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Tapping Potentials of Innovation for Food Security and Sustainable Agricultural Growth: An Africa-Wide Perspective

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Tapping Potentials of Innovation for Food Security and Sustainable Agricultural Growth

An Africa-Wide Perspective[1]

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[1] An earlier version of this study was published as a Program of Accompanying Research for Agricultural Innovation (PARI) study in September 2015.

Abstract

While in the past, increased use of inputs and expansion of agricultural land accounted for a good part of agricultural growth in Africa, improvements in productivity will need to be a major driver of growth in the future. Thus, agricultural innovations are needed to sustainably increase productivity, i.e. output per unit of all inputs, while maintaining environmental quality and resources. Such innovations require enhanced investments in research and development. This study identifies potentials in agriculture and food systems in Africa for enhanced food security.

For maximum impact, the Special Initiative "One World – No Hunger" of BMZ needs to take note of the whole African landscape of actions in agriculture and food security. Therefor this study provides a detailed review of related ongoing and recent initiatives, in order to help identify in what ways investments under the "One World – No Hunger" Special Initiative from a broad strategic perspective might best connect and serve in coherent and complementary ways to increase food and nutrition security and sustainable agricultural productivity growth.

Innovations in the agricultural sector are key to ensure food security and achieve the right to food. Investments in the agricultural sector are crucial not only to increase food production but also because the returns on investments in terms of poverty reduction effects are often highest in in this sector. Furthermore, food insecurity and violent conflicts are inextricably interlinked with food insecurity being both a driver and a consequence of violent conflicts and related refugee flows.

African countries have recently made major commitments to invest in agriculture. The Comprehensive Africa Agriculture Development Programme (CAADP), that was initiated in 2003 and has been reinforced by the Malabo Declaration in 2014, is now the reference point and measure of commitment in Africa. With CAADP, African countries committed to spend 10% of their total public expenditures on agriculture to achieve an annual agricultural growth rate of 6%. Other African and international initiatives, including new partnerships between African governments, donors and the private sector like the New Alliance for Food Security and Nutrition or Feed the Future, have since been launched to support the CAADP process.

Investment opportunities differ across Africa. In view of the above mentioned goals, it is suggested here that development investments by Germany target countries which reveal potentials indicated by

1. having a track record of political commitment to foster sustainable agricultural growth, as indicated by performance under CAADP, and
2. showing actual progress in sustainable agricultural productivity driven by related innovations, as indicated by comprehensive productivity measurement and innovation actions on the ground, and
3. prioritizing actions for hunger and malnutrition reduction and showing progress (for instance measured by the Global Hunger Index), but where agricultural and rural development and nutrition interventions are likely to make a significant difference, as indicated by public policy and room for civil society actions.

The records and potentials of 42 African countries are identified accordingly, using comprehensive assessments of agronomic, economic and governance criteria that can be transparently tracked.

Keywords: Agriculture, Innovations, Food and Nutrition Security, Agricultural Policy, Sustainable Growth

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1 The Evolving Context of Agriculture and Food Security in Africa

After many years of neglect, agriculture in Africa has recently attracted growing attention. Several big initiatives aiming at enhanced agricultural growth have been put in place that have made a difference. As a consequence, several countries overcame stagnation and show a strong growth performance.

1.1 Agricultural growth is key for poverty reduction

In sub-Saharan Africa, 63% of the population live in rural areas and their employment relates to agriculture (The World Bank, 2015). The intensity of (unskilled) labour, which is in many cases the predominant asset of the poor, is especially high in agriculture, making agriculture the sector where the poor can most easily benefit from growth, especially in countries where a large share of the land is cultivated by small- and medium-scale farmers. Due to these characteristics, the poverty reducing effects of agricultural growth are much larger than the impacts of growth in any other sector (Christiaensen et al., 2011). And because most poor in rural areas in Africa have access to land, raising agricultural productivity is a more potent lever to reduce poverty and food security in Africa than in any other region.

1.2 A short summary of recent developments

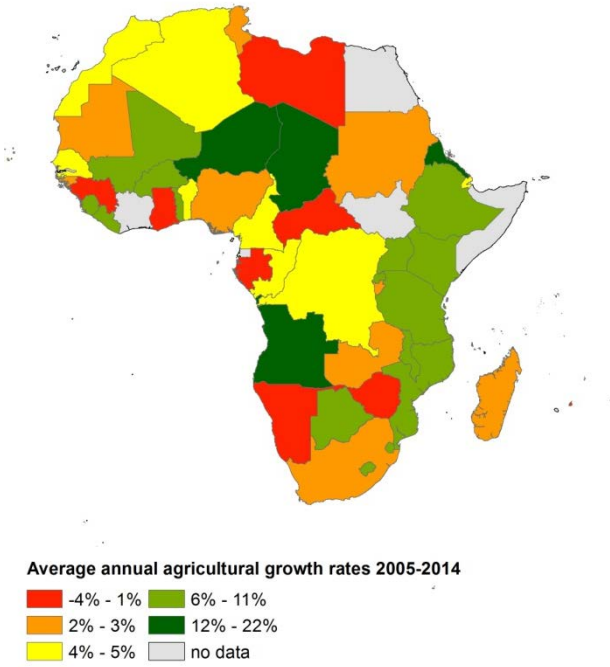
A view on the postcolonial history of economic development and growth in agriculture shows that the current situation offers an exceptionally good opportunity for investment that was not given in the past. After strong GDP per capita growth in the 1960s and 1970s, per capital GDP growth fell to -1.4% in the 1980s and 0.4% in the 1990s. The agricultural sector showed a similar performance. While the sector grew only at 2.5% per year in the 1970s, growth accelerated to 3.2% per year in the 1990s. Since then, growth further improved and was around 4.2% in 2014, well above the population growth rate of 2.7% (Badiane and Collins, forthcoming; The World Bank, 2015). In general, over the past 15 years, African countries have experienced the longest period of economic and agricultural growth since independence. Moreover, growth has accelerated and spread across all major sub-regions (Badiane and Collins, forthcoming; Badiane and McMillan, 2015).

Now is a good time to invest in agriculture: Agricultural growth has similarly accelerated but is still uneven across countries and has been very volatile in many countries. While countries like Angola, Lesotho, Niger and Ethiopia experienced average agricultural growth rates between 8 and 14% p.a. between 2005 and 2014 (but partly with high growth variability), several other countries still face significant growth challenges. In several countries, such as Mauritius and Zimbabwe, growth rates of the agricultural sector were even negative (The World Bank, 2015; see Figure 1).

Improved competitiveness: Many African countries have also improved competitiveness and now show a strong trade performance on continental and major regional markets. Regional and global trade can – under certain conditions – contribute to food security through their impact on long term output and productivity growth and the induced effects on employment and incomes, and by promoting competition and specialization in production. Moreover, trade can help to mitigate excess price variability and stabilize food supply. Therefore, it is a positive sign that the share of African exports of agricultural products in value terms has risen sharply from 0.15 to 0.34% in the second half of the last decade (Badiane and Odjo, forthcoming). However, there is still ample room for more regional integration and trade. Based on the distribution and correlation of production volatility and the current patterns of specialization in production and trade of agricultural products across countries, Badiane and Odjo (forthcoming) find great potential for raising cross-border trade that would reduce the instability of local food markets. Their simulations suggest that even modest

increases in yields would significantly raise trans-border trade beyond what is already projected under continuation of current trends.

Figure 1 Average annual growth rates between 2005 und 2014



Data source: http://www.resakss.org/region/africa-wide/caadp-targets

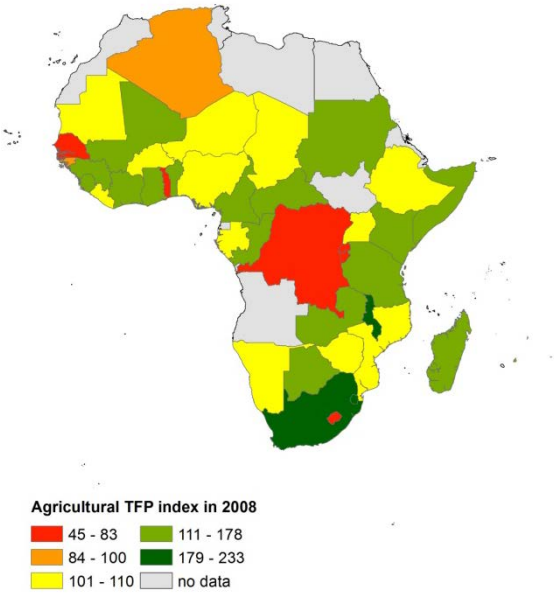
Country heterogeneity: As Figure 1 and Figure 6 further below show, there are significant sub-regional and national differences across African countries concerning the performance of the agricultural sector. While the overall picture is encouraging, significant efforts are still needed in many countries to sustain and further accelerate agricultural growth. This becomes even clearer when looking beyond the absolute rates of growth to trends in per capita agricultural production as the rapid growth in the past 15 years has at best allowed very few countries to make up for the lost decades of the 1970s and 1980s. Except for some Western African countries, Ethiopia, Mozambique and Angola, average regional per capita production is still well below the levels of the 1960s. For Africa as a whole, it would take several more decades to make up for the stagnation and decline during the three decades preceding the current recovery (Badiane et al., 2015). Thus, innovations are needed to accelerate the rate of increase of per capita production sustainably over the next years and decades to keep up with increasing and changing demand from a growing population.

1.3 The importance of improving productivity

The importance of productivity improvements: Agricultural growth can come from different sources. While the expansion of the agricultural area or increased use of inputs were important in the past and will also partly be crucial in the future, science and technology are needed to increase output per unit of input. The decisive measure for this kind of innovation-led growth is the "total factor productivity", i.e. the "ratio of total commodity output (the sum of all crop and livestock products) to total inputs used in production, including all land, labor, capital, and materials. If total output is growing faster than total inputs, this is an improvement in total factor productivity. An increase in total factor productivity implies that more output is being produced from a given bundle of agricultural resources." (Fuglie and Nin-Pratt, 2013, p. 20).

Agricultural productivity has shown similar patterns of decline and growth as the overall sectoral growth trends. While there have been improvements in agricultural innovation-led productivity in the last two decades or so in many countries, some countries are still on levels below the ones in the 1960s (Fuglie and Rada, 2011).

Figure 2 Agricultural TFP index in 2008



TFP Index 1961 = 100
Data source: Fuglie and Rada (2013)

Badiane and Collins (forthcoming) stress that "[b]oth wealth creation and competiveness, and thus long-term growth and poverty reduction, are driven by increases in productivity, which are in turn determined by the pace of technical change. This highlights the critical importance of investments in policies to promote technological and institutional innovations in the agricultural sector." Especially investments in research and development (R&D) have been identified as important drivers of increases in productivity (Fuglie and Rada, 2013).

The necessity of investments in agricultural R&D: Investments in R&D for agriculture show high returns: According to Fuglie and Rada (2013), every dollar spent on national R&D for agriculture generated returns in the order of $3 on average. This number is even surpassed by investments in international agricultural research as each $1 invested in technical improvements by CGIAR yields an estimated $6 in benefits (Fuglie and Rada, 2013).

Yet, while investments in agricultural research yield high returns and increase productivity, they often take time to materialize. Alene (2010) finds a 10-year lag between growth in expenditure on agricultural R&D and agricultural productivity growth (cited from Badiane and Collins, forthcoming).

As has been mentioned, labour is the most important asset of poor people. Therefore, improvements in labour productivity are especially important as drivers of rising overall agricultural productivity. Badiane and Collins (forthcoming) report that both land and labour productivity have risen considerably in the past couple of decades and grew at around 3.5% per year during 2000–2011 after slow or even negative growth in labour productivity from 1980 to 2000 almost everywhere in Africa. Nigeria, the largest agricultural economy in Africa, reversed this trend most impressively and showed 9.25% annual growth in labour productivity between 2000 and 2011. Other countries like Angola, Morocco and Mozambique have also exhibited growth rates in agricultural value added per worker of between 5 and more than 9% per year between 2000 and 2011 (The World Bank, 2015).

At the same time, land productivity growth rates improved in most sub-regions after 2000 from less than 2% during the period between 1980 and 2000. East Africa is the big exception, where land

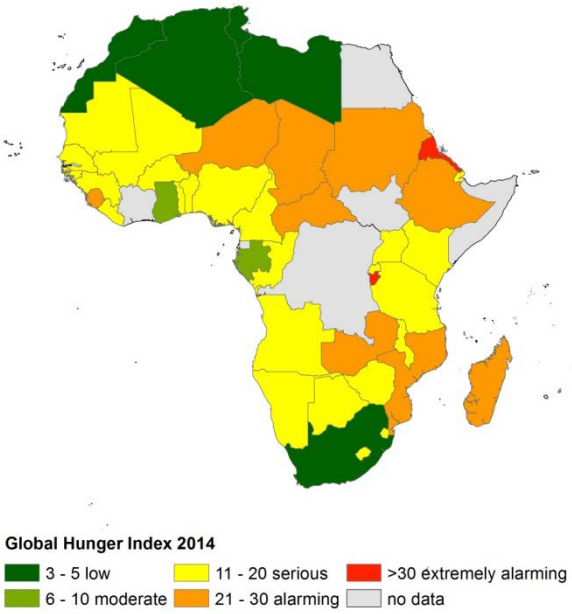
productivity growth rates dropped by nearly half. All these trends show that Africa has made a positive turn but there is still a clear need for investments to raise productivity in order to sustain and accelerate the recent progress.

1.4 Food insecurity is intertwined with violent conflicts and lack of rights

The Right to Food: The Right to Food as part of the right to an adequate standard of living is a universal human right as enshrined in the Universal Declaration of Human Rights (UN, 1948). Despite important progress in fighting hunger und malnourishment, many people are still deprived of this basic human right (see Figure 3). More than 23% of the population in sub-Sahara Africa, i.e. more than 222 million people are currently undernourished (FAO, 2015). To progressively achieve the right to food, it is fundamental to invest in the agricultural sector for the reasons highlighted earlier. The rights issues also need to take land rights into account (Baumgartner et.al. 2015).

Food insecurity and conflicts: There is plenty of evidence that conflicts and food security are closely linked: While conflicts in many cases cause food insecurity, improvements in agricultural productivity and food security can reduce the risk of conflict as conflicts are often caused by a scarcity of (agricultural) resources. Rising demand for land and water, more variable climates and higher frequencies of extreme weather events, rising inequalities between urban and rural areas and greater price volatility will further increase pressure on resources and resource scarcity (Bora et al., 2011; von Braun, 2009). To which extent these factors are politically destabilizing depends on the political and socio-economic context (Pinstrup-Andersen and Shimokawa, 2008).

Figure 3 The Global Hunger Index in Africa



Data source: Amy et al. (2014)

There are several historic examples of food insecurity leading to violent conflicts. Recent examples include the food price spike in 2007/08 that led to protests in more than 60 countries that turned into violent riots in countries where governance was weak (von Braun, 2010). As the poor spend a large share of their incomes on food, increasing food prices directly hurt the poor, especially if the increases are sudden and large (Bora et al., 2011).

The role of migration: Migration is another important factor in this context and has at least two causes and divers patterns. While migration is largely a result of economic development and

increases as Africa becomes wealthier it is also often a result of violent conflicts and causes stress and conflicts. Crop losses often induce migration and environmental problems may cause conflicts over resources, both leading to more migration. In the receiving areas, migrants can beget social tensions and cause or worsen resource scarcity, increasing the risk of conflict there (Bora et al., 2011). The problem is huge. The UNHCR projects that there are about 15 million "people of concern" in Africa in 2015, i.e. refugees, asylum seekers or internally displaced people (http://www.unhcr.org).

While food security is often a driver of violent conflict, it is also often its consequence. Violent conflicts typically reduce the availability of and access to food and affect the appropriate utilization of food. The FAO (2002) has estimated losses of almost $52 billion in agricultural output through conflict in sub-Saharan Africa between 1970 to 1997 (Bora et al., 2011). Messer, Cohen and D'Acosta (1998) estimate that during periods of conflict, agricultural production drops on average 12.3% each year (cited from Kimenyi et al., 2014).

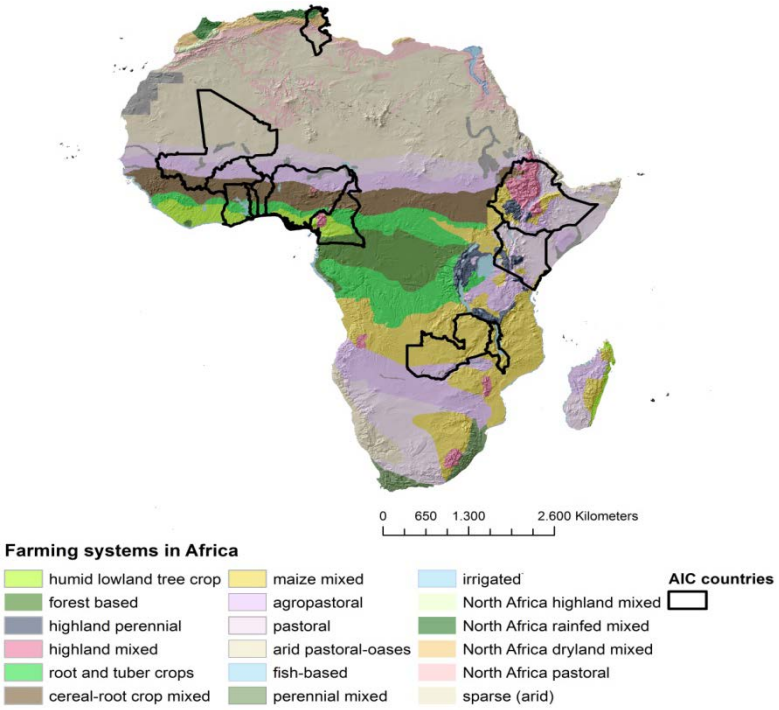
Impacts of conflicts on agricultural and livestock value chains often include reduced a) human mobility as people across all value chains fear movement outside protected areas due to the threat of attacks on the fields or when trying to reach customers or markets; b) reduced access to inputs and output markets; c) frequent theft of cash, products and equipment especially on markets as well as d) sharply rising prices for transportation, inputs and farm products, that further hamper the mobility of people and the availability of farm inputs and outputs and reduce exports. In addition, there is usually a sharp reduction in the delivery of health, education and other services to the conflict regions (Kimenyi et al., 2014).

Thus, conflict and food security are inextricably linked. Food security and reduced pressure on natural resources through increased productivity as well as improved reliability of agricultural production to reduce volatility of supply and food prices are crucial to reduce the risk of violent conflicts that more often than not lead to a vicious cycle of destroyed resources, displacement of people and other implications that worsen food insecurity. Agricultural innovations for food security need to be seen in this broader context.

1.5 Great diversity in African agriculture

When discussing issues related to agriculture in Africa, it needs to be stressed that agriculture in Africa is very diverse. As Figure 4 shows, there are many different farming systems. Even within counties, agricultural diversity can be high, as it is the case, for instance, in Ethiopia, Kenya or Madagascar and many Western African countries. Agricultural policies and the development of agricultural technologies need to take this multifaceted diversity into account.

Figure 4 The diversity of farming systems in sub-Sahara Africa



Data source: HarvestChoice (2015)

The maize mixed farming system covers 16% of land area in sub-Sahara Africa, mostly in the eastern, central, and southern regions. Almost 100 million rural people rely on this system, of whom 58 million live on less than $1.25 a day. These people make up 23% of the total rural poor in sub-Sahara Africa. The highland areas of eastern and southern Africa are characterized by smaller fragmented systems, such as the highland perennial and highland mixed systems. These systems cover only 2% of the area but are home to 17% of the rural poor. The agropastoral farming system, the root and tuber crop system and the cereal-root crop mixed system together cover more 30% of the land area and provide the livelihoods for many people, many of whom are poor. Together, these farming systems are home to 40% of the rural poor in sub-Sahara Africa (Sebastian, 2014).

1.6 Opportunities and challenges of Africa's small farm sizes

Similarly to the high diversity in farming systems, population densities and available land resources are very unequal in Africa. The most densely populated 20% of Africa's arable lands contain 25 times more people than the least densely populated 20%. (Jayne et al., 2014). Thus, there are both land abundant and land constrained areas in Africa.

Increasing land constraints: Rapid population growth in densely populated rural areas exacerbates existing land constraints and increases pressure on farm land and farm sizes. Despite the mentioned land abundancy in certain areas, the pressure on farm land cannot be easily relieved by area expansion as most of the underutilized land resources in Africa are concentrated in relatively few countries (Chamberlin et al., 2014). As a result, rising population densities in many African countries severely affect agricultural systems by causing shrinking land sizes of most smallholder farms (Jayne et al., 2014; Lowder et al., 2014). Thus, for the majority of African countries, farmland expansion cannot be relied on to sustain future growth.

Small farm sizes: While there is a growing group of medium-scale "emergent farms" cultivating 5–20 ha of land, which result out of land acquisition by salaried urbanites and relatively privileged rural individuals (e.g. in Zambia; Sitko and Jayne, 2014), the majority of farmers are still operating on farms with less than two hectares. Lowder et al. (2014) estimate that in sub-Saharan Africa, about 60% of

farms are smaller than one hectare and control close to 20% of the farmland; another 20% of the farms are between one and two hectares and also cultivate about 20% of the total farmland. Only very few farms are larger than 50 hectares and these few farms comprise only a small share of total farmland.

The predominantly small land sizes raise questions concerning productivity as economies of scale would suggest lower output per hectare for small farms. However, empirical observations often find inverse relationships between farm sizes and yields (von Braun, 2014). While farms with larger land sizes mostly depend on hired labor, which involves higher (transaction) costs than relying on family labour, large farms often enjoy a credit cost advantage. However, the optimal farm size is heavily influenced by the capacity of small versus large farm communities to engage in political lobbying and rent seeking and the development of the non-agricultural sector, which especially influences the cost of labour, and will thus vary in different contexts (von Braun, 2014).

Innovations for agricultural growth need to consider the challenges of small and further shrinking farm sizes and the related implications for productivity. As farm size is a factor that cannot be easily changed, innovations are needed that strengthen the advantages of smallness and transform those factors that advantage large farms in a way that also small farms can benefit.

1.7 The need to produce more food with less impact on the environment

Apart from shrinking farm sizes, the growing population leads to increasing demand for more and different food and non-food biomass products and thus increases pressure on resources. Agricultural production to satisfy the rising demand needs to be balanced with all aspects of sustainability. The quest for sustainability and increased food production has long fueled the debate about organic versus conventional agriculture. The new paradigm of “sustainable intensification” (The Montpellier Panel, 2013) has helped to dissolve the strict border between organic and conventional agriculture and combines different approaches to allow for the production of more food with less impact on the environment. The goal is to intensify “food production while ensuring [that] the natural resource base on which agriculture depends is sustained, and indeed improved, for future generations” (p. 4). The concept has now been widely adopted by national governments, the FAO, agricultural research organizations, agribusinesses and donors (see also Baulcombe et al., 2009; Garnett et al., 2013). Sustainable intensification does not only combine ecological and genetic intensification but includes socio-economic intensification, i.e. human and social capital as well as enabling environments and the creation of sustainable livelihoods, as a third pillar that is equally important to increase food production with reduced impacts on the environment (The Montpellier Panel, 2013).

Reducing yield gaps: This quest for combining different approaches to increase yields is in line with the findings of recent assessments of the prospects for reducing yield gaps, i.e. of reducing or eliminating the difference between actual yields and potentially attainable yields in a certain area. Recent research shows that nutrient and water management are the two most critical factors for yield improvements. While especially in Africa increased amounts of fertilizer are needed to increase yields, it would be possible to close global yield gaps on major cereals to a difference of less than 25% between attainable and current yields with minimal changes to total worldwide nitrogen and phosphate use if intensification is coupled with a reduction in nutrient imbalances and inefficiencies (Mueller et al., 2012). Additional to adequate nutrient and water management, innovations like precision agriculture techniques, high-yielding hybrids and multifunctional landscape management or organic nutrient inputs are highly important to close yield gaps and increase resource efficiency (Mueller et al., 2012; Pradhan et al., 2015).

Innovations in the seed sector: Innovations in the seed and pesticide sector are similarly important. Concerning seed, two different levels need to be addressed. The first level is the benefits and challenges related to improved (hybrid) seed varieties on the one hand and traditional varieties and landraces on the other (see e.g. Balcha and Tanto, 2008; Thijssen et al., 2008). While the first offer

benefits like higher yields or resistance against droughts or different pests, the latter are often easier to obtain, require less cash and are vital to conserve agro-biodiversity. The second and related level is the seed systems in the different countries that often do not perform well and lead to undersupply and unsatisfactory quality of improved seeds (Husmann, forthcoming; Spielman et al., 2011; Tripp, 2000). Balancing advantages and disadvantages of different types of seeds and addressing the challenges in the seed systems are both critical to make farmers more productive and resilient.

Farm mechanization: An often less stressed but very important aspect of sustainable intensification is farm mechanization. Mechanization efforts need to combine the use of small, multipurpose and inexpensive power sources such as two-wheel tractors with the promotion of energy saving technologies and ensure profitability for farmers. Adequate farm mechanization will also reduce labor drudgery and thus make farming more attractive to the youth (Baudron et al., 2015; James and Faleye, 2015; Langford, 2015). While agriculture is currently the occupation of last resort especially for better educated young people, innovations including in mechanization are needed to make the agricultural sector offer meaningful and well-rewarded work for skilled young people (Filmer and Fox, 2014). Of course, this will have implications on the labor market where the benefits of the absorption of unskilled labor in the sector need to be balanced with efforts to increase labor productivity.

Road and ICT infrastructure: Investments in infrastructure are similarly critical to foster sustainable intensification and improve agricultural performance. Access to input and output markets and information require improvements in road and network infrastructure. But due to a lack of transport infrastructure, the majority of people in rural Africa still need several hours to get to the next market (HarvestChoice, 2011). Similarly, while mobile phones have become the most ubiquitous telecommunication technology in developing countries and can be expected to play a major role in the future development of the agricultural sector, many people in Africa still suffer from limited network coverage. Yet, those who have access to networks benefit from an increasing number of services that are delivered through mobile phones (m-services) in areas such as health, education, agriculture and entertainment. In the agriculture sector, better access to information, markets and financial services are among the most commonly cited uses of mobile phones, followed by the delivery of extension and other public services and the use of mobile phones in supply chain management (Aker, 2011; World Bank, 2011; Zhenwei Qiang et al., 2012; see also Baumüller, 2015). While the rise in ICTs is widely discussed now, the use of mobile phones in agricultural service delivery is still at an early stage. Most of the services have yet to reach scale and long-term financial sustainability (Baumüller, 2015).

Gender issues: Generally, when discussing sustainable intensification and innovations in agriculture, it is important to keep gender issues in mind as innovations affect women and men in different ways. Past agricultural modernization processes have not been gender neutral. Women are highly involved in agriculture but their contribution tends to be underrated. Agricultural innovations may involve trade-offs and negative side-effects for different social groups. Trade-offs and side-effects depend on the type of innovation and the local context. Thus, the development and introduction even of technology-focused – in contrast to institution-focused – innovations need to consider gender and social disparity considerations as well as local specificities (Beuchelt and Badstue, 2013; Beuchelt, forthcoming).

2 Policies, Strategies and Collaborations: A Synthesis of the African Agenda(s)

As the preceding sections have outlined, the role of agriculture in the national economies and the sector's wider implications for poverty reduction and food security, including the reduction of the risk of violent conflict, is now well recognized. As a consequence, several major policies and strategies to support agriculture in Africa have been put in place. The major initiatives focusing on agriculture and rural development are discussed in the following, starting with the most recent one and then going back in history.

2.1 African countries commit to focus on agriculture and food security

Agriculture and food security as clear policy priorities in Africa: The recent period of economic recovery has coincided with a profound transformation in the agricultural policy and strategy landscape. Over that last decade, Africa transitioned from externally driven, frequently changing policy and strategy agenda with shifting priorities that have defined most of its post-independence history to a more consistent, coherent and internally owned and led agricultural sector development framework. In the new, post structural adjustment policy and strategy landscape, African countries have resolved some of the decade long tensions around the roles of government versus the private sector and the market and that of agriculture versus non-agriculture. As a consequence, agriculture, rural development and food security have remained clear priorities on the African growth and poverty reduction agenda for several years now. Moreover, the quality of sector governance, reliance on the private sector and the promotion of more competitive markets are deeply entrenched in the current agenda (Badiane and Makombe, 2015). This new focus is at the heart of the Comprehensive Africa Agriculture Development Programme (CAADP) which was adopted by the African Union Commission in 2003. It has been reconfirmed again by the 2014 African Union Summit in Malabo, Equatorial Guinea, where the most recent major policy, the so called **Malabo Declaration,** was adopted by the AU Heads of State and Government. In the Malabo Declaration on Accelerated Agricultural Growth And Transformation for Shared Prosperity And Improved Livelihoods, the AU Heads of State and Government commit to end hunger and halve post-harvest losses by 2025, recommit to the CAADP principles and thus further strengthen the CAADP process (see section 2.2).

More specifically, the main pillars of the declaration are (1) the recommitment to the principles and values of the CAADP process; (2) the commitment to enhancing investment finance in agriculture; (3) the commitment to ending hunger in Africa by 2025; (4) the commitment to halving poverty, by the year 2025, through inclusive agricultural growth and transformation; (5) the commitment to boosting intra-African trade in agricultural commodities and services; (6) the commitment to enhancing resilience of livelihoods and production systems to climate variability and other related risks; (7) the commitment to mutual accountability to actions and results and to (8) strengthening the African Union Commission to support delivery on these commitments.

The Malabo Declaration places unprecedented emphasis on implementation, results and impact and has a strong emphasis on accountability. Unlike the 2003 Maputo Declaration that was the starting point for the CAADP process, the Malabo Declaration emerged from a process that was highly inclusive with widespread participation of the civil society, farmer organizations the private sector.

2.2 CAADP as the cornerstone for fostering agricultural development

CAADP is arguably the most prominent program of the New Partnership for Africa's Development (NEPAD), an Africa-wide growth and development initiative of the African Union. CAADP was launched on the AU Summit in Maputo, Mozambique, in 2003 and is an integrated, agriculture-led framework for development that aims at reducing poverty and increasing food security. In the

Maputo Declaration, AU Heads of States and Governments, committed their countries to working towards achieving an average 6% annual agricultural growth rate and, as part of these efforts, to invest at least 10% of total government expenditures in the agriculture sector (Bahiigwa et al., 2013).

Implementation of CAAPD: The response to CAADP and mobilization for its implementation on the ground did not wait long and started in early 2004, with the all-Africa conference on "Assuring Food and Nutrition Security in Africa by 2020: Prioritizing Actions, Strengthening Actors, and Facilitating Partnerships," in Kampala, hosted by the President Museveni of Uganda and attended by Presidents Obansajo of Nigeria and Wade of Senegal. The conference was organized by the International Food Policy Research Institute (IFPRI) and was the centerpiece of a longer-term policy consultation process on African food and nutrition security and brought together more than 500 participants to deliberate on how to bring about change and action to assure food and nutrition security. The conference laid the foundation of the partnership between IFPRI and African organizations which became instrumental in the implementation of CAADP. The partnership was launched with funding from the German Government, which became the very first donor to support CAADP implementation.

Box 1: The 8 steps in the CAADP process:

1. Roundtable held and compact signed
2. Investment plan drafted, reviewed and validated
3. Business meeting held
4. "Country SAKSS established"
5. GAFSP funding approved
6. Grow Africa first wave
7. JSR Assessment conducted
8. New Alliance Cooperation Framework launched

The CAADP process consists of different stages. The first step is signing a CAADP compact. The following steps are holding a roundtable; developing a national agriculture and food security investment plan (NAFSIP); and holding a business meeting for the implementation of the NAFSIP. Countries that have gone through these steps become eligible to receiving a grant from the Global Agriculture and Food Security Programme (GAFSP). Completing the CAADP cycle also sets the stage for membership in the New Alliance for Food Security and Nutrition (see section 3.5), along with participation in Grow Africa, a partnership with the World Economic Forum (see section 2.3). As part of the implementation process post business meeting, countries establish a country SAKSS (Strategic Analysis and Knowledge Support System) platform; carry out an assessment and prepare action plans to strengthen their respective agriculture joint sector review (JSR) processes (Benin and Yu, 2013). These last two steps are critical elements of the efforts to promote evidence based policy planning and implementation through strong accountability processes based on inclusive review, learning, and benchmarking.

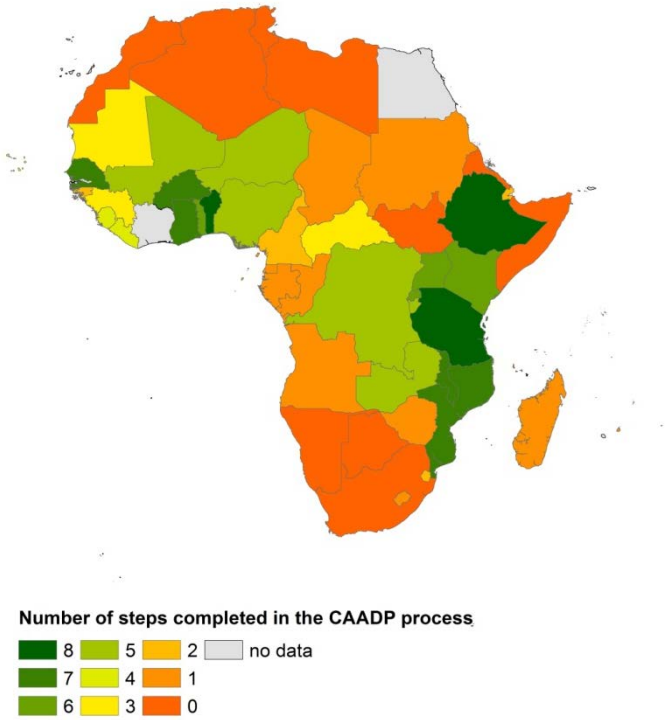
The principles and values of CAADP in the first decade (2003 – 2013) are still valid and shall also guide the implementation modalities in the next decade (2015-2025). These principles and values include African ownership and leadership; accountability and transparency; inclusiveness; evidence-based planning and decision making and harnessing regional complementarities. In addition, it is stressed that CAADP is people-centred and aims at private sector driven development, systemic capacity and subsidiarity, and peer learning and multi-sectorialism (http://caadp.net/about-us).

Current state of CAADP implementation: To date, 42 out of 54 countries in Africa have held a roundtable and signed a CAADP compact. A total of 30 have prepared investment plans, of which 26 have held their business meetings. Nine countries have established SAKSS platforms, with another 6 under preparation. By the end 2015, at least 17 countries will have undertaken assessments to strengthen their JSR processes and the first ever regional JSR will have been completed in for the ECOWAS region (Bahiigwa et al., 2015).

Following the launch of CAADP in 2003, African countries saw a rapid growth in public agricultural expenditure: From 2003 to 2008, expenditures increased by an average of 7.7% per year, an improvement over the pre-CAADP annual average growth rate of 6.6% in 1995–2003. After the Maputo target date of 2008, which coincided with the onset of the food and financial crises, the pace of growth of agricultural expenditures decreased markedly. The continent as a whole saw an annual

decrease in the rate of agricultural expenditure of -1.3% from 2008 to 2013, which was mainly driven by large drops in Nigeria and Angola as these countries accounted for a significant share of public agricultural expenditure in Africa in the years following CAADP's launch. Excluding these two countries, the continent as a whole exhibited positive but very slow annual growth in public agricultural expenditure of 0.03% (Bahiigwa et al., 2013, p. 3).

Figure 5 Number of steps African countries have completed in the CAADP process



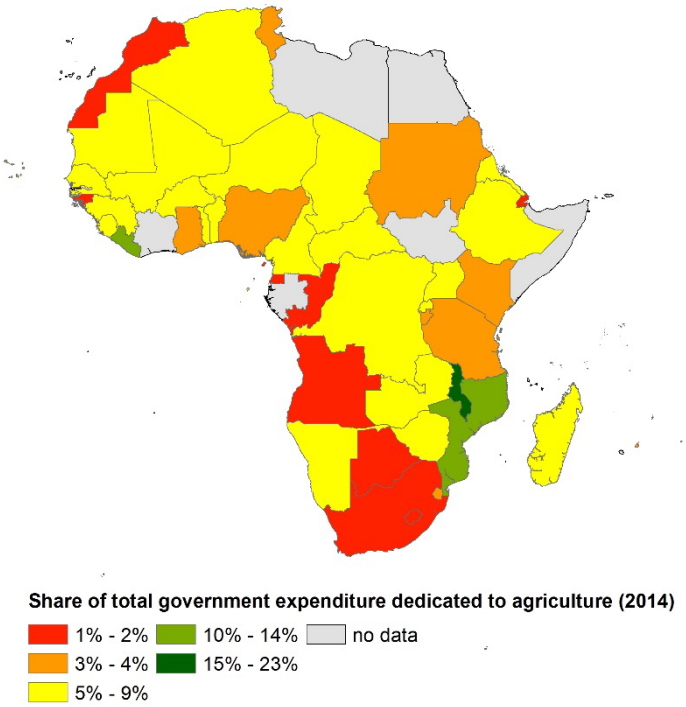
Data source: Badiane and Makombe (2015)

Since 2005, 11 countries have surpassed the CAADP 10% expenditure target in any single year: Burkina Faso, Ethiopia, Guinea, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Zambia, and Zimbabwe. However, only seven of them have surpassed the target in four or more of the last ten years: Burkina Faso, Ethiopia, Madagascar, Malawi, Mali, Niger, and Zimbabwe. In other countries, performance vis-à-vis the CAADP 10% target is mixed (Bahiigwa et al., 2013).

Targeting of agricultural investments: While the commitment by the governments to invest in agriculture must be generally welcomed, expenditures need to be carefully targeted to maximize impact. Evidence shows that not all types of public agricultural expenditures are growth-inducing. Prominent among those types of expenditures that are growth-inducing are investments in agricultural R&D. However, such expenditures take time to show results. Thus, it is important to find a balance between investments that have immediate but possibly short-lived benefits and those that take time to manifest but that offer large and long-lasting economic benefits (Benin and Yu, 2013).

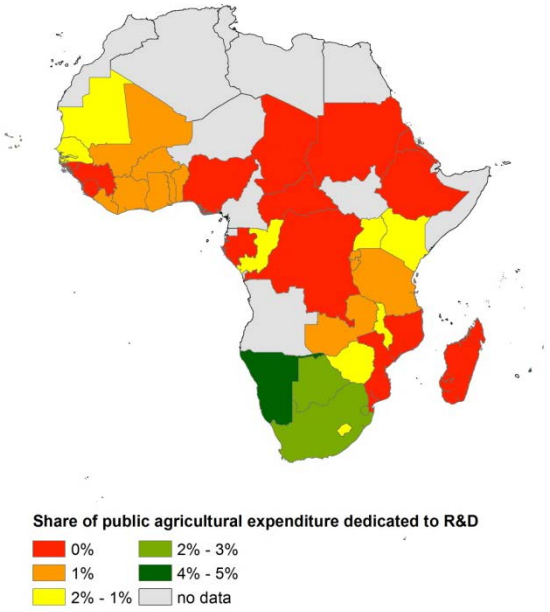
Despite the evidence showing that investments in agricultural R&D are key drivers of productivity growth, "only five of 15 countries (Nigeria, Senegal, Togo, Guinea, and The Gambia) are planning to make any sizable investments in R&D in the CAADP investment plans, which raises concerns about whether countries will be able to achieve the aspired growth rates if they underinvest in critical areas" (Badiane and Collins, forthcoming).

Figure 6 Share of total government expenditures dedicated to agriculture in 2014



Data: ReSAKSS based on SPEED Database (IFPRI 2015), AUC 2008, World Development Indicators (World Bank 2015), and national sources

Figure 7 Share of public agricultural expenditure dedicated to R&D

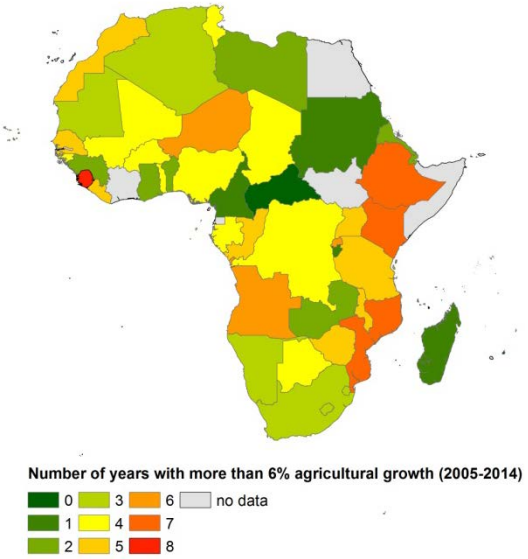


Data source: www.asti.cgiar.org

The 10%-expenditure target was set to achieve at least 6% agricultural growth per year. But despite the impressive performance of the agricultural sector in many countries (see section 1.2), a number of countries, 15 in total, have achieved the 6% agricultural growth target in only two or less years since 2005. Between 2005 and 2014, 20 countries in Africa had three or four years with agricultural growth higher than the aspired 6%. Sierra Leone showed agricultural growth higher than 6% in eight

out of the ten years between 2005 and 2014, Ethiopia, Mozambique and Kenya in seven (The World Bank, 2015; www.resakss.org).

Figure 8 Number of years with at least 6% growth in agriculture



Data source: World Bank (2015)

A correlation analysis shows that the progress of countries in the CAADP process, a country's share of public expenditure dedicated to agriculture and the agricultural growth performance are linked: There is a clear and positive correlation between the number of steps a country has completed in the CAADP process and the country's percentage of public expenditure dedicated to agriculture (correlation coefficient r=0.52). Moreover, the share of government's expenditures on agriculture out of total public expenditure and the number of years a country achieved at least 6% agricultural growth show a similar positive correlation (r=0.29). A similar correlation can be shown for the relationship between a country`s number of years with more than 6% agricultural growth and the number of steps completed in the CAADP process (0.37). While such a simple analysis cannot claim to show any causality, it seems that countries focussing on the agricultural sector are rewarded with relatively stronger growth in the sector.

2.3 New partnerships between African governments, donors and the private sector

Not only the political background changed in favor of agriculture recently, also the set of actors and the forms of collaboration have been enriched and strengthened by important new partnerships between African governments, donors and the private sector. These partnerships that focus on agricultural growth and food security also emerged in the last decade or so and go far beyond classical bi- or trilateral cooperation or public-private-partnerships.

International multi-stakeholder partnerships under African leadership: One important example of these partnerships is the **Alliance for a Green Revolution in Africa (AGRA)**. AGRA was founded in 2006 through a partnership between the Rockefeller Foundation and the Bill & Melinda Gates Foundation. Today, AGRA also receives funding from other governments, agencies and international organizations. By 2020 AGRA strives to reduce food insecurity by 50% in at least 20 countries, double the incomes of 20 million smallholder families, and to put 15 countries on track to attain and sustain a Green Revolution. AGRA's approach is to provide expertise, make grants and build capacity, facilitate the sharing of knowledge and information, and to bring stakeholders together. AGRA works in Africa with a presence in 17 African countries. Since its inception, AGRA has funded 673 projects at

a cost of $386 million (as at 2014; http://www.agra.org/grants/). AGRA's independent evaluations of potential investments is noteworthy.

CAADP efforts are complemented by initiatives started by development partner countries. One major example is **Feed the Future**, a global food security initiative launched by Barack Obama as one of the first foreign policy acts of his presidency. At the 2009 G-8 Summit in L'Aquila, Italy, he pledged to mobilize at least $3.5 billion toward global food security, which leveraged additional commitments of more than $18.5 billion from other donors. Feed the Future focuses on climate-smart development, gender integration, improved nutrition, inclusive agriculture growth, private sector engagement and research and capacity building (www.feedthefuture.gov).

Complementing international initiatives: Complementing and bolstering these efforts, the **New Alliance for Food Security and Nutrition** (New Alliance) that has been launched at the G8 summit in May 2012 as a partnership between G8 nations, African countries and the private sector is working in 10 African countries, with more than 160 local and international companies, and mobilized more than $7 billion in planned investments only two years after its launch. The New Alliance and **Grow Africa** claim to have reached more than 2.6 million smallholders through services, training, sourcing or production contracts. Participation in both these initiatives is now one of the steps of the CAADP process (see **Box 1**).

Another large initiative that is closely linked to these initiatives and CAADP is the **New Vision for Agriculture**. The New Vision is an initiative of the World Economic Forum that aligns regional and national leaders to catalyze action-oriented partnerships in 11 countries across Asia, Africa and Latin America. Anchored around government plans, the partnerships engage the private sector, farmers' organizations, donors, civil society organizations, various public sector institutions and other stakeholders. These activities have engaged over 250 organizations and activated commitment, collaboration and innovation among a broad network of over 800 leaders. Global platforms, including the G8 and the G20, have provided support to complement and accelerate these activities, leading to a commitment of over $3 billion by the private sector for investments in African agriculture. The actual impacts of this and the other major initiatives needs still to be evaluated.

One of the partnerships catalyzed by the New Vision for Agriculture is **Grow Africa**. Grow Africa is a multi-stakeholder platform with the goal of accelerating private sector investment in 12 CAADP countries. It is established as a regional partnership, which is jointly convened by the African Union and the New Partnership for Africa's Development (NEPAD) to mobilize investment and partnership in alignment with the national plans of African countries (World Economic Forum, 2015).

Civil Society Initiatives: The engagement of civil society for rural development and hunger reduction has always remained strong in Africa. When international NGOs are involved, their engagement – such as by Welthungerhilfe and Bread for the World - is more and more implemented indirectly through local partners. This engagement is large and growing: for instance German NGOs spend more than 300 million Euros per year on support for Africa, which is more than the German private sector invests on the continent (205 million Euros in 2013; Deutsche Bundesbank and Afrika Verein der Deutschen Wirtschaft, 2015). An increasingly vibrant African civil society sector with growing professional strength facilitates also potentially growing effectiveness in food and agriculture related action programs at a local level. The potentials for unusual alliances between civil society and business actors seems to be growing in some countries, but there are also some countries in Africa that politically restrict the work by NGOs.

The importance of African entrepreneurs: Furthermore, African entrepreneurs are gaining importance at unprecedented speed. With an increasing number of innovation hubs and continuously improving start-up infrastructure, entrepreneurs are shaping the African landscape in many different areas. Many of these entrepreneurs give up regular and well-paid jobs to realize their own business ideas. These ideas range from developing mobile apps that connect people in remote areas with medical doctors in real time or providing price, weather, planting and other information to farmers to offering practical agronomic and business skills trainings for young farmers (see

examples on http://www.howwemadeitinafrica.com or http://www.forbes.com/lists/). While many of these start-ups still face challenges when trying to scale up their businesses, the multitude and great diversity of services offered by African entrepreneurs and the entrepreneurial spirit that is spread with these initiatives has already changed the African investment landscape and will continue to do so in the future.

As becomes clear, all major initiatives focusing on agriculture and food security in Africa are referring to and aligned with CAADP. The CAADP principles and targets – set by African governments - are the reference point for developments in the agricultural sector. Any (new) intervention should therefore be streamlined with CAADP and fitted into the quickly evolving system of African initiatives and the mentioned new partnerships in order to ensure coherence with African policies and strategies.

3 Innovation Initiatives to Tap Potentials in Africa

Additional to the various policies and strategies to spur agricultural growth that have been launched by African and international actors, there are various efforts to support innovation and science for agriculture and food security in Africa. Starting from low levels, Africa has a rapidly evolving science sector in agriculture, food security and nutrition. The **African Association of Agricultural Economists**, for instance, was established in 2004 and is already a vibrant body whose publications and conferences are on world-class scientific levels (http://www.aaae-africa.org). The **African Academy of Sciences**, founded in 1985, is now well positioned and a major diver of scientific and technological development in Africa (http://www.aasciences.org).

3.1 Strong and growing political support for innovations in agriculture

Supporting science for food security: Also on the political level, there is growing interest and support from African governments for innovations for agriculture and food security. A major effort in this context is the **Science Agenda for Agriculture in Africa (S3A)**. This agenda was published in 2014 and is an organizing framework of issues, science options and partnerships for the transformation of national science and technology institutions in order to achieve a social and economic transformation of Africa. The priority is to bring about a more productive and efficient food and agricultural sector. The Science Agenda is operationalized within CAADP. More specifically, the S3A is the broader framework for the implementation of the Framework for African Agricultural Productivity (FAAP), which is a reference document for implementing the CAADP tenet on agricultural science and technology (FARA, 2014, p. 5).

A strategy to foster agricultural innovations: Another important step in setting the stage for increased support for agricultural research and innovation was taken in April 2014, when the African Ministerial Conference on Science and Technology approved the **Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024)**. STISA-2024 was adopted as the continental framework for accelerating Africa's transition to an innovation-led, knowledge-based economy within the overall framework of the broader and long-term AU Agenda 2063. It is the first of the ten-year incremental phasing strategies to respond to the demand for science, technology and innovation to impact across critical sectors. The STISA-2024 has six priority areas, one of them is the eradication of hunger and achieving food security. Other priority areas are the prevention and control of diseases; communication (physical and intellectual mobility); protection of our space; live together - build the society; and wealth creation (African Union Commission, 2014). The implementation of STISA-2024 will take place at national, regional and continental levels. Member states are encouraged to integrate the strategy into their national science, technology and innovation programs while regional economic communities, regional research institutions, networks and partners should leverage the strategy in designing and coordinating initiatives. On the continental level, the African Union Commission and the NEPAD Agency are expected to advocate and create awareness, mobilize necessary institutional, human and financial resources, track progress and monitor implementation (African Union Commission, 2014).

Finally, the **EU-Africa cooperation on Science, Technology and Innovation** (STI) provides important support for innovations in the food and agricultural sector. The cooperation is intended to strengthen knowledge-based societies and enhance the development and deployment of effective solutions for societal challenges such as climate change, affordable renewable energy, infectious diseases or food and nutrition security. It is implemented largely through the **EU-Africa High Level Policy Dialogue (HLPD) on science, technology and innovation**, which recently established a group of 10 experts from Europe and Africa to work on a roadmap towards this EU-Africa Research and Innovation Partnership, focusing on food and nutrition security and sustainable agriculture.

3.2 Measuring progress and improving data availability to foster innovation

Several other initiatives have been put into place to accompany the mentioned science and technology strategies. One of them is the **African Science, Technology and Innovation Indicators (ASTII)**, which is the first significant attempt to measure S&T activities in Africa. The ASTII initiative was launched in 2007 by NEPAD and has encouraged participating countries to conduct R&D and Innovation surveys and collect data on appointed indicators. ASTII compiles, processes, and disseminates data on institutional developments and investments in worldwide agricultural R&D. ASTII comprises a network of national, regional, and international agricultural R&D agencies and is facilitated by IFPRI (http://www.asti.cgiar.org/globaloverview).

A related initiative is the **African Observatory of Science, Technology and Innovation (AOSTI)**, which was established by the AU in 2009 and serves as a continental repository of STI statistics and source of policy analyses. The organization commissioned the **Assessment of Scientific Production in the Africa Union 2005–2010** that focusses on scientific knowledge that has been published in peer-reviewed journals and cited in other publications, but also includes a section on patenting in Africa (http://aosti.org/).

Another effort to institute processes for broad-based STI data collection and analysis is the first **Africa Science, Technology and Innovation Review 2013** that was commissioned by the UN Economic Commission for Africa. Amongst other aspects, the review aims at providing data to enable member states to make informed policy decisions in the areas of science and technology and to help monitor their performance over time in a wide range of science, technology and innovation-related issues. The STI Review addresses the entire innovation value chain from training and research and development to technology development, acquisition, use and application. It also attempts to describe the innovation ecosystem in Africa (UNECA, 2014).

As these initiatives show, there is an emerging basis on the continent now with which innovations in the food and agricultural sector can be developed and disseminated.

4 What Should German Development Investments Focus on to Foster Agricultural and Rural Development and Food and Nutrition Security?

In order to identify strategic directions for German development investment in Africa, a few criteria and principles are proposed here. They are in line with good development practice as specified by development partners (Accra principles etc.) emphasizing partner countries leadership, and also consider specifics of high expected returns to investment for sustainable agricultural growth and food security.

Building on Progress: Important progress in the policy and scientific landscape make African countries strong partners for the development and implementation of agricultural innovations. Policies to strengthen innovation as well as initiatives to measure countries' progress and commitment to achieving sustainable innovation-led agricultural growth for food security and employment provide fertile grounds for public investments as well as investments by the private sector.

Other than in previous decades of development cooperation with Africa, since the last decade, German development cooperation in support of sustainable agricultural growth and food security can nowadays relate to more coherent and sound strategies and policies in Africa. As the preceding sections have shown, Africa has introduced initiatives and policies to foster agricultural growth and strengthen R&D for agricultural innovation.

The "One World – No Hunger" initiative of the German Government thus comes at a time where a good number of African countries have departed from stagnation and neglect of agriculture and food security and made progress towards increased investments. As a consequence, German development investments need to directly connect to the Africa-wide and country specific initiatives under CAADP in order to maintain policy coherence.

Linking to the set of African initiatives: Germany's engagement for food and nutrition security in Africa needs to link Germany's strengths in different subject areas with the potentials in different countries and be harmonized with the major initiatives that have been outlined. Particular German strengths are for instance agricultural science, technology development, vocational training and farmers' education, cooperation arrangements, farmer organizations for inclusion and inventiveness, food and agricultural policy analyses, value chain optimization, etc. Over the past decades, German development research and cooperation on the ground also has learned a lot at an international level due to engagements in Asia, Latin America and Africa.

Value chains plus enablers to focus on: While an approach to work in selected value chains in different countries can help to spur growth and innovation on the regional level along these value chains, the "One World – No Hunger" initiative has also the potential to function as a more general "enabler" for selected countries in the context of the African activities in S&T. In other words, the German initiative can support countries in the processes of agricultural development in terms of different measures of supports that are needed to achieve what is outlined in their respective agricultural strategies, and mostly derived from CAADP.

Questions for optimal targeting of German investments are the "where", "how" and "in what" to invest.

Targeting which countries: The **"where"** can partly be identified by analyzing the past performance of the different countries. Priority should be given to countries that have made progress in the CAADP process as this process requires countries to analyze their agricultural sector and to develop an agricultural strategy. Having gone through such a process implies that the stage is at least to a certain degree set for agricultural investments. Countries without sound agricultural and food security strategies, on the contrary, may not be adequate investment targets. Building on these

prerequisites of an agricultural strategy and other progress in the CAADP process, the 10% public spending target for agriculture, the past performance concerning agricultural growth and TFP growth can serve as important indications for how fertile the ground for German agriculture development investments is. While some positive signals in past records are important to avoid dead end investments, investments also need to be targeted towards countries where hunger and undernourishment are still major challenges. But also here, recent progress in the fight against hunger can serve as an indication of the dedication of the respective government to address this problem.

In sum, in view of the above mentioned goals, and in pursuit of efficiency and effectiveness, development investments by Germany should target countries and locations that

1. have a **track record of political commitment** to foster sustainable agricultural growth, as indicated by performance under CAADP, and
2. **show actual progress** in sustainable agricultural productivity driven by related innovations, as indicated by comprehensive productivity measurement and innovation actions on the ground, and
3. **prioritize actions for hunger and malnutrition reduction** and show progress (for instance measured by the Global Hunger Index), but where agricultural and rural development and nutrition interventions are likely to make a significant difference, as indicated by public policy and civil society actions.

If these criteria are applied, Ethiopia, Mozambique, Sierra Leone, Kenya, Niger, Malawi, Senegal, Congo (Brazz.), Mali and Zambia may be among the „top ten" to be considered. All these countries have already signed a CAADP compact. Five of these countries (Ethiopia, Kenya, Malawi, Mali and Zambia) are "AIC countries", i.e. countries with Agricultural Innovation Centers (see Table 1 for more information on AIC countries). Among the 12 AIC countries, only three countries (Togo, Cameroon and Tunisia) do not figure among the top 25 of the 42 countries ranked according to the criteria outlined above.

Table 1: Analysis of potential of AIC and other African countries
(AIC countries are shaded)[1]

Rank	Country	(1) Production potential score		(2) Political commitment score			(3) Hunger status and progress score		Overall score
		Percent score agricultural growth	**Percentage point score innovation**	**Percent score public agricultural expenditure**	**Percent score innovation investment**	**Percent score progress on agricultural policy**	**Score hunger problem to be addressed**	**Percentage point score progress on hunger reduction**	
		Index: Number of years with >6% agricultural growth (2005-2014)[2, 5]	Index: Percentage point change in TFP (2001-2008)[3,6]	Index: Number of years with government expenditure on agriculture >10% (2005-2014)[2,5]	Index: Average share of agricultural GDP spent on R&D (2005 to 2011)[4,7]	Index: Number of steps in CAADP process completed (% of the maximum of 8)[5]	Index: Value of Global Hunger Index (2014)[3,8]	Index: Reduction in prevalence of undernourishment (2001-2011)[3,9]	
1	**Ethiopia**	**70**	**60**	**80**	**26**	**100**	**100**	**100**	**78**
2	Mozambique	70	60	20	43	88	100	100	72
3	Sierra Leone	80	100	0	22	50	100	100	71
4	**Kenya**	**70**	**100**	**0**	**100**	**75**	**60**	**60**	**68**
5	Niger	60	100	40	0	63	100	60	65
6	**Malawi**	**50**	**100**	**90**	**78**	**88**	**30**	**30**	**63**
7	Senegal	50	30	0	81	88	30	100	54
8	Congo (Brazz.)	50	100	0	97	13	60	30	52
9	**Mali**	**40**	**60**	**60**	**61**	**63**	**30**	**60**	**52**
10	**Zambia**	**20**	**100**	**30**	**38**	**63**	**100**	**0**	**51**
11	Tanzania	50	60	0	51	100	60	30	50
12	Burundi	10	0	0	64	63	100		49
13	Angola	60		0	0	13	60	100	48
14	**Benin**	**20**	**60**	**0**	**53**	**100**	**0**	**100**	**47**
15	Rwanda	60	0	0	61	75	30	100	47
16	**Ghana**	**20**	**100**	**0**	**62**	**88**	**0**	**60**	**47**
17	**Burkina Faso**	**40**	**0**	**40**	**39**	**88**	**60**	**60**	**45**
18	Sudan	10	30	0	25	13	100		(44)
20	Uganda	50	0	0	100	75	60	30	43
22	Zimbabwe	50	0	60	48	13	60	60	42
24	**Nigeria**	**40**	**60**	**0**	**33**	**63**	**30**	**30**	**37**
26	Madagascar	10	30	40	21	13	100	30	37
27	Liberia	50	0	10	47	50	60	30	35

29	**Togo**	**40**	**0**	**0**	**43**	**75**	**30**	**60**	**35**
30	Gambia	30	0	0	82	50	30	60	35
31	Cote d'Ivoire	30	30	0	49	75	60	0	34
32	**Cameroon**	**10**	**30**	**0**	**0**	**25**	**30**	**100**	**31**
35	Chad	40	0	0	14	13	100	0	26
40	Congo DRC	40	0	0	17	63			23
41	**Tunisia**	**40**		**0**	**0**	**0**	**0**	**0**	**13**

Explanations:

[1] Columns (1), (2) and (3) constitute one group each. Within these groups, indicators are weighted equally. The overall score is the average over these groups, with all three groups entering with the same weight. Missing data is omitted. Thus, if for one indicator in group (1) data is missing, the score for group (1) is built only with the other indicator that then enters with 100% (instead of 50% when data for both indicators is available).

[2] Number of years in which growth or expenditure goal was reached in % of total years in observation period (relative success in %).

[3] For these indicators 4 classes of progress are built based on quartiles of countries. The worst quartile has a score of 0, the second a score of 30, the third quartile of 60 and the best quartile has a score of 100.

[4] Score is 100 if 1% or more of AgGDP is spent on R&D.

Note: empty cells indicate missing values, which are excluded from scoring

Data sources:

[5] www.resakss.org

[6] Fuglie & Rada (2011)

[7] www.asti.cgiar.org/data

[8] Global Hunger Index 2014 (Amy et al., 2014)

[9] Food security indicators FAO (2015)

Sound approach to investment: The identification of how and in what to invest would also benefit from some general principles and criteria. Concerning the **"how"** to invest, should be guided by principles of good governance, achieving investment at low transaction costs, sound financial practices, and avoidance of any leakages or diversions of funds. Partnership principles need to be accompanied by strong monitoring and evaluation systems that assess achievements relative to mutually set goals. A lot can be learned from ongoing initiatives. AGRA, for instance, has established independent evaluation panels that assess potential investments. It would also be desirable to link with the country level review and dialogue processes to foster accountability and facilitate learning and partnerships needed for scaling up.

Results oriented investment: The answer to the question **"in what"** public development investments should go should be guided by expected social outcomes, i.e. impacts on reduction of hunger, and by positive income and employment effects on small farms and in rural areas in particular for youth and women, as well as long term comparative advantages of production in the context under consideration. This is most likely in the cases of value chains and geographic areas that have large potential for productivity increases and significant smallholder presence, and play an important role as an actual or potential source of employment and income for vulnerable groups, including women and youth. Moreover, investments to be undertaken in these contexts should be scalable for the largest impact possible.

While these criteria on the African side should be among the key guiding criteria, it should also be taken into account that a partnership approach between Africa and Germany in the field of agriculture and food security should match specific German strengths with the African needs concerning innovation-enhancing investments in agriculture. Here are a few examples: The system of vocational training for farmers and applied education for future farmers (while working part time) have proven to be very successful in Germany and could be adapted by other countries. The German science system in agriculture, which is organized in private and public organizations and is characterized by a close elation between researchers and farmers, could benefit African countries if adequately adapted. The medium size agro-industry, incl. seed industry, as well as civil society organizations are also important to consider.

If the selected criteria are appropriately followed without treating them too much like a rigorous prescription, development investments in African agriculture and for food security will make a major contribution to the eight priority areas of the German "Charter for the Future" issued in 2014 and are in line with the Sustainable Development Goals (2015).

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