows to follow cohorts of individuals, defined as groups of people with fixed membership criteria that can be identified in every cross-sectional wave. Deaton (1985) first introduced the technique by following individuals belonging to the same birth cohort. The method has subsequently been widely used for the study of welfare and poverty dynamics (Dang and Lanjouw, 2013, 2015; Ianchovichina and Dang, 2016), while recent studies have focused their analysis on synthetic panels based on individual probability of experiencing a specific condition, given a set of observable characteristics (Nielsen and Sheffield, 2009; Seawright, 2009).

Relevance to the NAIP appraisal

This method can be used to support planning investments for the Malabo resilience goal as well as other objectives and monitoring the progress towards the goal, especially where long-term household-level panel data are not available.

How does the technique work?

The technique consists of a first stage that estimates the probability of being in a specific condition (e.g. poor, undernourished) as a function of some exogenous factors observable in each year of analysis. Subsequently, the individuals in each survey wave are divided into quintiles according to their predicted probability of experiencing that condition, given their observable characteristics included in the model. Finally, the quintiles within different waves are combined to create a pseudo-panel of individuals belonging to the same propensity score stratum over time. In the second stage, a regression model is estimated capturing the impact of a variation in the exogenous variable on the probability of experiencing a specific condition (e.g. poverty, undernutrition), controlling for pseudo-panel fixed effects, year fixed effects, and time-varying biophysical variables.

Examples of uses

Signorelli S., Azzarri C., Roberts C. (2016). "Malnutrition and Climate Patterns in the ASALs of Kenya: A Resilience Analysis based on a Pseudopanel Dataset," *Technical Report Series, no. 9*, Technical Consortium for Building Resilience in the Horn of Africa, ILRI, IFPRI, USAID.

Where to access?

The cross-sectional data used as pseudo-panel data can be downloaded from the Demographic and Health Survey (DHS) website here: http://dhsprogram.com/data/available-datasets.cfm. The publication can be accessed here: https://www.ifpri.org/publication/malnutrition-and-climate-patterns-asals-kenya-resilience-analysis-based-pseudo-panel.

vii. Ex-Ante Impact Assessment Tools of Technology Potential

What is it?

Ex-ante impact assessment tools of technology potential take the form of case studies to illustrate trade-offs, potential, and constraints to the adoption of seemingly more profitable agricultural systems by smallholder farmers in developing countries.

What is this for?

The tools are used to understand the farm-scale impact of alternative agricultural technologies on performance indicators and assess whether the new technologies are feasible for farmers given their current resources. These case-studies can provide policy guidance that aims to relax farm-scale constraints to improving sustainable agricultural household livelihoods.

Relevance to the NAIP appraisal

Tools in the Bioeconomy Modeling Toolbox can help to prioritize technology investment options, based on their potential merits and tradeoffs, biophysically and economically, at a spatially-disaggregated level.

How do the tools work?

The tools combine process-based crop simulation models and/or agronomic field trials with economic-focused mathematical models. Given the complexity and site-specific nature of agricultural household livelihoods, no generic tool is available; rather methods are designed to match the research questions and study context. Stata, GAMS, and Mathematica are the programs generally used for analyses.

Examples of uses

Examples of questions currently being asked regarding previous studies in Malawi and China:

- Are maize-groundnut rotations in Malawi feasible given current smallholder farmer household labor demographics and the demands of the systems?
- What are the risk (stability, vulnerability, and resilience) implications associated with smallholder farmers in China changing crop management towards a conservation agriculture focus?

Where to access?

Please contact Adam Komarek (a.komarek@cgiar.org) for more information.

viii. Crop Investment Analytics Framework

What is it?

Spatially-explicit, systematic return on investment (ROI) assessment framework for screening and comparing crop-related investment options with a range of specific attributes (e.g., crop species and varieties/traits, target geographies, technologies, time, beneficiary groups, and potential adoption profiles).

What is this for?

This framework provides tools for assessing spatially-explicit biophysical and economic potential of climate-smart and other investment options and helping to prioritize them.

Relevance to the NAIP appraisal?

This framework can assess the potential economic profitability of proposed climate-smart investment options on technology and transportation infrastructure.

How was it developed?

This framework was developed by combining process-based crop simulation models with economic-focused mathematical models and spatial models to estimate transport costs and farm-gate prices of agricultural inputs and outputs. The four main components of the framework are:

1. Grid-based, harmonized multi-disciplinary datasets as a basis for identifying where the investment is most suitable (or least suitable based on the presence of constraints for performance).
2. Simulation-estimated potential crop yield responses to the investment and their probability distribution profiles based on multi-year daily weather sequence data.
3. Spatial modeling of farm-gate prices of inputs (i.e., farmers' investment to adopt the investment) and outputs (i.e., marginal increases in yields), propagated from the prices surveyed at major markets using transportation infrastructure mapping and transport cost modeling.
4. Economic analysis of the profitability of investment options to farmers, based on spatially-explicit value-to-cost ratio analysis and net economic returns.

Examples of uses

This framework was used for AGRA's breadbasket area identification analysis in East and Central Africa (https://www.dropbox.com/s/sqb1s661fprdjl8) and CIMMYT's wheat potential analysis in SSA (https://www.dropbox.com/s/4elwq44fqyus8ta).

Where to access?

Underlying grid-based datasets are available at the HarvestChoice project website (http://harvestchoice.org/data). Contact Jawoo Koo (j.koo@cgiar.org) for more information on the overall framework and analytical tools; contact Zhe Guo (z.guo@cgiar.org) for the spatial modeling of road networks, transportation costs, and farm-gate prices.

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Annex B.8: Mutual Accountability in National and Regional Agricultural Investment Plans

In the 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods (Doc. Assembly/AU/2/XXIII)[41], commitment to mutual accountability to actions and results was one of the seven commitments adopted by African Heads of State and Government (HOSGs). The leaders committed to a systematic regular review process, using the CAADP Results Framework, of the progress made in implementing the provisions of the declaration. They resolved to conduct a biennial agricultural review process that involves tracking, monitoring and reporting on progress in implementing the declaration.

In order to ensure adequate monitoring and evaluation of agriculture sector developments as guided by CAADP, the African Union called for the development of an M&E system, which can be used across the continent for this purpose. In 2010, a continent-wide M&E framework for CAADP was developed by the Regional Strategic Analysis and Knowledge Support System (ReSAKSS), experts from the African Union, NEPAD Planning and Coordination Agency (NPCA), the Forum for Agricultural Research in Africa (FARA), and other organizations (Benin et al., 2010). With this commonly agreed framework, a basic foundation was laid for performance indicators which can be used for mutual accountability and peer review across sub-national units, countries and regions as well as at the continental level. These indicators may be regarded as a minimum set of indicators to which countries can add according to their specific realities and interests when designing performance measurement systems to support country-level agriculture sector reviews. This section is intended to help countries understand mutual accountability in general and agricultural joint sector reviews (JSRs) in particular, how they relate to the NAIP process, and how to conduct an inclusive, technically robust and evidence-based JSR process.

What is mutual accountability?

Mutual accountability is a situation in which governments, donors, the private sector, farmer organizations, civil society and other key stakeholders are all accountable to each other for development results. The Paris Declaration on Aid effectiveness[42] identifies Mutual Accountability for Development Results as one of the principles necessary for development effectiveness. At the country level, development of a framework of joint action and sharing of performance information based on mutually agreed performance criteria is a key condition to ensuring the implementation of a CAADP process that is mutually accountable. The process is guided by key principles, including: (i) a shared vision or agenda among the cooperating parties (e.g. the Malabo Declaration or country CAADP compact); (ii) common objectives and strategies aimed at achieving the vision (e.g. RAIPs and NAIPs, cooperation agreements); (iii) jointly agreed indicators based on mutually agreed performance criteria (e.g. CAADP Results Framework, country M&E system); and (iv) genuine dialogue and debate based on consent, common values and trust (e.g. CAADP Partnership Platform, Summit of HOSGs, country JSR workshop).

To operationalize the commitment to mutual accountability, AUC and NPCA, with support from ReSAKSS, have been supporting African Union member states to strengthen their mutual accountability platforms through agricultural joint sector reviews (JSRs). ReSAKSS developed a JSR concept note in 2013 that

[41] For details on the Malabo declaration, see http://www.au.int/en/sites/default/files/decisions/9661-assembly_au_dec_517_-_545_xxiii_e.pdf

[42] See www.mfdr.org/sourcebook/2-1**Paris**.pdf

provides details on the process of conducting a JSR[43]. In 2014 and 2015, eighteen countries were supported, and the process started in another twelve countries in 2016.

This section is aimed at assisting countries to develop and implement credible and inclusive JSRs.
With no intention to replace the national M&E system, the ***primary purpose of the JSR*** is to determine and evaluate observed results of sector performance and their comparison with the intended results or targets in the NAIPs or RAIP. Therefore a JSR seeks to examine the effectiveness and efficiency of the "operationalization" of the sector strategy or development plan. An appropriate NAIP or RAIP should have its own results frameworks with indicators and verifiable data sources and performance measurement plans.

Mandate to conduct a JSR

The mandate for commissioning a JSR lies with the ministry responsible for agriculture at the country level. The purpose, scope, scale and timing of the JSR will be determined by the ministry management in consultation with key strategic partners in the sector. It is important to ensure that the JSR process involves the participation of the key stakeholders from the outset and that there is completeness and comprehensiveness in consideration of the key performance areas under review. This will contribute to increased ownership of the findings of the review by the Ministry of Agriculture and all major stakeholders, which in turn will boost the likelihood of implementing the recommendations of the review.

The principles of a JSR

National Ownership: JSRs are a government-led national exercise and the process is, preferably, to be initiated and driven by the ministry responsible for agriculture and/or designated national coordinating entity.

Relevance: JSRs should be relevant to the NAIP or other cooperation agreement. A JSR committee should ensure that the design, scope, scale, and any special focus areas for the review are relevant to the status and trends of agriculture sector development in the country.

Inclusiveness and Participation: All relevant partners and stakeholders should be part of the whole process in order to institutionalize inclusiveness. Particular attention must be paid to securing genuine participation and not mere consultation of farmers and those directly involved in the development of the agriculture sector in the country.

Commitment to results by all participants: Genuine involvement in the planning and implementation of the review also implies that participants agree to follow up on the findings and recommendations.

Impartiality: The choice of the review team as well as the review methodologies should be transparent in order to enhance objectivity and minimize biases and prejudices.

Evidence-based: The review will be informed by data and analysis from national M&E frameworks, complemented by data from partners' programs or projects, specific sub-sector reviews and reviews of discrete elements of the agricultural sector. It should also take into account and incorporate scientific and technical developments.

[43] The concept note can be found at http://www.resakss.org/2014conference/docs/JSR%20Concept%20Note.pdf

Enhancing national planning: Reviews are a critical part of programming cycles, not an end. The timing of the JSRs should inform future agriculture sector programming. In the medium term, the timing should also coincide with national development planning and budgeting cycles. Ultimately, the execution of JSRs should contribute to strengthening the national planning and implementation systems.

Sensitivity to gender and human rights: The JSR process provides an excellent opportunity to factor in the important, but often downplayed or even neglected crosscutting considerations of gender and human rights.

Learning experience: A major consideration and benefit of the JSR process is that it enables participants to learn from each other's expertise and experiences and contribute to building national capacity for implementation.

What is monitored in a JSR?

The nature of the JSR that a country conducts will be guided by what needs to be monitored. For the NAIP, aligned to the Malabo Declaration, the review will consist of five broad areas or themes:

i) High level development results that a country aspires to achieve in its NAIP, e.g. income growth, poverty and hunger reduction, food security and nutrition, and increased resilience to shocks.
ii) Overall agricultural sector performance, with specific subsector and commodity targets, for example doubling agricultural productivity or tripling intra-regional trade.
iii) Required financial and non-financial resources to effectively implement the NAIP mobilized from both public and private sources.
iv) Policies, programs, and institutions and processes that are required to create the right environment for successful implementation of the NAIP.
v) Linkages within and across sectors, focusing on areas that require multi-sectoral coordination for effective implementation.

JSR Best Practices

JSRs need to be credible national (or subregional) exercises. Their successful undertaking requires national ownership and leadership, relevance to National Agriculture and Food Security Investment Plans (NAIPs) or cooperation agreements, inclusive participation, commitment to results by all participants, impartiality through evidence-based objective analyses, sensitivity to gender issues, and the capacity to enhance national planning and provide learning experiences. ReSAKSS developed **best practices for JSRs** to guide agricultural stakeholders in conducting successful JSRs. The best practices include a series of building blocks, or milestones that occur within a set sequence that are required to establish and carry out comprehensive and regular JSRs. The JSR best practices are available on RESAKSS website on http://resakss.org/sites/default/files/JSR-Best-Practices/JSR%20Best%20Practices%20Matrix%20(March%202014).pdf

The Table below summarizes the JSR Best Practices.

AGRICULTURE JOINT SECTOR REVIEW (JSR) BEST PRACTICES

	JSR BUILDING BLOCKS	BEST PRACTICES
1	Existence of a JSR Steering Committee (SC)	SC provides strategic direction for the establishment and operation of the JSR. It is usually chaired by the Ministry of Agriculture and includes as members leading donors and 3-4 other representatives of key stakeholder groups.
2	Existence of a JSR Secretariat	Secretariat coordinates activities and operations of the JSR and JSR SC. It can be made up of core staff from the Planning & M&E Unit of the Ministry of Agriculture.
3	Existence of JSR Terms of Reference (TOR)	TOR to lay out JSR objectives, state and non-state stakeholders and their roles, roles of the SC and Secretariat, operating principles, structure and frequency of JSR meetings and follow up and implementation of actions, etc. TOR may also need to be developed for consultants hired to conduct JSR studies.
4	Resources are mobilized	Mobilize resources (human and financial) to support operations of the JSR.
5	Steering Committee / Secretariat invites a broad and inclusive group of state and non-state actors / stakeholders to participate in JSR	A key aspect of the JSR is that it allows a broad group of state and non-state stakeholders to influence overall policies and priorities of the sector by assessing how well they have implemented their commitments stipulated in the CAADP compact, NAFSIP, and related cooperation agreements such as under the New Alliance for Food Security and Nutrition.
6	Existing agricultural policy dialogue and review processes; data quality and analytical capacities are assessed	An assessment of any existing agricultural policy dialogue and review processes, data quality, and analytical capacities and tools and networks and any existing knowledge systems is key to identifying any gaps and coming up with ways to fill gaps and enhance capacities, tools, and processes through the JSR.
7	JSR Studies / Analysis Conducted	Consultants may need to be hired and supervised by the SC to conduct JSR studies. Consultants can come from think tanks, universities, or private companies and should work closely with staff from the Planning Unit, and the JSR SC and Secretariat.
8	JSR Review Team Established	Team made up of a multi-stakeholder group (state and non-state actors) with technical expertise to review and comment on various JSR studies and reports and ensure outputs of reviews are implemented.

Methodology for conducting JSRs: What Should Be Reviewed?

Introduction and Background

The concept of mutual accountability is rooted in Managing for Development Results (MfDR), which is a management approach that involves using performance information at all stages of the development process to make better and more effective decisions and steer development efforts toward clearly defined goals (AfCoP 2012). Mutual Accountability means that each Stakeholder takes accountability and responsibility for their actions within the framework of collective action.

Since the launching of the Comprehensive Africa Agriculture Development Programme (CAADP) in 2003, the demand for inclusive stakeholder participation in setting policy and investment priorities and, consequently, for mutual accountability in the agriculture sector has increased. These have resulted in the signing of 30 country CAADP compacts and the preparation of national agricultural investment plans (NAIPs) in 26 of those countries;[44] which together spell out the development objectives of the sector, the policies and strategies to achieve those objectives, and stakeholder pledges and commitments to implement the polices and strategies.

To facilitate the mutual accountability process, the CAADP Mutual Accountability Framework (MAF) was developed (AUC-NPCA 2011). A key instrument for promoting mutual accountability is the Joint Sector Review (JSR), which a set of guidelines has been developed to assist country stakeholders to develop and implement the JSR (see CAADP MA-M&E JAG 2012). JSRs provide a platform to assess the performance and results of the agriculture sector and in turn assist governments in setting sector policy and priorities. Specifically, they aim to assess how well state and non-state stakeholders implemented pledges and commitments stipulated in the CAADP compacts, NAIPs, and related cooperation agreements in the sector. By allowing a broad spectrum of stakeholders to get insights into and influence overall policies and priorities of the sector, JSRs serve as a management and policy support tool for inclusive stakeholder planning, programming, budget preparation and execution, monitoring and evaluation, and overall development of the sector.

The CAADP JSR guidelines includes specific recommendations on the ***how*** to successfully conduct the process, which should be consistent with principles of ownership, relevance, inclusive participation, commitment to results by all participants, impartial-evidence informed, and learning, among others. This concept note elaborates on the content (or the ***what***) of the JSR.

Rationale, Goal, and Objectives

JSRs in the agriculture sector are not new in the continent. Several countries (e.g. Ghana, Kenya, Mozambique, Rwanda, Tanzania, and Uganda) already conduct JSRs on a regular basis.[45] However, for such existing JSRs to be more effective as a mutual accountability tool and in making evidenced-based policies and investments in the sector, they will need considerable strengthening in terms of design, data and analysis, transparency, and stakeholder inclusion. To this end, it is important that there is empirical

[44] As at February 2013, see CAADP website for details.

[45] This is called Agricultural Joint Sector Review in Ghana and Joint Implementation Review in Tanzania, for example. In general, many countries undertake some form of joint review, either specific for the agricultural sector or for the economy as a whole (see sample links for Ghana, Kenya, Mozambique, Rwanda, Tanzania, and Uganda).

evidence on the achievement of jointly agreed milestones and targets. Even in countries that do not currently conduct a JSR or where there are no mutual accountability platforms, it is still important to have empirical evidence on the achievement of stated milestones and targets in the sector by way of strengthening national monitoring and evaluation systems and agriculture sector reviews in general.

The primary objective of this work is to provide analytical and technical support to countries to strengthen their national agriculture JSRs. The result of this will be improved evidence-based policies, planning, budgeting, and program implementation, based on a reliable assessment and reporting of performance in the sector against mutually-agreed targets. The support will aim to strengthen in-country technical and analytical capacity to conduct and develop JSRs and to undertake rigorous documentation of JSRs using the CAADP JSR Guidelines.

Activities, Methods, and Outputs

The overall content (or the ***what***) of the JSR follows from the aims of the JSR as stated in the Guidelines:

i. Describe and analyze the structure, conduct and performance (SCP) of the sector against mutually-agreed milestones and targets (including actions agreed in previous JSRs).

ii. Identify strengths, weaknesses, opportunities and threats (SWOT) in the sector.

iii. Based on the results and findings in the above, make recommendations for improving performance (RfIP) in the sector.

While these may seem rather general, the substance (including its boundaries or scope) derives from the phrase "mutually-agreed milestones and targets". Identifying what the mutually-agreed milestones and targets are is fundamental in the JSR process or in any mutual accountability process. This is a nontrivial point, because it is futile to hold someone accountable for things they have not agreed to do or are not interested in doing. The ineffectiveness of existing JSRs as a mutual accountability tool in many countries is due largely to this, considering that governments and donors (the main stakeholders in current JSRs) often have different priorities and preferences for mode of support to countries (Kolavalli and Keefe 2012). In the CAADP process, such mutually-agreed milestones and targets are articulated in documents such as the CAADP compacts, NAIPs, and New Alliance Cooperation Frameworks, which we use the term "cooperation agreements" to collectively refer to them.[46]

The contents of these cooperation agreements, which lays out what is mutually-agreed upon and which in turn should define the boundaries or scope of the review, are usually organized around five main areas: (1) development results such as income growth, poverty and hunger reduction, food security and nutrition, etc.; (2) overall agricultural sector growth target, with specific subsector and commodity targets; (3) required financial and non-financial resources; (4) policies, programs, institutions, and implementation processes; and (5) linkages (including pathways to achieve the development results), enabling environment and assumptions. Therefore the substance or topic of a JSR can focus on any one or combinations of these five areas. We will take each of them to elaborate further, laying out the: (i) main questions to be answered, (ii) methodologies and data needed to be used in answering the questions, and

[46] These also include the Global Agriculture and Food Security Program (GAFSP) project appraisal documents, GrowAfrica business cases, and other CAADP-related initiatives whose implementation is rooted in collective action and inclusive participation between the state and non-state parties including donors, private sector, NGOs, farmers, etc.

(iii) the outputs or reports to be generated. First, it is useful to define the concepts associated with the three elements that the JSR aims at (SCP, SWOT, and RfIP in the sector).

Structure, conduct and performance (SCP): The SCP framework derives from the analysis of markets. In this context, the structure consists of the relatively stable features in the agricultural sector (e.g. resource endowments, climate, policies, institutions, etc.) that influences how the different actors in sector operate and interact with each other (to achieve shared or individual goals and objectives). Conduct means what the different actors do to achieve their objectives and goals, while performance is the success in achieving the objectives and goals.

Strengths, weaknesses, opportunities and threats (SWOT): Strengths are characteristics of the specific intervention (e.g. policy, program, institution, process, mechanism, etc.) that give it an advantage over other competing or potential interventions in achieving a particular objective. Weaknesses on the other hand are characteristics that place the intervention at a disadvantage relative to others. Opportunities are elements that could be exploited to the advantage of the intervention in achieving its objectives, while threats are elements in the environment that retard the intervention in achieving its objectives.

Recommendations: These must be implementable and derive from the data, information, analysis and findings of the review. Based on the SWOT analysis for example, recommendations could be derived by matching the strengths to opportunities to define a competitive advantage, or by converting weaknesses and threats into strengths and opportunities that can be exploited. The recommendations need not be a long wish list. Where there is more one, they need to be prioritized to reflect immediate, medium and long term actions. Sequencing is also important here.

We now take each of the five areas listed above to elaborate further on the content of the review in terms of: (i) main questions to be answered, (ii) methodological and data needs, and (iii) the outputs and reports. The presentation here is consistent with the 'proposed layout of the JSR report' included in the Annex of the JSR guidelines. However, the layout included in the guidelines is more along the lines of the content of the general CAADP M&E report, while the presentation below follows the content of a cooperation agreement, the basis for mutual accountability. And so while the CAADP M&E report (or the layout in the JSR guidelines) will contribute to a mutual accountability report, because not all of the content of existing and potential cooperation agreements is known, there is some generality to the presentation. But it carries the tone of reviewing performance in relevant indicators against mutually-agreed upon targets.

1. Review of Progress in Development Results

These are usually associated with medium- to long-term outcomes for the country as a whole such as reducing poverty and hunger, increasing food security and nutrition, increasing household incomes, increased competitiveness, among others. In the case of Ghana's METASIP for example, it states to achieve 85% food self-sufficiency annually, while in the case of Mozambique's New Alliance it states to help 3.1 million people emerge from poverty and hunger. Therefore, the interest here is to assess the direction in which the values of the indicators associated with the outcomes are moving against stated targets and benchmarks. As such, major questions include:

- Is the country on track to achieve its stated goals and outcomes?
- What are the achievements (a) in different parts of the country and (c) across different socio-economic groups—based on age and gender, sector of employment, size of operation, etc.?

Methods. Regarding whether the country is on track to achieve its overall objectives and outcomes, this can be addressed using descriptive statistics; first calculating the percentage difference or change between the baseline (or end) and current values of the relevant indicators, and then analyzing the progress associated with the difference or change. Most of the indicators here are fairly straightforward and the data for analyzing them can be obtained from food balance sheets, core welfare indicators questionnaire (CWIQ), demographic and health surveys (DHS), labor surveys, household income and expenditure surveys, and other relevant national household surveys.[47]

Depending on the representativeness of the data at sub-national levels and across different socio-economic groups, they can also be used in answering the question on how the achievements have been distributed across different parts of the country and among different socio-economic groups.

The main problem is that the data on these indicators are not collected on an annual basis, because their values are slow to change over time. And so simulations (e.g. using straight line extrapolation) can be used to obtain inter-survey measures. Normally, this requires handling large micro-level datasets and applying weighted sampling techniques.

Outputs. The main output will be in a form of a summary table showing the baseline values, endline target, and current status of the indicator, using color codes as done in a scorecard for example for visual effect, based on analysis of the percentage difference between the current value and end target value for example (see Table 1.1). These should be part of a report describing the main trends and findings structured according to: introduction, methodology and data, results and findings, conclusions, recommendations, and annexes of tables and charts on indicators and other detailed information. In addition, a dataset with more details on the indicators and their measures over the relevant periods of time should be provided.

Table 1.1: Progress in achieving development results

Indicator and measurement	Baseline		End Target		Current Status	
	Year	Value	Year	Value	Year	Value*
Indicator 1						
Indicator 2						
…						
Indicator n						

* in addition use color codes based on the percentage difference (D)=[(current-target)/target]*100:

D≥100%	Target achieved or surpassed
α < D < 100%	On track
D ≤ α	Not on track or deteriorated
	No data (explain why there are no data)

α is an agreed-upon value or benchmark of progress or being on track.

2. Review of Agricultural Sector Performance (Growth and Trade)

The agricultural sector consists of crops, livestock, forestry and fishery subsectors, which are in turn made up of numerous commodities and commodity groups. In the cooperation agreements, specific growth rate and trade targets are given for the entire sector as well as for different subsectors, commodity groups, or individual commodities. For example, the continent-wide target of 6 percent annual growth rate for

[47] See the CAADP M&E framework (Benin et al. 2010) for the details on these and other indicators.

the entire sector has been adopted by many countries. To cite some specific examples: Ghana's METASIP states to raise agGDP growth from 5.1 to 6% per year; Mozambique's states to achieve 7% agGDP growth rate per year; Rwanda's GAFSP states to develop 900 hectares for irrigation; and Senegal's AMAP states to raise non-traditional agricultural exports from 3,052 to 12,000 tons in three years. Compared to the development results, the targets here tend to be more short- to medium-term in nature and so assessment of progress should be more precise. The major questions here include:

- To what extent have the growth and trade targets in the overall agricultural sector, as well as in the different subsectors and commodities, been achieved?
- How have the different subsector and commodity achievements contributed to progress in achieving the sector's overall performance?
- What are the achievements in subsector and commodity production and productivity under (a) different agro-ecologies of the country, (b) different technology packages and husbandry, and (c) different types of producers—based on size of operation and gender and age of farmers, etc.?

Methods. Regarding whether the growth and trade targets in the overall sector and in different subsectors and commodities been achieved, this can be addressed using descriptive statistics; first calculating the percentage difference or change between the baseline (or end) and current values of the relevant indicators, and then analyzing the progress associated with the difference or change. The indicators here are also fairly straightforward,[48] and those measured at the aggregate and national levels are relatively easy to come by and can be obtained from national accounts data. The main challenge will be obtaining up-to-date information as many national accounts data are produced with a lag of one or two years. Therefore, the current values of some indicators may have to be estimated based on the most recent data that are available.

Regarding how the different subsector and commodity achievements have contributed to progress in achieving the sector's overall performance, this can be addressed using decomposition methods in an accounting sense. The models, especially the social accounting matrices (SAMs), that were used in analyzing alternative agricultural growth and investment options in the CAADP roundtables will be particularly useful here (see Diao et al. 2012). Depending on the country, this will involve either updating an existing model or developing a new one.

Answering the third question on how achievements in subsector and commodity production and productivity have been distributed across different parts of the country and among different socio-economic groups will also involve decomposition methods and will require detail disaggregated data on the relevant indicators across the different units of analysis desired. Such data, except district-level production data for some commodities, are not readily available from the national statistics bureaus. These will have to be developed from available household survey and GIS data, including biophysical and infrastructure. IFPRI's Spatial Production Allocation Model (SPAM) (You et al. 2009) will be particularly important here.

Outputs. As with the development results, the main output here will also be in the form of a summary table showing the baseline values, endline target, current status of the indicator, and an assessment of the progress associated with the key indicators agreed on (see Table 2.1). Color code based on analysis of

[48] See footnote 1.

the percentage difference between the current value and end target value can also be used to enhance visualization of the results. Similarly, a report and dataset should be included.

Table 2.1: Progress in achieving agricultural sector targets

Indicator and measurement	Baseline		End Target		Current Status	
	Year	Value	Year	Value	Year	Value*
Indicator 1						
Indicator 2						
…						
Indicator n						

***** in addition use color codes based on the percentage difference (D)=[(current-target)/target]*100:

D≥100%	Target achieved or surpassed
β < D < 100%	On track
D ≤ β	Not on track or deteriorated
	No data (explain why there are no data)

β is an agreed-upon value or benchmark of progress or being on track.

3. Review of Progress in Meeting Financial and non-Financial Commitments

The main thing here is assessing the extent to which the different partners or signatories (government, donors, private sector, NGOs, CSOs, FBOs, etc.) to the cooperation agreements have met their commitments, including the composition and quality of the disbursements or expenditures made.[49] And so the key questions here include:

- To what extent have the different partners been able to meet their overall financial and non-financial commitments?
- What is the composition and quality of the actual disbursements and expenditures and how have these been spent across the different (a) objectives of the sector, (b) subsectors and major commodities, (c) policies, programs and institutions, (d) leading or major implementation units at all levels, and (e) socio-economic groups in different parts of the country?
- How have the amount, nature, and allocation of expenditures influenced (a) incentives of the different implementing agencies to deliver, (b) delivery of public goods and services, (c) production and productivity in different subsectors, and (d) overall sector growth?

Methods. In answering the first question, there is need to consider different indicators for the different partners, consistent with their roles and responsibilities. For the **state or government**, the main thing here will be looking at actual expenditures expressed as a percentage of the budgeted amounts. For **donors**, this will involve analyzing actual disbursements expressed as a percentage of the pledged or committed amounts, in line with the Paris Declaration on Aid Effectiveness principles of alignment and harmonization. For the **private sector**, the analysis of achievement versus planned will likely involve non-monetary indicators such number of contracts executed, number of people employed or employment opportunities created, number of processing plants established, etc. against their planned levels.[50] Assessing progress

[49] See the 2012 ReSAKSS ATOR for details on how the budgets of the NAIPs have been distributed across different objectives, activities, functions and target populations (Benin and Yu 2013).

[50] The GrowAfrica business cases have more on these types of indicators.

of the commitments of **NGOs, CSOs, and FBOs** may also involve some of these indicators in addition to number of farmers mobilized, amount of co-funding mobilized, etc. against their planned levels.

The second question on composition, quality, and distribution requires detail disaggregation of data on the different indicators according to the different classifications mentioned above to the extent that they are applicable.

Regarding how the disbursements and allocation of expenditures have influenced different indicators (including incentives, delivery of public goods and services, sector productivity and outcomes), it will be good to focus on the big or critical investments (e.g. R&D, irrigation, farm subsidies) and calculate rates of return on investment.

The fundamental data required to do the analyses in this section have to be provided by the individual partners themselves, which is unlike the data needed for the other topics that can be obtained from third-party agencies. Therefore, the success of the review here will depend on the willingness and ability of the different partners to provide the financial and nonfinancial data timely. While some of the data (particularly governments spending and ODA) are publicly available, they may be too general to measure up against what is mutually-agreed upon between the different partners in the cooperation agreements. For example, government spending often includes donor funding that is channeled through government accounts. These together makes up public agriculture expenditure (PAE). And so while it is easy to separate the contribution of government and (individual) donors to PAE (which is part of answering the first question), it will be impossible to assess differences in government and donor funding composition, quality, and distribution (i.e. answering the second question). Another level of challenge with existing PAE data derives from the fact that the government's audited accounts, which is source of PAE data, reflect more the outlays associated with the organizational structures of government (which is fine with getting information to address expenditure allocation across leading or major implementation units) rather than outlays associated with the other indicators of disaggregation needed.[51]

On the data for NGOs, CSOs, FBOs, there is need to separate or distinguish general private sector investment flows, including foreign direct investments (FDI), from commitments and related investments deriving from the cooperation agreement. General private sector investment in the sector may be considered as outcomes of government policies or as a measure of crowding-in of private investment by public spending.[52]

The rates of return on investment analysis will require data on the outputs and outcomes of the investments, which can be obtained from project documents and household/farm surveys. Expert opinion surveys will be useful here to gain insights on important but unobservable/measurable effects.

Outputs. Regarding the commitments and allocation of expenditures, the main output will be a summary table showing the planned and achieved (both in levels and as ratio of planned), using color codes as done in a scorecard for example to indicate progress for quick visual effect. It will be good to also consider progress against long-term commitments versus progress on annual basis (see Table 3.1). On the rates of return on investment analysis, the main output will be summarized in a table showing for each investment and amount invested the calculated rates compared with what is expected or with other international benchmarks. However, because it takes time for investments to materialize, these may be done

[51] The on-going PAE classification work by IFPRI's public investment team using case studies of Ghana, Kenya, and Mozambique will be important for developing the data aggregation methodology.
[52] This is reviewed under the section on the linkages.

occasionally. As before, these outputs will be accompanied by a detail report of the findings of the review and datasets.

Table 3.1: Progress in meeting financial and non-financial commitments

	Long term					Annual			
	Units	**Planned or Targeted (a)**	**Incremental Amount Achieved (b)**	**(b)/(a)***		**Units**	**Planned or Targeted (d)**	**Achieved (e)**	**(e)/(d)***
Donors									
Total (all donors)									
Donor 1									
…									
Donor n									
Government									
Total agriculture									
Disaggregated									
Indicator 1									
…									
Indicator n									
Private Sector, NGOs, CSOs									
Indicator 1									
…									
Indicator n									

* in addition use color codes based on the ratio of achieved to planned (R):

≥ 1	Target achieved or surpassed
δ < R < 1	On track
≤ δ	Not on track or deteriorated
	No data (explain why there are no data)

δ is an agreed-upon value or benchmark of progress or being on track.

4. Review of Policies, Programs, Institutions, and Implementation Processes

Ultimately farmers, producers, and traders are the ones that have to make the necessary investment decisions that will bring about the expected improvements in production, productivity and trade that will help achieve the sector's overall growth and trade objectives. But because farmers', producers, and traders' investment decisions are based on the potential profitability and risks of alternative investment opportunities in and outside agriculture, which are influenced by government decisions (in addition to other factors outside their control), the core issue here is assessing how the different sector policies (e.g. land, seed, producer price, trade, etc.), programs (e.g. extension, irrigation, fertilizer subsidy, etc.), and institutions (pesticide laws, water use rights, grades and standards, etc.) have contributed to creating an enabling environment for increased farmer and private sector investments. The focus here is on the policies, programs and institutions (*PPI*s) that are specified in the cooperation agreements, including the strategies for improving the capacity of the agencies and organizations that are involved with developing and implementing the *PPI*s. It is important to first identify all the *PPI*s stated in the cooperation agreement and then focus on a few critical ones for the remainder of the review. And so major questions to answer here include:

- What progress has been made in making and implementing the different *PPI*s that were identified and targeted in achieving the sector's objectives and targets? And how have different stakeholders contributed to the progress made?

- What are the processes and mechanisms in place to ensure that investments in the sector reflect the agreed upon policies and programs?

- What progress has been made in building or strengthening the capacity of policymakers and different agencies and organizations involved in making and implementing the different *PPIs*?

- How can the relevant institutions, processes, and mechanisms be strengthened to achieve higher value for money, including implementation of policies and programs that lead to greater profitable investments by farmers and the private sector in different parts of the country?

Methods. On progress made in implementing different *PPIs*, the first thing that needs to be done is compiling a list (inventory) of the different *PPIs* identified in the relevant cooperation agreements (see Box 1 on sample policy actions in the case of Mozambique for example). Expert opinion surveys and public records will then be used to determine the status of implementation of each *PPI*, which should be based on the policy matrices in the cooperation agreement. For each *PPI*, the expert opinion surveys will be used to map out key players and actors (e.g. ministers, principal secretaries, directors, parliament members, federal executive council, state governors, other cabinet members, donors, farmers, researchers, etc.) involved, their roles, and their influence in making and implementing it. The same applies to the second question on stocktaking of the different processes and mechanisms in place ensure that investments in the sector reflect the agreed upon policies and programs.

Box 1: Example of Policy Actions in Mozambique's New Alliance Framework

- Pass seed law
- Adopt seed and fertilizer regulatory frameworks
- Adopt rural land use rights and transfer regulations
- Eliminate specified internal and non-tariff barriers to trade
- Enact food fortification regulations; define institutional coherence
- Enact mobile finance regulations

Based on the map of the key players and actors involved, the next questions on progress made in building or strengthening their capacity in making and implementing the *PPIs* and how to strengthen mechanisms and processes can be addressed using narratives and descriptive statistics of change between baseline (or end) and current values of the relevant indicators on capacity for policymaking, programs planning and implementation, organizational management, and institutional development, among others. This will be done using structured questionnaires to assess changes in the capacity of the different stakeholders, as well as needs/gaps in performing their roles effectively.[53]

Outputs. The main outputs will be two summary tables: the first will be a scorecard of progress in the major *PPI*s against any policy matrices (see Table 4.1); and the second is also a scorecard type of progress in building or strengthening the capacity of the different actors involved in the above (see Table 4.2). These will be accompanied by a detail report of the findings and recommendations of the review, and a dataset on the values of the indicators.

Table 4.1: Progress in implementing policies, programs and institutions

Indicator and measurement	**Current Status***
Indicator 1	Narrative …

[53] The capacity needs assessments that is currently being carried out by ReSAKSS for the establishment of country SAKSS can provide useful baseline information on key actors engaged in strategic policy analysis, investment planning and implementation, monitoring and evaluation, and knowledge management. The assessments are being carried out at the individual, organizational, and policy process levels.

Indicator 2	
…	
Indicator n	

* use color codes based on narratives:

Green	Target achieved or surpassed
Yellow	On track
Red	Not on track or deteriorated
Grey	No data (explain why there are no data)

Table 4.2: Progress in strengthening capacity of different actors

Indicator and measurement	**Baseline**		**End Target**		**Current Status**	
	Year	**Value**	**Year**	**Value**	**Year**	**Value***
Indicator 1						
Indicator 2						
…						
Indicator n						

***** in addition use color codes based on the percentage difference (D)=[(current-target)/target]*100:

D ≥ 100%	Target achieved or surpassed
η < D < 100%	On track
D ≤ η	Not on track or deteriorated
	No data (explain why there are no data)

η is an agreed-upon value or benchmark of progress or being on track.

5. Linkages, Enabling Environment, and Assumptions

This section is composed of two parts. The first is on linkages among the different sections above, in particular between investments and agricultural sector performance, and between agricultural sector performance and overall development results. The second component is on risk factors, particularly those things that are outside the control of the implementers of the cooperation agreement.

5.1. Linkages with Development Results

The main thing here is to see how any progress made meeting the financial and non-financial commitments as well as progress made in implementing the *PPI*s have contributed to: changes in agricultural productivity, growth, and trade; performance in other sectors; and overall development results. As such, major questions include:

- How has the progress made in different partners meeting their financial and non-financial commitments, as well as how they have been allocated, influenced agricultural production, productivity, and growth?
- How has the progress in making and implementing the different *PPI*s, as well as progress in building or strengthening the capacity of policymakers and different agencies and organizations involved, influenced agricultural production, productivity, and growth?
- How has agricultural sector performance contributed to the achievements in other sectors as well as the progress made in achieving the country's overall goals and outcomes (development results)?

- Could higher agricultural growth and greater development outcomes been achieved? Or could it have been worse? How and why?

- What are the different or new interventions, in and outside of agriculture, that could be made to hasten overall progress and lead to better-distributed outcomes?

Methods. The basic thing here is getting a sense of cause-effect relationships by way of assessing the effectiveness of the different efforts. Answering these questions is very important for raising and maintaining the high profile of the role of agriculture in the economy, especially if the ministry of finance is to be convinced to allocate more funds to the sector. Because outcomes take time to materialize through different pathways, answering these questions will require detail data on different variables identified in the pathways and over many years. It will also require complex methods. But the fundamentals of the different approaches are situated in the project evaluation literature (see e.g. Ravallion 2008 and Imbens and Wooldridge 2008). In answering the first three questions, different impact assessment tools will be needed (see Benin et al. 2012). Expert opinion surveys will be used to gain insights on important but unobservable/measurable factors that cannot be captured in the quantitative methods.

Answering the fourth question on whether greater outcome could have been achieved will involve simulation techniques using results from the impact assessment. Answering the question on the different or new things that need to be done to achieve greater and better-distributed progress will involve analyzing the above findings together to arrive at recommendations.

Outputs. The main output will be a summary table showing how progress made in the different sections has contributed to different outcomes (see Table 5.1). Ideally, these will be elasticities (e_{ij}), and color-coding could be used to enhance visual presentation of the results in terms of comparing estimates with international standards of results of other initiatives. These will be accompanied by a detail report of the findings and recommendations, and a dataset on the values of the indicators.

Table 5.1: Effect of progress in implementing agreement on agricultural and non-agricultural sector performance, and overall development results

X	**Agricultural sector**			**Non-agricultural sectors**			**Overall results**		
↓ Y→	**Indicator 1**	**Indicator 2**	**…**	**Indicator 1**	**Indicator 2**	**…**	**Indicator 1**	**Indicator 2**	**…**
Financial commitments									
Indicator 1	e_{ij}								
Indicator 2									
…									
PPIs									
Indicator 1									
Indicator 2									
…									
Capacity building									
Indicator 1									
Indicator 2									
…									
Implementation processes									
Indicator 1									
Indicator 2									
…									
Agricultural Sector performance	n.a.	n.a.	n.a.						

elasticity (e_{ij}) = (% change in Y_j)/(% change in X_i or progress in X_i)

Indicator 1	n.a.	n.a.	n.a.						
Indicator 2	n.a.	n.a.	n.a.						
…	n.a.	n.a.	n.a.						

n.a.=not applicable

In addition and based on comparison to some standard elasticity (ê), or for qualitative measures, use color codes:

> ê	Above average
= ê	Average
< ê	Below average
	No data (explain why there are no data)

5.2. Enabling Environment and Assumptions

The substance of this part of a JSR derives primarily from the section on risk assessment, and assumptions of underlying the pathways of impact, i.e. the channels through which implementation of the proposed policies, programs, investments, and institutions are expected to achieve the subsector and commodity targets, which in turn are expected to lead to achievement of the sector's growth and productivity targets, and then the country's overall outcomes. These involve mostly things that are outside the control of the implementers of the sector strategy. But they could also be due to inaccurate assessment of the things under the control of the implementers, including the situation that is supposed to be improved, or the instruments that are proposed to be used, or the expected outcomes to be achieved. Key questions for the review here include:

- Have any of the risk parameters changed in a manner to affect implementation of the strategy and achievement of results? How have they changed and what are their potential impacts on implementation of the strategy and achievement of results?
- How valid are the data, assumptions and analysis used in setting the benchmarks/targets stated in the strategy or cooperation agreement?
- What are the more reliable benchmarks/targets to set?

Methods. The first questions can be addressed using comparative descriptive statistics or narrative of change between the baseline and current values of the relevant risk parameters, and then analyzing whether the change is substantial enough to derail implementation and/or achievement of the results.

Addressing the second question involves assessment of the underlying data, assumptions and analysis used in the strategy or cooperation agreement. Basically, this is a review of the baseline information and its consistency with the stated targets. Although, the review of the assumptions in general appears last in the series of review topics, it is probably the first thing to be reviewed, by way of validating the cooperation agreement or strategy to begin with. This can be done by reviewing the sources of data and their values against other competing sources and values. The assumptions and analysis can be judged against the state of the art literature and evidence on the different topics as well as pathways of impact for example. Then, more reliable benchmarks and targets can be recommended to the extent that the data, assumptions and analysis deviate from what is more believable.

Outputs. The main output will be a summary table showing how the different assumptions and risk parameters have changed and an assessment of how the changes may have affected different outcomes (see Table 5.2). Color-coding could also be used to enhance visual presentation of the results (see notes

to Table 5.2). These will be accompanied by a detail report of the findings and recommendations, and a dataset on the values of the indicators.

Table 5.2: Change in assumptions and risk factors and its effect on implementing agreement and achieving of results

Assumption/Risk Parameter	**Initial/Baseline assessment**	**Current assessment or change from baseline***	**Effect of change implementation of the cooperation agreement****	**Effect of change in achieving results*****

***** increased a lot (-2), increased a little (-1), no change (0), decreased a little (+1), decreased a lot (+2)
****** retarded it a lot (-2), retarded it a little (-1), no significant effect (0), enhanced it a little (+1), enhanced it a lot (+2)
******* retarded it a lot (-2), retarded it a little (-1), no significant effect (0), enhanced it a little (+1), enhanced it a lot (+2)

In addition to narratives and number codes, use color codes:

+1 or +2	Risk decreased; Enhanced implementation of agreement or achievement of results
0	No change in risk; Insignificant effect on implementation of agreement or achievement of results
-1 or -2	Risk increased; Retarded implementation of agreement or achievement of results
	No data (explain why not)

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Annex B.9: Institutional Architecture Assessment for Agriculture and Food Security Policy

The Institutional Architecture Assessment for Agriculture and Food Security Policy (hereafter, "IAA" or "the tool") is an approach to looking at the institutional structures, systems and processes by which agriculture and food security policy is developed, implemented, reviewed and revised. The tool has been used primarily at the national level but it can be used at whatever level policy is made and implemented, including sub-national levels (counties, districts) as well as supra-national levels like regional economic communities.

The IAA is predicated on the principle that open, clear, data-driven, inclusive, predictable and well-structured processes for making and implementing policy help to ensure that the resultant policies, programs and institutions actually serve the broad stakeholders in the sector for which those policies have been developed. The same elements of a policy architecture or system help ensure that policies are refined to greater effectiveness over time.

The IAA is a qualitative tool that depends on the knowledge of the policy process of key informants drawn from farmer groups, government, donors, the private sector, and civil society, in short from organized groups of stakeholders in agriculture and food security policy. It looks at the relationship of the various stakeholders in the policy process ("Mapping of Institutional Architecture Inventory") and then considers where a jurisdiction is in relation to six policy elements and sub-elements or indicators. In all, the tool considers about 40 questions related to the policy process in order to determine the completeness of the policy process (a rating of "green" being equivalent to complete, "yellow" to partially complete, and "red" to incomplete).

The tool is applied by a team of two or three experts including a team leader who will be responsible for organizing the process, ensuring that the right stakeholder informants are met, and ensuring that the report is written well and on time. One of the team members should ideally have had experience using the IAA or be familiar with its strengths and weaknesses, how it should be used and what conclusions can be drawn from its application. Another team member should thoroughly understand the organized stakeholders of the agriculture sector so as to make sure that a representative "sample" of each stakeholder group is interviewed. If workshop facilitation is not a strength of either the team leader or the agriculture policy expert, it might be useful to bring on board a facilitator as a third member of the team. Validation workshops are highly recommended, although they were not always a feature of the initial IAAs, which for reasons of time were generally given only two weeks of field time. These may easily extend the time required for the fieldwork to three weeks rather than the two weeks recommended in the Guidelines.[54]

The report consists of a 15-20 page document with an executive summary, and includes sections on institutional mapping, capacity for food security reform indicators, and recommendations for future priorities and actions, plus a brief summary of the validation workshop.

The validation workshop is intended to be an opportunity for the government and other stakeholders to review the initial findings of the IAA team and to contest, agree with, or refine the findings and determine what these mean in terms of actions to improve the institutional architecture and processes by which policy is made.

[54] "Institutional Architecture for Food Security Policy Change: Guidelines for the Assessor," Draft: March 25, 2013, Africa Lead and Enabling Agriculture Trade.

Methodology

Part I: Mapping of Institutional Architecture Inventory

The first step in this process will be to map out the key systems, processes, and relationships that influence the food security policy development process. This approach will involve identifying and mapping the relationships among the following: the guiding policy framework; the key institutions that hold primary responsibility for implementation; inter-ministerial coordination mechanisms; and private and civil society organizations, as well as think tanks and research organizations, that impact and influence the food security policy change process. These factors will be examined in the context of the broader economic and social dynamics that impact the policy change environment.

Part II: Capacity for Food Security Policy Reform

The second part of this assessment involves an analysis of a country's capacity to undertake transparent, inclusive, predictable, and evidence-based policy change. The country is examined through the following six components of the policy formation process to determine its readiness for policy change:

- Policy Element 1: Predictability of the Guiding Policy Framework
- Policy Element 2: Policy Development and Coordination
- Policy Element 3: Inclusivity and Stakeholder Consultation
- Policy Element 4: Evidence-based Analysis
- Policy Element 5: Policy Implementation
- Policy Element 6: Mutual Accountability

Each of these components is analyzed through a set of indicators that determine the capacity and effectiveness of the overall policy change process. Each indicator is assessed using a three-tier rating system, which highlights the priority and level of attention needed to improve the effectiveness of the condition. Indicators will be accompanied with a narrative analysis of key gaps and constraints to the policy change process. Indicators should serve as a baseline of the country's capacity to undertake policy change, and comparisons could be made the following year to ascertain progress made.

Part III: Recommendations

The third part is a succinct section that draws conclusions based upon the above set of findings, and develops recommendations for future priorities and action. To the extent possible, the information should be documented and objectively verifiable – and should be directly supported by the findings documented through the assessment framework analysis process. Conclusions should be brief (1-2 paragraphs per element).

Part IV: Validation Workshop

The final step of the IAA process is a validation workshop that brings together all stakeholders to review the IAA results and discuss and debate the findings. This helps ensure "buy-in" from the country stakeholders and raises awareness among key players about the policy process and how they (key players and country stakeholders) might influence it.

Annex B.10: Agricultural Science and Technology Indicators

ASTI is active in nearly 80 countries of Africa, Asia, and Latin America and the Caribbean. ASTI collects primary data through national surveys in close collaboration with its national institutional partners. Surveys, which are distributed to all government, higher education, and nonprofit (and, if possible private for-profit) agencies known to conduct agricultural research in a given country, focus on the following categories of information:

- Institutional information, such as the location and affiliation of agricultural R&D agencies.
- Human resource information, such as the number of researchers and support staff employed, together with their ages, gender, educational disciplines and qualifications, and level of seniority.
- Financial information, such as funding levels and sources (i.e, government, donors, sales, commodity taxes, other), and spending levels and allocations.
- Research focus, including details of the coverage of commodities.
- R&D outputs, such as the number of scientific publications and the release of new crop varieties and agricultural technologies.
- Numbers of students enrolled and graduated at agricultural higher education agencies, and degree programs offered.
- Qualitative information on the status of national agricultural R&D systems and the associated institutional and policy environment.

Methodology

ASTI collects and processes its datasets according to the standard procedures and definitions developed by the Organization for Economic Co-operation and Development (OECD) and the United Nations Educational, Science, and Cultural Organization (UNESCO), as described in the Frascati Manual, the Oslo Manual, and the Canberra Manual.

The Frascati Manual, originally published in 1963, has become the global standard for national and international organizations and has been revised numerous times. It should be noted, however, that the manual was devised by and for industrialized countries and hence is not always directly applicable to the developing world. As a result, ASTI has found it necessary to make some adjustments, particularly in the institutional classifications of agricultural R&D agencies.

Agency survey data is harmonized with historical time-series data and aggregated to provide national-level data series by institutional categories. Secondary data and estimates may be used to fill minor gaps in the primary data. The data and trends are analyzed in collaboration with country partners and informed by qualitative information gathered from key actors at agricultural R&D institutions.

Examples of use

ASTI outputs are frequently referenced in high-level meetings and reports. ASTI's most recent set of data and outputs for Africa are playing an important role in informing the discussions surrounding the Comprehensive Africa Agriculture Development Programme (CAADP) and the Science Agenda for Agriculture in Africa. A 2014 external review concluded that ASTI data and analyses have provided an effective platform allowing policymakers to track countries' agricultural R&D progress over time. The findings and outputs of ASTI's work have important policy relevance at the national, regional, and international levels and are widely recognized as the most authoritative source of information on support

for and the structure of agricultural R&D worldwide. In addition, an increasing number of countries use ASTI data as a tool to advocate for increased R&D funding, raising the retirement age of scientists, developing training opportunities, and more. ASTI data has also facilitated improvements in the monitoring and evaluation systems of many agricultural R&D institutes in Africa.

Publications

A series of country factsheets published in 2013-2014 present key agricultural R&D indicators and feature a more in-depth analysis of some of the main challenges that individual agricultural R&D systems are facing, and the policy options to address these challenges. A new series of factsheets will be published in 2016 with data updated to 2014.

www.asti.cgiar.org/publications/africa-south-of-the-sahara

How to access the indicators

The data download tool allows users to explore in-depth datasets on agricultural research spending and staffing in numerous low- and middle-income countries and to filter the data by country and indicator. http://www.asti.cgiar.org/data

Interactive country pages allow users to access detailed investment and human resource trends in agricultural research, and download factsheets and other information. http://www.asti.cgiar.org/countries

The benchmarking tool allows users to rank and compare agricultural research investment and capacity levels across countries. http://www.asti.cgiar.org/benchmarking/ssa

Annex B.11: Typology, prioritization, and decentralized performance tracking.

Most investigators, policymakers, analysts, and organizations find themselves compelled to select, download, host, and preprocess excessively large and unrefined amounts of data, invest in tools and preprocessing time to make the data ready for their specific and actual research needs and at the end only use these data partially. These issues are now becoming even more challenging considering the ever increasing data sources and sizes, the various pre-processing paths, and data-inherent issues. This adds to the ancillary time required from organizations to figure out the best data pre-processing strategies, limits data usability due to the prohibitive need for resources, and subsequently renders very inefficient the endeavor of research.

More relevant to the African continent is the assessment of the extent of the effect on natural resources of climate change and human activities, which requires reliable and relevant data accessible to researchers and decision makers concerned with the impacts of, adaptation to, and mitigation of this change.

At present, whatever limited data relevant to climate change studies related to agriculture sectors in Africa are in general spread through various research centers, international institutions, or local entities and individuals and not necessarily readily available for those involved in adaptation and mitigation studies and policymaking. Over the last few decades and with the advent of spatial analysis technology, a critical need for rapid access, expertise, and training is becoming evident in Africa. At all levels, academic research, applications, or general policy making, this need is expressed in the form of course development, funding, capacity building and data services.

Leveraging from high readiness level technologies, we are building an advanced data exploration system to enhance country data and knowledge management, called the ReSAKSS Country eAtlases (RCA) prototype, with a focus on serving policymakers, analysts, and other stakeholder communities in Africa working on different sectors, such as agriculture, natural resource management, and climate change.

The system will support pre-analysis, bundling, and a host of other standard data manipulation activities. This online system allows for the direct access, browsing, basic manipulation, and download of a list of agriculture, socioeconomic, basic biophysical and climate data records with minimum computing and expertise needs. It provides a set of online capabilities for the visualization and qualitative and quantitative exploration of these data records prior to download, and thus reduces the work load on the data users and addresses the network bandwidth and latency characteristics of Africa.

The ReSAKSS Country eAtlases' aim is to support evidence-based policy planning and implementation and inclusive policy review and learning processes in Africa by (i) providing an online, highly interactive and dynamic data environment rich with standard pre-processing and essential data analysis tools, (ii) assembling in one resource data from a variety of domains necessary for effective policy design and targeting, and (iii) ensuring broad access to high quality and disaggregated data across sectors, administrative regions, social strata, and agroecologies to facilitate inclusive review and dialogue processes.

The eAtlases will respond to the need for a centralized data center accessible to anyone from anywhere in the world and especially to African researchers and policy makers. The International Food Policy Research Institute (IFPRI) has been developing a data server that brings all the available socio-economic, remote sensing, spatial, and climate data from different sources into a centralized, user friendly, and highly interactive system.

Here we propose to prototype a system geared to serve and address issues specific to the African continent. This proposed prototype builds on the value of centralizing these services to researchers, policy makers, and applications developers.

We hypothesize that an online and highly interactive and dynamic data environment rich with standard pre-processing and essential data analysis tools could address multiple issues specific to Africa, and we list:

- Speedy access to data;
- Availability in one location of data generally housed in different institutions;
- Data analysis and preprocessing tools;
- Assistance with performing the most basic steps (e.g. time series analysis, anomaly analysis, trend analysis, etc.);
- Efficient system that considers network issues and hardware limitations in most African academic, research, and application institutions;
- Up-to-date and near real-time system.

Here we propose to:

- Design a server-side infrastructure for the online manipulation of a list of socio-economic, basic biophysical and climate data with a focus on routine preprocessing (data filtering, time series and anomaly generation, reformatting, subsetting, bundling, etc.);
- Focus the data analysis on addressing the most repetitive and time-consuming data preprocessing needs to eliminate the need for expensive user-side processing and storage hardware;
- Develop an intuitive and rich web-based client application to support interacting with these data records;
- Develop a set of data preprocessing best practices and tools;
- Promote local and regional capacity building for dealing with climate change by providing a specialized tool and hands-on training on the use of this system.

This system has the potential to serve all state and non-state actors involved in policy planning, implementation, and monitoring; policy analysis, review and dialogue; and design and targeting of agricultural and other investments, and will be geared towards specific countries in Africa, where network issues and technology resources could be a challenge. The system is of particular interest to users with limited resources and time and investigators who wish not to invest into resources for data preparation and preprocessing. Generally, these are the groups that will find this system useful:

- Government ministries and agencies;
- Academic institutions, research institutions and policy analysts;
- Civil society organizations and farmer organizations;
- Agribusiness and other private sector firms

Annex B.12: International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) for strategic foresight

IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) is a linked modeling framework that includes a global partial equilibrium, multi-market agriculture model; global water models linked to IMPACT (a global hydrology model, water basin management models, and water stress models); and the DSSAT crop modeling suite that estimates yields of crops under varying management systems and climate change scenarios from global climate models. The IMPACT suite of models is a well-established set of tools with an extensive record of refereed published outputs. This suite of models has the following key features:

- It is highly spatially and temporally disaggregated.
    - On the supply side, the analysis is based on major watersheds in geographic units called Food Production Units (FPUs) (320 FPUs in 154 water basins globally). Commodity yield and cropped area changes include exogenous (from climate change and public and private sector investments) and endogenous (from farmer response to changing prices) sources.
    - On the demand side, the level of analysis is the country, with 159 countries included explicitly. Demand is determined by income, population growth, and prices facing a representative consumer in each country.
    - 58 agricultural commodities (crops, livestock, oilseeds and oils, and sugar) are modeled, including nearly all CGIAR mandate crops.
    - Water availability and use are modeled at the FPU level.
    - Land use and land use change are modeled at the FPU level.
    - Analysis is done on an annual time step, extending from 2005 to 2050. The water models operate at monthly time step and incorporate crop calendars.
- The IMPACT model is solved by finding equilibrium prices that clear world markets, equating supply (cropped areas and yields for crops) and demand across all commodities.
- Beyond equilibrium measures of food availability, changes in gross revenue to farmers, water use, and land use change, the modeling suite also generates estimates of welfare measures such as supply of nutrients, population at risk of hunger, and numbers of malnourished children in each country.

At this stage, use of the IMPACT framework for NAIP appraisal and design will be focused on providing future projections of plausible scenarios and environments in which the NAIPs will operate that will help guide the formulation of the plans.

The following indicators relevant to NAIP appraisal and design are often components of scenario specifications:

- Productivity enhancements (yields, production, and sources of growth) for commodities of interest
- Post-harvest loss analysis
- Growth in investment in agriculture research and investment
- Climate change impacts on the agricultural sector

The outcomes of scenarios show impacts on a variety of metrics, including, for example, food security and nutrition, regional trade (net), and nutrition assessment of climate smart agricultural production alternatives.

IFPRI's IMPACT model and the associated Global Futures and Strategic Foresight team are based at IFPRI's headquarters in Washington DC, but collaborate with all CGIAR centers (GFSF partners) and researchers from most of the CGIAR Research Programs (CRPs), including all eight of the agri-food system CRPs. Initial analysis must be carried out by current GFSF team members, while embedding this capacity at the national/regional level for independent analysis requires a significant investment in training and skills development.

Further resources

Global Futures and Strategic Foresight website: globalfutures.cgiar.org

IMPACT model website: www.ifpri.org/program/impact-model

Robinson, S; Mason d'Croz, D; Islam, S; Sulser, TB; Robertson, RD; Zhu, T; Gueneau, A; Pitois, G; and Rosegrant, MW. 2015. The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model description for version 3. IFPRI Discussion Paper 1483. IFPRI, Washington, DC. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129825