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Mariam Amadou Diallo and Fleur Wouterse

How can CAADP implementation help countries achieve the SDGs and become resilient to climate change? *A tale of six African countries*

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Mariam Amadou Diallo and Fleur Wouterse

AKADEMIYA2063 - Kicukiro/Niboye KK 341 St 22 | P.O. Box 1855 Kigali-Rwanda
AKADEMIYA2063 | Lot N*3 Almadies | BP 24 933 Ouakam Dakar-Senegal
Email: hq-office@akademiya2063.org | www.akademiya2063.org

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Authors

Mariam Amadou Diallo is an Associate Scientist at AKADEMIYA2063:
mdiallo@akademiya2063.org.

Dr. Fleur Wouterse is a Principal Researcher at the Global Center on Adaptation:
fleur.wouterse@gca.org

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ACRONYMS

AfDB	African Development Bank
ASYB	African Statistical Yearbook
AUC	African Union Commission
BaU	Business-as-usual
CAADP	Comprehensive Africa Agriculture Development Program
CGE	Computable General Equilibrium
EDPRS	Economic Development and Poverty Reduction Strategy
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GTP II	Growth and Transformation Plan II
HCE	Household Consumption and Expenditure
IHS4	Fourth Integrated Household Survey
MGDS	Malawi's Growth and Development Strategy
MGDS III	Third Malawi Growth and Development Strategy
NAIPs	National Agriculture Investment Plans
NEPAD	New Partnership for Africa's Development
NAP	National Agriculture Policy
ND-GAIN	Notre Dame Global Adaptation Initiative
NDP	National Development Plan
PDES	Economic and Social Development Plan
PEDSA	Strategic Plan for the Development of the Agricultural Sector
PIF	Policy and Investment Framework
PRSPs	Poverty Reduction Strategy Papers
PSTA – IV	Strategic Plan for Agricultural Transformation in Rwanda
RCP	Representative Concentration Pathway
SAM	Social Accounting Matrix
TFP	Total Factor Productivity
UNECA	United Nations Economic Commission for Africa
WDI	World Development Indicators

Abstract

Building back better after COVID-19 means making the agriculture sector more resilient. In this paper, using data from Côte d'Ivoire, Ethiopia, Malawi, Mozambique, Niger and Rwanda, we develop a Computable General Equilibrium (CGE) model and micro-economic simulation model to assess how the implementation of National Agriculture Investment Plans (NAIPs) will help to achieve the SDGs, Agenda 2063 and Malabo Declaration objectives of agricultural growth, hunger eradication and reduction of poverty and inequality. Our simulation results show that if an agriculture-led investment strategy was pursued, there would be significant progress in terms of reaching the above-mentioned objectives as well as enhanced resilience to climate shocks. Our paper also shows that neither an industry-led nor a services-led growth strategy would produce the same magnitude of results. The agricultural sector is found to outperform the industry and services sectors in terms of job creation, food expenditure, and poverty reduction in all six countries. External and budget-constrained financing options for these investments generate the most consistent positive impacts on socio-economic goals.

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1. Introduction

The COVID-19 induced global economic recession has caused many to lose their sources of income and has left many vulnerable people unable to afford the food they need. Income losses not only reduce demand for food but also induce shifts in the mix of products consumed, notably resulting in lower consumption of more nutrient-rich foods and relatively higher consumption of calorie-rich foods. This year's State of Food Security and Nutrition in the World report estimates that between 720 and 811 million people were affected by hunger in 2020, an increase of 161 million from 2019 (FAO 2021). Most of these affected people are in sub-Saharan African countries. Other threats arose from disruptions in agricultural input markets, farm production, marketing and distribution of food caused by the need for social distancing to combat the global health crisis (Laborde et al. 2020).

Even before the COVID-19 pandemic, countries in sub-Saharan Africa faced declining per capita gross domestic product (GDP) growth, a rising prevalence of undernourishment, a high proportion of child stunting, an increasing number of poor people and a declining share of and growth in government agriculture expenditure. Climate change has also affected food security in many ways. The consequences of extreme weather events for crop production are highly visible and well known. Since the 1980s, climate change has already reduced crop yields by about 5-10% in some regions (Iizumi and Ramankutty 2016). Worldwide production of maize, rice, wheat, and soya is projected to fall 9% by 2030 and 23% by 2050 (Haile et al. 2017). Particularly threatened areas include coastal regions with high current levels of agricultural production, including Bangladesh and Vietnam, and drought-prone locations, such as large parts of East and West Africa, Morocco, and parts of South Asia and China. Economic impacts are also expected as climate change leads to fluctuating

food prices, which have an indirect negative effect on production as these fluctuations signal risks and reduce incentives to invest in agriculture.

The agricultural sector plays a pivotal role in Africa in terms of employment, income, trade, and food security. It is widely acknowledged that a well-performing agricultural sector is fundamental for Africa's overall economic growth as well as to address hunger, poverty, and inequality. However, in most sub-Saharan African countries, agricultural productivity and production growth have remained relatively modest. Since the 1980s, the African agricultural sector is said to have been neglected by governments and donors. The sector has long remained undercapitalized and underdeveloped (Zimmerman et al. 2009). Agriculture is also a complicated policy field as it is a cross-cutting sector that overlaps with several other policy fields, especially natural resource management. In 2001, the New Partnership for Africa's Development (NEPAD) initiated the Comprehensive Africa Agriculture Development Program (CAADP). The program recommended four thematic pillars around which national agricultural strategies should be built: sustainable land and water management, rural infrastructure and market access, food security and agricultural research (Zimmermann et al. 2009). The two most tangible targets that countries have committed to under CAADP and recommitted to under the Malabo Declaration of 2014 are to allocate at least 10% of their national budgets to agriculture and achieve 6% agricultural growth. In addition to the commitments for the agricultural sector, African countries are engaged in ongoing national policy planning processes, standard frameworks like PRSPs and continental (Agenda 2063) and global (SDGs) agendas.¹ Many African countries have also signed the Paris Agreement on Climate change and have developed Nationally Determined Contributions on climate action and National Adaptation Plans.

¹ In 2015, countries adopted Agenda 2063, Africa's blueprint and master plan for sustainable development and economic growth. Countries are also committed to implementing the SDGs with their overarching aim of sustainably accelerating economic growth and eradicating poverty and inequality by 2030.

Although agricultural production and productivity continued to increase in 2020 in contrast to many other economic sectors, the continent has not been able to achieve the target of 6% annual growth in value-added agriculture for the CAADP period. Furthermore, for Africa as a whole, government expenditure in agriculture as a share of total government expenditure declined from 2.5% in the 2014–2019 period to 2.1% in 2020. Only four countries (Ethiopia, Malawi, Benin, and Lesotho) met or surpassed the CAADP and Malabo Declaration target of allocating 10% of the national budget to agriculture in 2020 (Ulimwengu et al. 2021). Both the COVID-19 pandemic and climate change impacts point to the need for greater efforts at the national and international levels to achieve food security. African countries will need to enhance public spending on agriculture with a greater focus on measures aimed at enhancing the resilience of the sector. To raise the level of agricultural investments and prioritize quality investments, evidence should be incorporated into policymaking, especially regarding the extent to which investments in agriculture support progress towards selected commitments and the overarching aim of enhancing resilience in the face of economic, health and climate shocks.² This is the need we aim to address in the current paper. To do so, we develop an integrated results framework for selected objectives of CAADP/Malabo, SDGs and Agenda 2063 and quantify targets. We then make use of computable general equilibrium (CGE) modelling and micro-economic simulation modelling based on data from Côte d'Ivoire, Ethiopia, Malawi, Mozambique, Niger and Rwanda to assess the economy-wide implications of an agricultural investment strategy.

The rest of the paper is organized into four sections. Section 2 describes the context for each country and specific development challenges. Section 3 presents and describes the integrated results framework. Section 4 describes the methods – the CGE and the micro-economic simulation model – and data used. We present results in Section 5 and conclude in Section 6.

2. Country context and development challenges

Despite the negative impacts of the COVID-19 pandemic on many sectors of the economy, agricultural output in sub-Saharan Africa increased in 2020 compared to 2019 (Zeufack et al. 2021). Many countries experienced strong agricultural growth, and nearly 20 countries met the CAADP 6% growth target in 2019–2020. While this growth is likely due to many factors, it reflects findings that the agricultural sector was not as adversely affected by the COVID-19 pandemic as other economic sectors (Ulimwengu et al. 2021). Agricultural productivity growth benefits smallholder farmers in terms of improved incomes, employment, and livelihoods. It also helps consumers by reducing prices and increasing food availability. Therefore, productivity growth plays a critical role in improving food security and contributing to poverty alleviation efforts. Of course, there is a lot of heterogeneity between the countries considered in this study and we describe the context of each in more detail below.

Côte d'Ivoire has enjoyed vibrant, robust, and stable economic growth since 2012 but experienced a slowdown in 2020 owing to the COVID-19 crisis. Poverty fell sharply from 46.3% in 2015 to 39.4% in 2020, however this decline was confined to urban areas as rural poverty levels rose by 2.4% over the same period. Figure 1 shows that Côte d'Ivoire's agriculture value-added growth rate was 5.2% in 2020. The high ND-GAIN climate vulnerability score of Côte d'Ivoire means that the country has a need for investment and innovations to improve climate change readiness and undertake urgent adaptation actions.³ For Côte d'Ivoire vulnerability to climate change stems mainly from projected changes in cereal yields and agricultural capacity. The former measures the decrease of the cereal yields from the baseline projection (1980-2009) to a future projection (2040-2069) using the Representative Concentration Pathway (RCP) 4.5 emission scenario while the latter reflects a country's capacity to acquire and deploy agricultural technology such as fertilizers, pesticides, irrigation and other agricultural equipment.⁴

² This study was conducted in the context of the Program of Accompanying Research for Agricultural Innovation (PARI) of ZEF supported by BMZ.

³ [Côte d'Ivoire | ND-GAIN Index](#)

⁴ A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. RCP 4.5 is described by the IPCC as an intermediate scenario[10]. Emissions in RCP 4.5 peak around 2040, then decline[13]. According to resource specialists IPCC emission scenarios are biased towards exaggerated availability of fossil fuels reserves; RCP 4.5 is the most probable baseline scenario (no climate policies) taking into account the exhaustible character of non-renewable fuels.

Figure 1: Value-added agriculture growth rate (%)

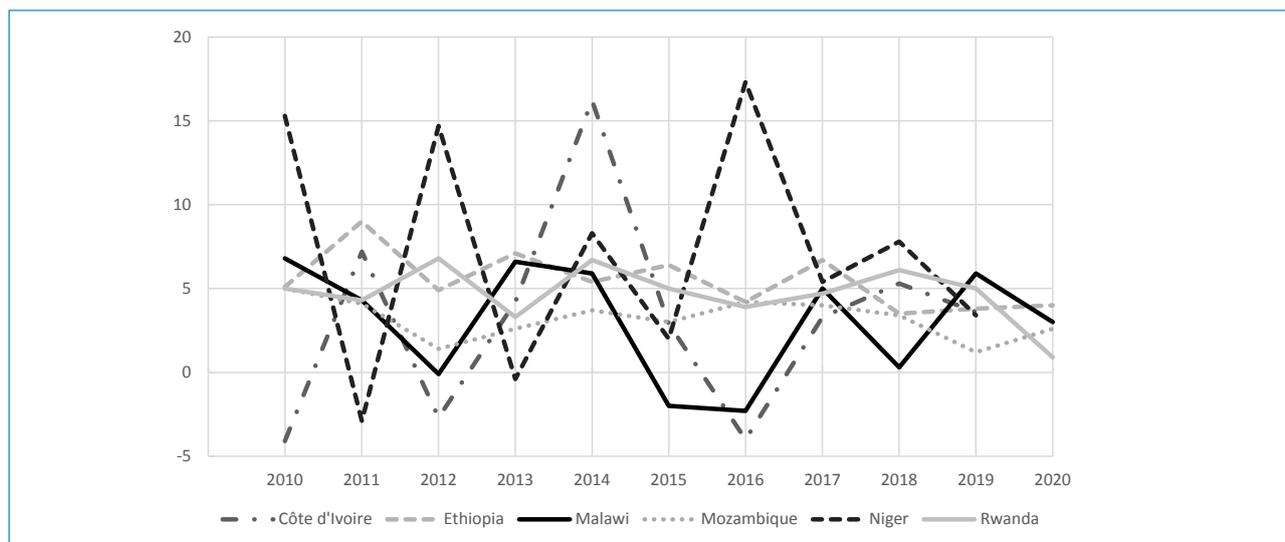


Figure 2: Public expenditure on agriculture (%)

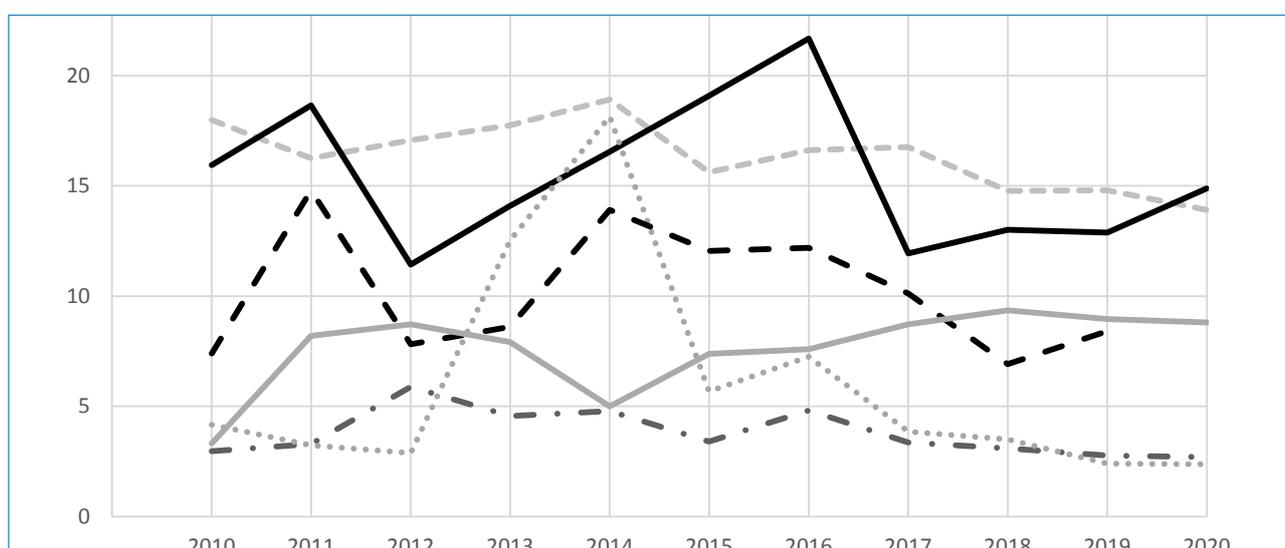


Table 1: Socio-economic indicators, baseline (2015)

	Côte d'Ivoire	Ethiopia	Malawi	Mozambique	Niger	Rwanda
Poverty rate (based on national poverty line in %)	46.30	23.52	51.50	46.10	44.86	38.20
Poverty rate (based on \$1.90 per capita/ per day poverty line in %)	29.80	30.80	69.20	63.70	45.40	56.50
Unemployment rate (% of the working age population)	3.10	2.20	5.85	3.43	0.52	1.14
Share of youth not in employment, education or training	36.0	10.48	32.9	No data	25.20	30.79
Inequality (Gini index in %)	41.50	35.00	44.70	54.00	34.40	43.70
Vulnerability index (ND-GAIN)	0.509	0.559	0.598	0.513	0.677	0.568

With more than 112 million people, Ethiopia is the second-most populous nation in Africa after Nigeria and the fastest growing economy in Africa. However, it is also one of the poorest with a per capita income of \$850. Ethiopia's economy experienced strong, broad-based growth averaging 9.4% a year from 2010/11 to 2019/20, however GDP growth slowed to 6.1% in 2019/20 due to the COVID-19 pandemic. The country's value-added agriculture growth rate was 4.0% in 2020. The share of the population living below the national poverty line decreased from 30% in 2011 to 24% in 2016. In Ethiopia, vulnerability to climate change as measured by the ND-GAIN index is high with the main contributor being a lack of agricultural capacity.

Malawi remains one of the poorest countries in the world despite making significant economic and structural reforms to sustain economic growth. The economy is heavily dependent on agriculture which employs nearly 80% of the population and is vulnerable to external shocks, particularly climatic shocks. The country's vulnerability mainly stems from the likely impacts of change climate on cereal yields and a low capacity to acquire and deploy agricultural technology. Malawi's economy continues to be heavily affected by the COVID-19 pandemic. Favorable weather and agricultural input subsidies have contributed to a one-time jump in the maize harvest, and tobacco production has also increased. As such the economy was expected to grow at 2.4% in 2021. While the national poverty rate has slightly declined from 51.5% in 2015/16 to 50.7% in 2019/20, poverty and inequality remain stubbornly high.

About two-thirds of Mozambique's population of more than 31 million live and work in rural areas. While the economy registered its first contraction in 2020 in nearly three decades, growth is expected to rebound over the medium term, reaching about 4% by 2022. The poverty rate is estimated to have increased from 61.9% in 2019 to 63.3% in 2020 owing to loss of income and employment, pushing an estimated one million people into poverty. The Gini index, which is a measure of income distribution across a population is comparatively high for Mozambique indicating that high-income individuals receive a much larger share of the total population's income. Economic recovery was expected to start in 2021, but this is subject to risks including rising COVID-19 cases, areas with military instability and delayed rollout of the COVID-19 vaccine. Mozambique's value-added agriculture growth rate was only about 3% in 2020. The score on the ND-GAIN vulnerability index reveals that Mozambique is also a country vulnerable to

climate-related disasters with limited capacity to respond appropriately.

Niger has a poorly diversified economy, with agriculture accounting for 40% of its GDP. More than 10 million people (42.9% of the population) were living in extreme poverty in 2020. The growth rate fell from 5.9% in 2019 to 3.6% in 2020 as a result of overlapping health, climate and security crises. However, the favorable economic outlook for 2021 could lead to a 5.1% rebound in growth. Recent gains in combating poverty are in danger of being wiped out, following a 0.2% drop in per capita income in 2020. The favorable economic outlook is expected to help reduce the poverty rate from 41.2% in 2020 to 37% in 2023. However, an annual population growth rate of 3.8% and a fertility rate of 6.9 children per woman continue to limit the fiscal space available to reduce poverty. Also, its geographical position in the Sahel, makes Niger highly drought prone. In fact, Niger is one of the most climate-vulnerable places in the world, ranking 180 (out of 181 countries using the ND-GAIN index). Vulnerability in Niger is elevated for two main reasons in rural areas, one is the continued strong population growth, the other the lack of agricultural capacity.

For Rwanda, growth averaged 7.2% over the decade to 2019 while per capita gross domestic product (GDP) grew at 5% annually. Over 50% of the country's GDP is derived from ecosystem services and 80% of employment is in the agricultural sector. The lockdown and social distancing measures, critical to control of the COVID-19 pandemic, sharply curtailed economic activities in 2020. GDP fell by 3.4% in 2020, the first recession in the country since 1994. Poverty declined from 77% in 2001 to 56.50% in 2015 based on the international poverty line. Rwanda's high ND-GAIN climate vulnerability score is mainly due to its large rural population and limited agricultural capacity.

Rwanda is one of the few African countries that managed to consistently achieve the CAADP growth target during the 2008–2019 period. Côte d'Ivoire, Mozambique and Niger also recorded notable growth and met the CAADP target of 6% in the same period. In terms of public spending in agriculture, Malawi and Ethiopia surpassed the 10% target while Niger and Rwanda came close to meeting the 10% target. Figure 2 also shows that both Côte d'Ivoire and Mozambique allocated less than 5% of their budget to agriculture. When we combine Figures 1 and 2, we also note that the 10% budget allocation to agriculture in and of itself is not a guarantee for growth in agricultural value-added products. The quality and composition of investments in agriculture

is important to ensure their effectiveness in meeting development objectives (Goyal and Nash 2016; Pernechele et al. 2021).

3. An integrated results framework

The Comprehensive Africa Agriculture Development Program (CAADP) is Africa’s policy framework for agricultural transformation, wealth creation, food security and nutrition, economic growth, and prosperity for all. It was adopted in Maputo in 2003 by African heads of state. In 2014, an evaluation of the achievements of CAADP in the first 10 years of its implementation (2003-2013) led to the formation and adoption of the Malabo Declaration, a statement that entails further commitments in pursuing the CAADP goals. The Vision for the Africa Agenda 2063 was adopted in 2013. Agenda 2063 is a strategic framework for the socio-economic transformation of the continent over the next 50 years. It builds on and seeks to accelerate the implementation of past and existing continental initiatives for growth and sustainable development. Some of the main characteristics and intentions of Agenda 2063 include, the creation and maintenance of equitable and people-centered growth and development as well as the eradication of poverty. The first implementation of the plan runs from 2013 to 2023. The Sustainable Development Goals (SDGs) aim to achieve a set of common goals that address urgent global environmental, economic, and political challenges by 2030. Among the seventeen SDGs considered by the United Nations Agenda, the agricultural sector is

expected to make a direct contribution to five goals: end poverty (SDG 1), end hunger (SDG 2), sustained, inclusive, and sustainable economic growth (SDG 8), inclusive and sustainable industrialization (SDG 9) and reduced inequalities (SDG 10).

The integrated results framework for this study is organized into two broad areas (Table 2). The overarching commitments made under CAADP and the 2014 Malabo Declaration are the achievement of 6% annual agricultural growth and attaining an agricultural expenditure share of 10%. These overarching goals are expected to end hunger and halve poverty and so are aligned with SDG 1 (end poverty) and SDG 2 (end hunger) as well as Goals 1 and 5 of Agenda 2063. The second area covers metrics on the sub-goals made under each of the specific thematic areas covered by a country’s national policies, the Malabo Declaration, Agenda 2063 and SDGs.⁵ Under the Malabo declaration these include agricultural investments (Goal II) and intra-Africa trade (Goal V). The relevant SDGs are sustainable economic growth (SDG 8), inclusive and sustainable industrialization (SDG 9) and reduced inequalities (SDG 10). Finally, goals under Agenda 2063 include transformed economies (Goal 4) and modern agriculture (Goal 5).

All selected countries have established formal national development plans to express their visions and strategies to achieve the defined targets. In general, policy guidelines cover the medium-term but they can also be long term (10 or more years). In most cases, the timeframe for national development

Table 2: Integrated results framework

CAADP/Malabo commitments		
6% annual agricultural growth, 10 % allocation of public expenditure to agriculture		
Goals (directly linked)		
SDGs	Agenda2063	Malabo/CAADP
Zero hunger (SDG 2)	A high standard of living, quality of life and wellbeing for all citizens (Goal 1)	End Hunger (Goal III)
No poverty (SDG 1)		Halve Poverty (Goal IV)
Sub-goals		
Promote sustained, inclusive and sustainable economic growth (SDG 8)	Transformed economies (Goal 4)	Increase in agriculture Investment (Goal II)
Industry, innovation and infrastructure (SDG 9)	Modern agriculture for increased productivity and production (Goal 5)	
Reduced inequalities (SDG 10)		

⁵ It should be noted that Agenda 2063 and the SDGs also contain goals for non-agricultural sectors, some of which are considered for this analysis.

plans is five years. The National Agricultural Investment Plan (NAIP) is based on a planning process strictly aligned with the national plan. In addition, it constitutes the reference document for all policies and strategies in the agricultural sector and incorporates the objectives and targets of CAADP. The NAIP may or may not be included in the agricultural development plan.

Côte d'Ivoire's Vision 2040 is the reference document for all plans and programs to be developed. To operationalize this vision, Côte d'Ivoire has adopted a shorter-term planning process through the national development plans (NDP 2016-2020). The aim of the NDP 2016-2020 is to set up a solid industrialization process by focusing on improving the transformation rate of agricultural raw materials and diversifying the industrial sector. In addition, poverty reduction and a better policy for redistributing growth benefits are presented as a pillar of this new vision. The NAIP 2017-2025 is aligned with this plan and has three strategic objectives: the development of value-added products from the agro-sylvo-pastoral and fisheries

sub-sectors, strengthening agro-sylvo-pastoral and fisheries production systems that respect the environment and advance inclusive growth, guaranteeing rural development and the well-being of the population.

The key objective of Ethiopia's Growth and Transformation Plan (GTP) II is to serve as a springboard to realize the country's aspiration of becoming a low middle-income country by 2025 by sustaining fast, broad-based and inclusive economic growth that accelerates economic transformation. GTP II focuses on ensuring rapid, sustainable and broad-based growth by enhancing agricultural productivity.

Malawi's Growth and Development Strategy (MGDS) focuses on the overall economy and agricultural development. The MGDS III has agriculture as one of its priority areas. The national agricultural plan (NAP) aims to achieve this medium-term goal in Malawi's agricultural sector. The NAP is aligned with CAADP protocol and international policy frameworks such as the SDGs.

Table 3: Inventory of agriculture sector-specific policies

Countries	Vision	NDP	ADP	NAIP
Côte d'Ivoire	VISION CI 2016-2040	National Development Plans (NDP) 2015-2020	-	National Agricultural Investment Program (NAIP 2017-2025)
Ethiopia	Vision 2025	Growth and Transformation Plan II (GTP II) (2015/16-2019/20)	-	Agricultural Sector Policy and Investment Framework (PIF)
Malawi	Malawi vision 1998-2020	The third Malawi Growth and Development Strategy (MGDS III) (2017 to 2022)	National Agriculture Policy (NAP) (2016-2020)	National Agricultural Investment Plan (NAIP) (2017/18-2022/23)
Mozambique	50 / 5 000 Résultats de traduction National Development Strategy (2015-2035)	Five-year Program (PQG): 2015-2019	Strategic plan for the development of the agricultural sector: PEDSA 2011 – 2020.	National Agricultural Investment Plan (PNISA), 2014-2018
Niger	SDDCI vision 2017-2035	Economic and Social Development Plan (PDES) 2017-2020	-	The 3N initiative "Nigeriens feed Nigeriens" 2016-2020
Rwanda	Rwanda National Strategic Vision 2000 – 2020	Economic Development and Poverty Reduction Strategy (EDPRS 2013 – 2018)	Strategic Plan for Agricultural Transformation in Rwanda PSTA – IV (2018-2024)	Included in PSTA

Source: Authors' illustration based on the national development plans

Mozambique's agriculture specific strategy is documented in the Strategic Plan for the Development of the Agrarian Sector 2011-2020 (PEDSA). PEDSA is based on a need to improve agricultural value chains and production. PEDSA is operationalized through the PNISA, which is an investment plan for the agricultural sector that is aligned with the CAADP principles. The timeline for the PNISA implementation was from 2014 to 2018.

Niger's Vision 2035 considers the development of productive agriculture that is less vulnerable to climatic hazards to help the country meet its food challenges and provide employment opportunities, especially for young people and women. In particular, Vision 2035 aims to develop a national strategy for sustainable land and ecosystem management. Vision 2035 is based, among other things, on the country's NAIP and an investment plan for the Initiative "Nigeriens feed Nigeriens" better known by the acronym 3N. The 3N plan focuses on revitalizing traditional rainfed agriculture, pursuing and accelerating investments in irrigation and restructuring and modernizing livestock systems.

Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS2 2013-2018) is the country's medium-term economic development plan. The strategy aimed to change the structure of the economy towards achieving the country's long-term targets set out in Vision 2020. Implementation of Vision 2020 began in 2003 and its principal aspiration is to transform Rwanda's economy into a middle-income country by transforming the country from a subsistence agriculture economy to a knowledge-based society, with high levels of savings and private investment, thereby reducing the country's dependence on external aid.

4. Methods and data

An economic modeling framework is built to assess the strategic options available to countries to accelerate growth, eradicate hunger and reduce poverty and inequality as envisaged by its agriculture-related policies and adherence to the CAADP/Malabo commitments, Agenda 2063 and the SDGs. The framework consists of an economy-wide general equilibrium model and a micro-economic simulation model. The two models are linked in a sequential manner, that is, the output from one model is used as an input by the other

model. A mix of economic models is necessary to properly address the multiple goals defined by the agricultural development agendas (Fofana et al. 2019). The macro-economic model addresses the country's growth and investment goals and targets. The micro-economic model deals with issues related to poverty and hunger. The micro-economic model also captures changes in income distribution and inequality measures across the population.⁶

The macro-economic model is an agricultural investment-focused computable general equilibrium (CGE) model grounded in the Walrasian small open economy framework. The model considers all institutional agents and economic sectors of a country's economy. It is an application of the model by Fofana et al (2019) that makes it possible to take into account growth and investment objectives and targets. With a relatively standard approach on certain aspects, it specifies the behavior of several economic agents. Consumers maximize their well-being given the prices on the market for goods and services and their income constraints. Producers maximize their profit given the prices of goods, services and factors of production while also taking into account the available technology. The government remains passive in the model as its role is to redistribute economic wealth through the collection of taxes (direct and indirect), transfers to households and firms and the supply of public services. In line with the assumption of a small open economy, we assume that international import and export prices are exogenous. Although the core setting of the model builds on the standard CGE framework, the model includes some special features related to the issue of agricultural transformation and investments as discussed by Fofana et al. (2019).⁷

The CGE model is calibrated using a Social Accounting Matrix (SAM). This is a square matrix that describes the transaction flows taking place within an economy during a given period (Fofana et al, 2015).⁸ The years of SAM development for the study countries vary. Côte d'Ivoire's SAM is from 2006 and was updated to 2015 (Fofana and Diallo 2015). Ethiopia's SAM is from 2011 and was also updated to 2015 (Ahmed et al. 2017). Malawi's SAM is from 2014 (Thurlow 2017) and Mozambique's from 2015 (Cruz et al. 2018). Niger's SAM was developed in 2014 (Fofana 2017) and Rwanda's SAM was developed in 2011 and updated to 2015 (Pradesha and Diao 2014).

⁶ The use of the growth-to-poverty elasticity parameter (Thurlow, Kiringai, and Gautam 2007) does not capture the changes in income inequality.

⁷ Among others, Decaluwé et al. (2013) and Lofgren et al. (2002) propose standard archetypes of a single country CGE model.

⁸ The updating process uses the macroeconomic and sectoral data available in the international databases, i.e., the World Development Indicator (WDI) database from the World Bank and the African Statistical Yearbook (ASYB) from the African Development Bank (AfDB), the United Nations Economic Commission for Africa (UNECA) and the African Union Commission (AUC).

Micro-economic simulation models are designed to predict individuals' reactions to a policy shock when facing different economic and institutional environments or constraints. They are useful in integrating the heterogeneous behaviors of economic agents and accounting for the aggregate costs and benefits of an intervention or shock (Bourguignon and Spadaro, 2006). There are multiple approaches to conducting a micro-economic simulation under a CGE framework and the choice among these approaches depends on data availability, the research question(s) and time constraints (Cockburn *et al*, 2012). The micro-economic simulation model is a statistical economic model built to capture income distribution among the population. The changes in the probabilities associated with individual income levels induced by changes in the mean (per capita) income are assessed through a generalized entropy measure (Lee and Judge, 1996). Further details about key characteristics of the micro-economic simulation models are available in Fofana *et al*. (2019).

The most recently available nationally representative household level survey is used to inform the micro-economic simulation model. For Côte d'Ivoire, we use the Household Living Standard Survey (ENV) from 2015 while for Ethiopia, we use the Household Consumption and Expenditure (HCE) survey from 2015/16. For Malawi, we use the fourth integrated household survey (IHS4) collected in 2016. For Mozambique, the household budget survey (IOF) from 2014 is used and finally for Rwanda, we use the Integrated Household Living Conditions Survey (EICV5) from 2016.⁹

The Business-as-usual (BaU) scenario tracks how a country would perform in achieving CAADP, SDG and Agenda 2063 targets if it continued on the current

growth trajectory and did not implement policy changes. For each country, the baseline scenario is based upon recent macro-economic and sectoral growth trends, using data from National Institutes of Statistics, the IMF, the AfDB, the AUC, UNECA and the World Bank. We then compare the Business-as-usual scenario with a scenario based on implementation of a country's NAIP. We describe results for poverty, inequality and resilience. Finally, we turn to an analysis of the impact of the financing options for increasing public investment in agriculture. Three options for financing agricultural investments are considered. The revenue-neutral option assumes that the investment budget is constrained and that an increase in investment in one sector e.g., agriculture entails a decrease in other sectors. The budget-neutral option assumes that increases in investment expenditures are funded through increased tax revenues. Taxation on household income and properties (direct tax) is selected for this option.¹⁰ The external financing option assumes that increases in investment expenditures are funded externally i.e., through international borrowing or development assistance.¹¹

5. Results

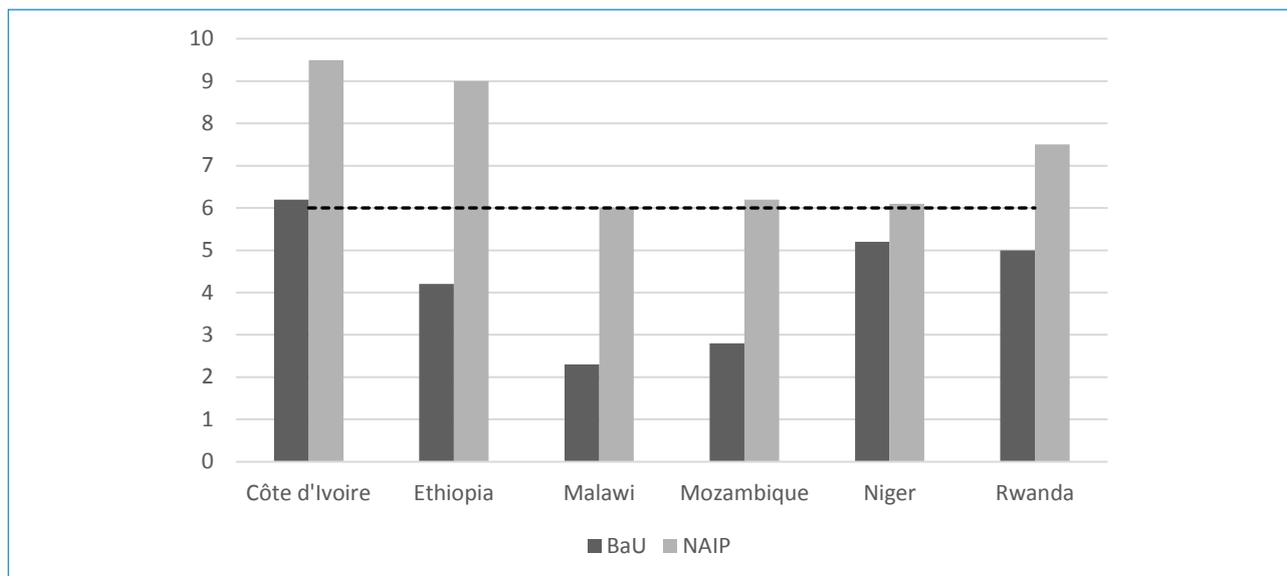
Figure 3 shows that under the BaU scenario, with the exception of Côte d'Ivoire, countries will not be able to achieve CAADP's 6% agricultural growth rate target. Mozambique and Malawi are off-track to meet CAADP targets with agricultural GDP growing at 2.9% and 2.3%, respectively. However, with the implementation of their National Agriculture Investment Programs (NAIP), all countries will achieve the CAADP's 6% agricultural growth rate target.

⁹ We use older surveys to replicate demographics, household consumption, expenditure patterns for each country at the beginning of the implementation of the various agendas and see progress made by countries.

¹⁰ While indirect taxes are also an important revenue source, we consider direct taxes because they are relatively simple to collect and other taxes (e.g. indirect taxes) will be more difficult to implement in the long-run.

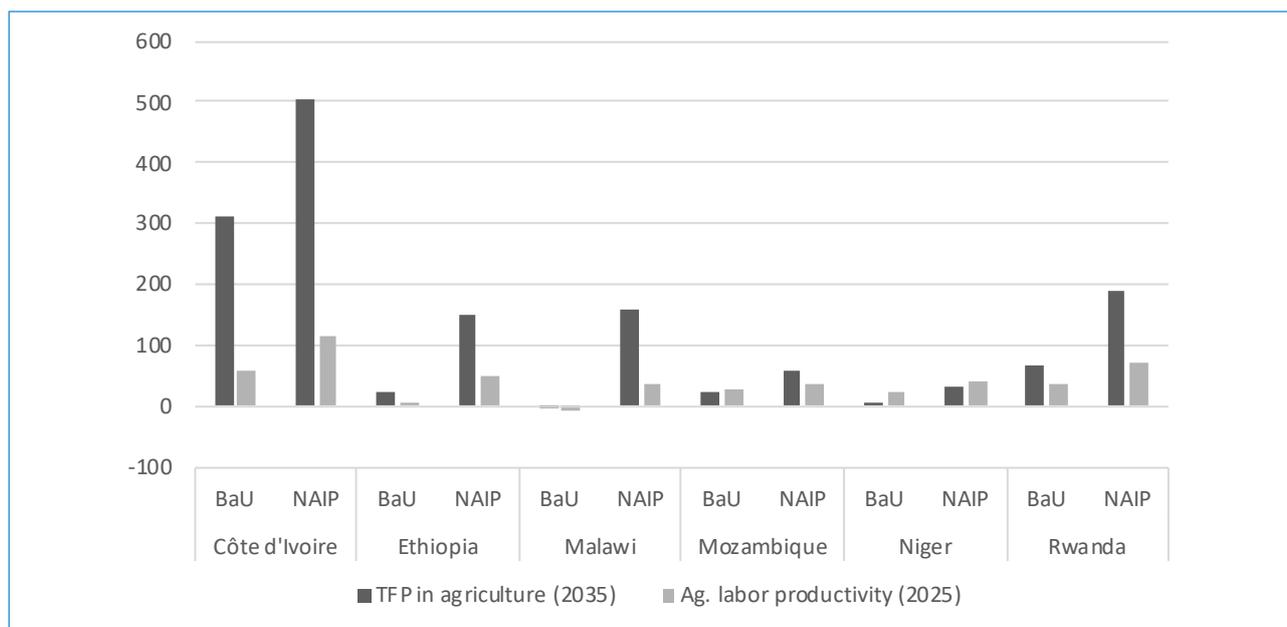
¹¹ It needs to be noted that these are not mutually exclusive financing mechanisms. In reality, countries combine different financing options. The simulation is mainly intended to help countries identify policies which are required to ensure that the set goals and milestones are met efficiently and effectively. We look at options separately to determine which option produces the highest yields. We also combine external and internal financing options in the analysis.

Figure 3: Projected agricultural GDP, annual growth (%) 2015-2025



As Figure 4 shows, implementation of a country's agriculture investment program would significantly enhance total factor productivity (TFP) in agriculture and productivity of labor in agriculture.

Figure 4: Projected changes in TFP in agriculture and labor productivity (%) 2015-2035



In Côte d'Ivoire, total factor productivity in agriculture is projected to increase fivefold and labor productivity is expected to double under NAIP implementation. In Malawi, both TFP and agricultural labor productivity are slated to decrease under a business-as-usual scenario but would record positive growth rates under implementation of the agriculture investment program. Increases compared to the business-as-usual scenario are more modest in Niger and in Mozambique. Figure 4 shows that Côte d'Ivoire and Ethiopia would thus meet the CAADP objective of increasing agriculture TFP by 100% albeit in 2035 and Côte d'Ivoire would also meet the Agenda 2063 objective of a fivefold TFP increase in agriculture.

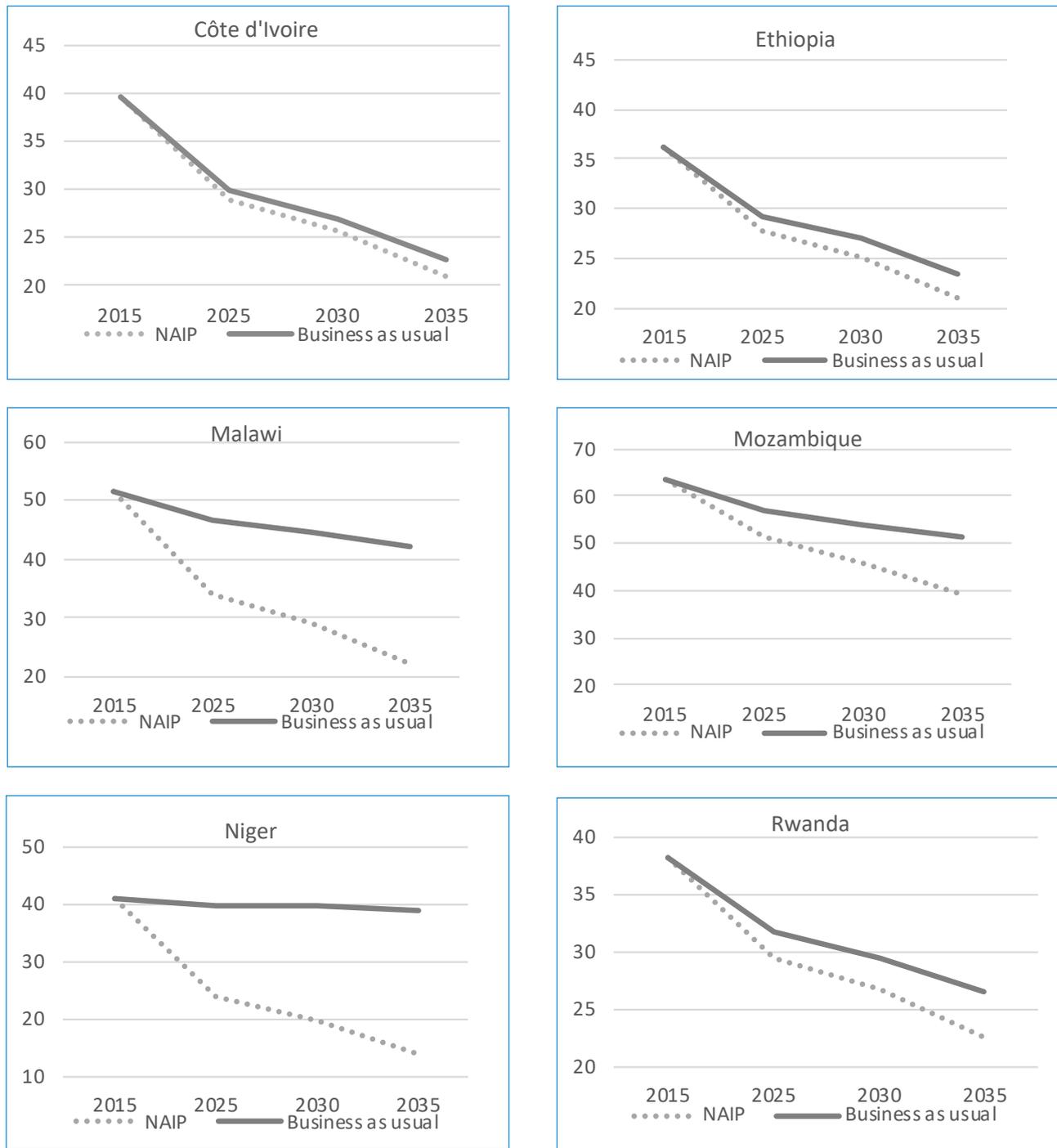
As discussed above, the climate vulnerability of the six countries in the food domain is largely driven by projected impacts of climate change on yields and a lack of agricultural capacity. The projected increases in TFP in agriculture and agriculture labor productivity would thus mean that countries would also be more resilient to changes in the climate that are set to lower yields.

Increases in TFP and in labor productivity also have implications for poverty. In fact, if countries would implement their NAIPs, substantial poverty rate reductions would be recorded, which would put countries on the path to halving poverty by 2030 or

even ending poverty by 2035. Figure 5 shows that reductions in poverty would be most substantial in Niger and Malawi. In fact, implementation of their

NAIPs would allow both Niger and Malawi to (almost) reach their SDG objective of halving poverty rates by 2030.

Figure 5: Poverty rate evolution (% of population below national poverty line) (2015-2035)

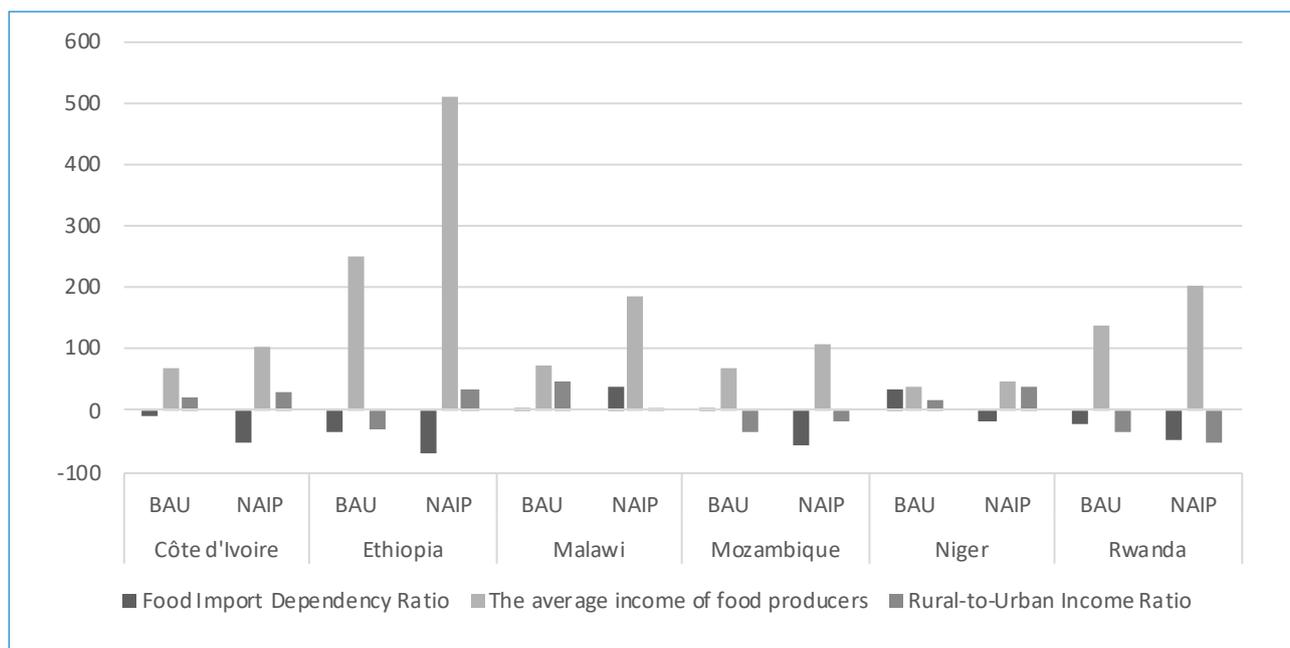


Notes: For Mozambique the international poverty line of \$1.90 per capita per day is used.

There are other ways in which an agricultural development strategy as formulated under the NAIP would contribute to meeting the SDGs and Agenda 2063 objectives. Figure 6 below shows how NAIP implementation would enhance smallholder

incomes, lower the dependency on food imports and reduce rural-urban inequality compared to the business-as-usual scenario.

Figure 6: Agricultural development, hunger and inequality goals (%) (2015-2035)



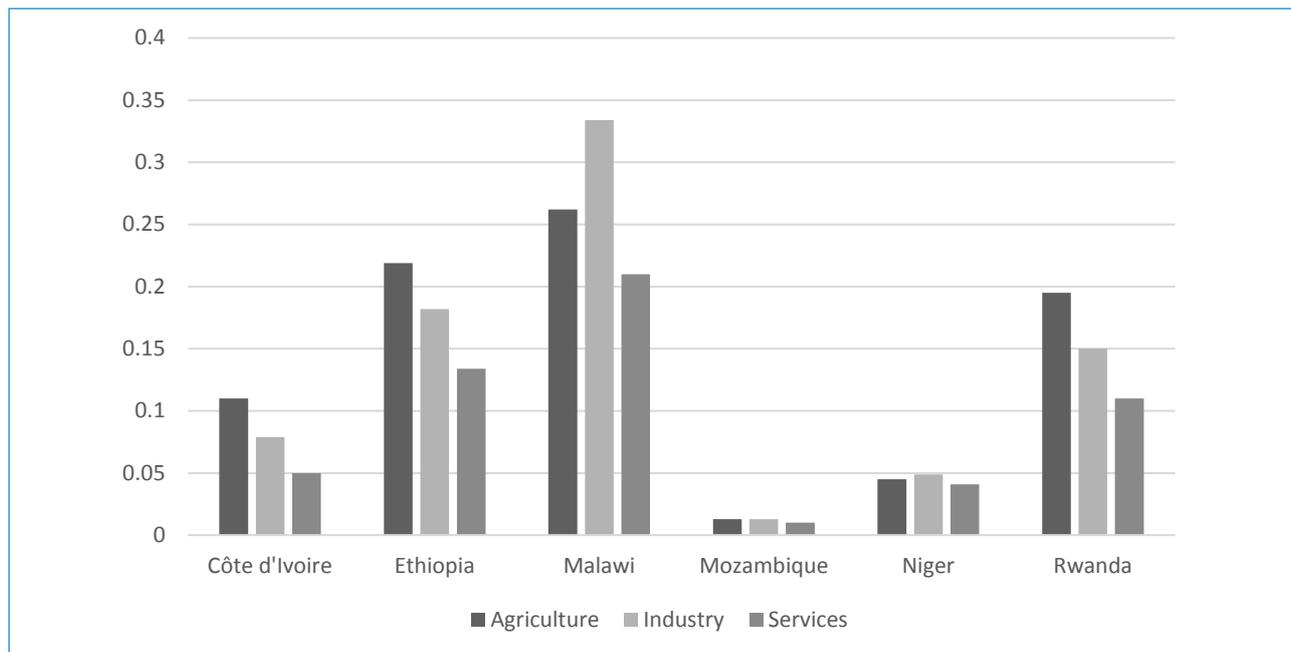
In all six countries, with the exception of Niger, the average income of food producers increases substantially. In Ethiopia, for example, the average income of food producers would increase fivefold under the NAIP while in both Malawi and Rwanda there would be an increase of 200%. Côte d'Ivoire and Mozambique would see a doubling of income for food producers in line with the SDG 2 target. The food import dependency ratio is significantly reduced in Côte d'Ivoire, Ethiopia, Mozambique and Rwanda compared to the business-as-usual scenario and Ethiopia meets the Agenda 2063 target of 70% reduction by 2063 required to eradicate hunger. Finally, the rural-to-urban income ratio, which is an indicator of inequality, substantially increases in, for example Ethiopia although not enough to meet the 50% target of Agenda 2063.

Having demonstrated the substantial progress in terms of enhancing resilience, reducing poverty,

hunger and inequality that would be generated through the pursuit of an agriculture-led development strategy, we now show below that neither an industry or services-led growth strategy would generate results of the same magnitude. Figures 7, 8 and 9 compare the impact of the one percentage point increase in allocation of public investment to agriculture, industry or services on, GDP growth, employment and poverty incidence respectively, under the assumption of external financing. In these simulations, public investment increases are initially assumed to be financed by external resources, that is, foreign loans, international development assistance and other external sources.¹² As Figure 7 shows, with the exception of Malawi and Niger, increasing public investment in the agricultural sector is more effective in terms of GDP growth than increasing it in the industrial or service sectors.

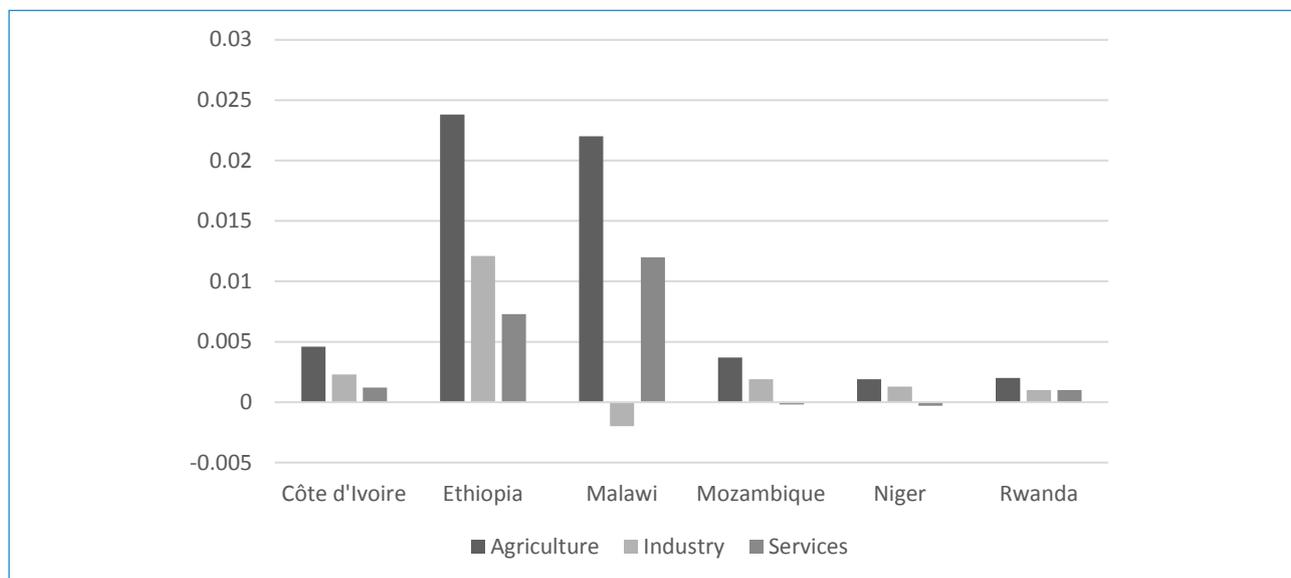
¹² This assumption is merely expositional and can be relaxed as public investments by national governments are expected to increase as well as stipulated by the CAADP framework.

Figure 7: Growth effects of a one percentage point increase in public investment by economic sector, percentage point change from baseline (2015)



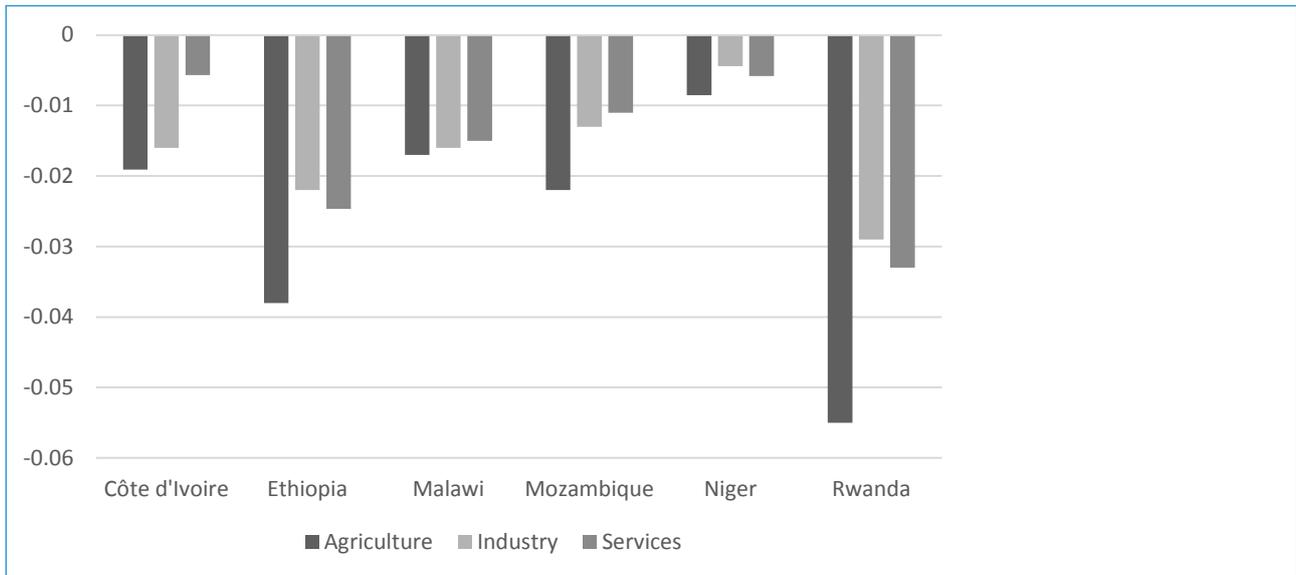
We also see in Figure 8 that for all countries, job creation effects of public investment in agriculture are much greater compared to both industry and services in all six countries.

Figure 8: Job creation effects of a one percentage point increase in public investment by economic sector, percentage point change from baseline (2015)



Finally, as Figure 9 shows, poverty reduction effects of a percentage point increase in public investment in agriculture are greater compared to those stemming from an increase in public investment in industry or services.

Figure 9: Poverty reduction effects of a one percentage point increase in public investment by economic sector, percentage point change from baseline (2015)

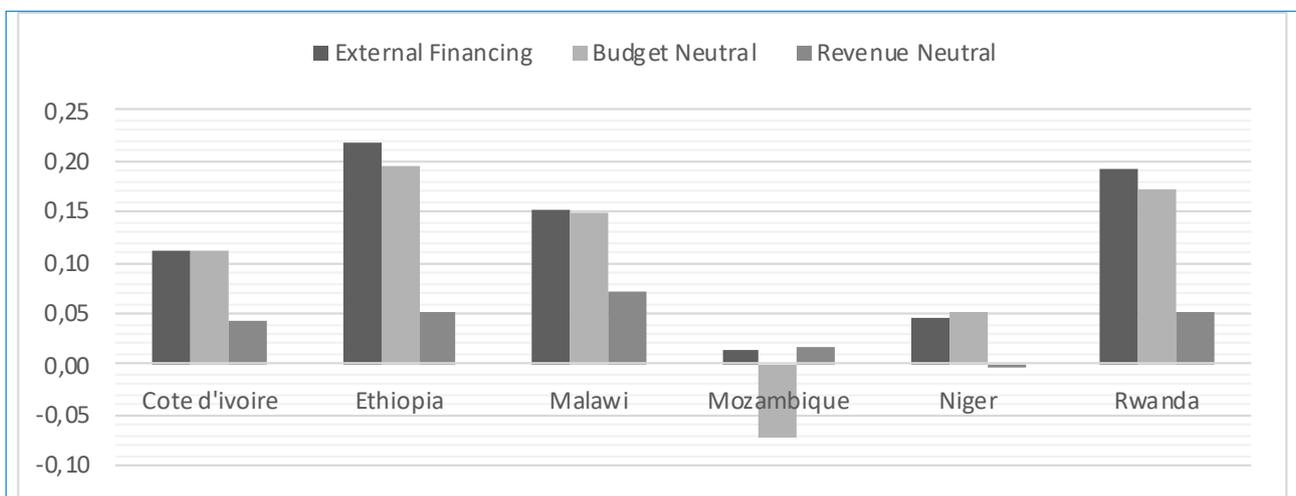


In summary, further increasing the expenditure allocations to agriculture in line with CAADP and Malabo commitments, would be beneficial to these countries' economies while also contributing to employment creation and poverty reduction.

Having established that an agriculture-led development strategy has the highest potential to meet the growth, hunger, poverty and inequality

objectives of the various development agendas and would also enhance the resilience of rural households, we now try to establish the most efficient way that such a strategy could be financed. Figure 10 shows that external financing of agricultural investments would generate the highest impact in terms of economic growth for all countries except for Niger.

Figure 10: Effects of financing options on GDP growth (%)



Among the financing mechanisms tested, the external financing option also generates the highest returns on employment creation (Figure 11) and on poverty

reduction (Figure 12) except for Mozambique. The budget-neutral option provides a high return on employment and poverty reduction.

Figure 11: Effects of financing options on employment

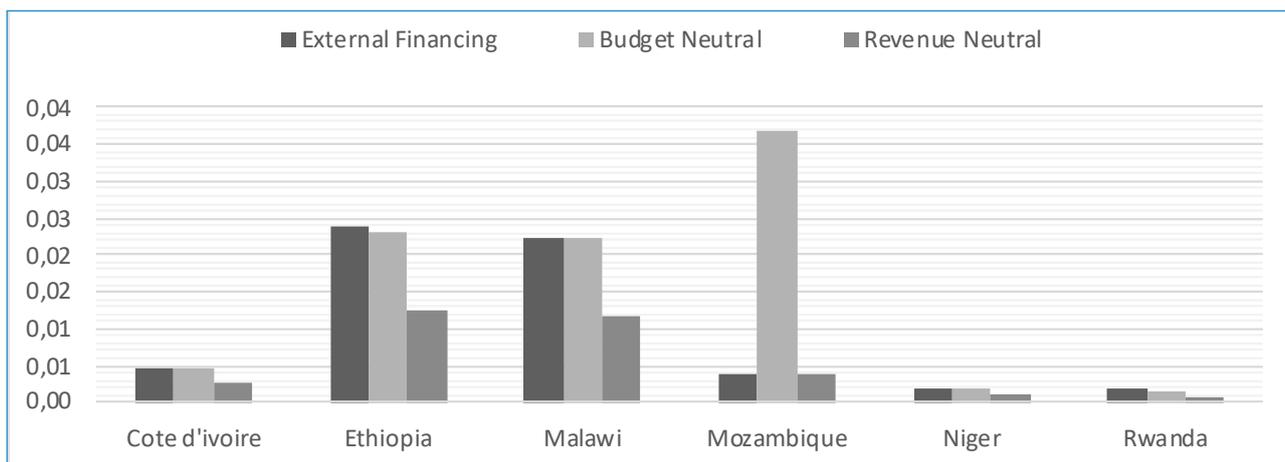
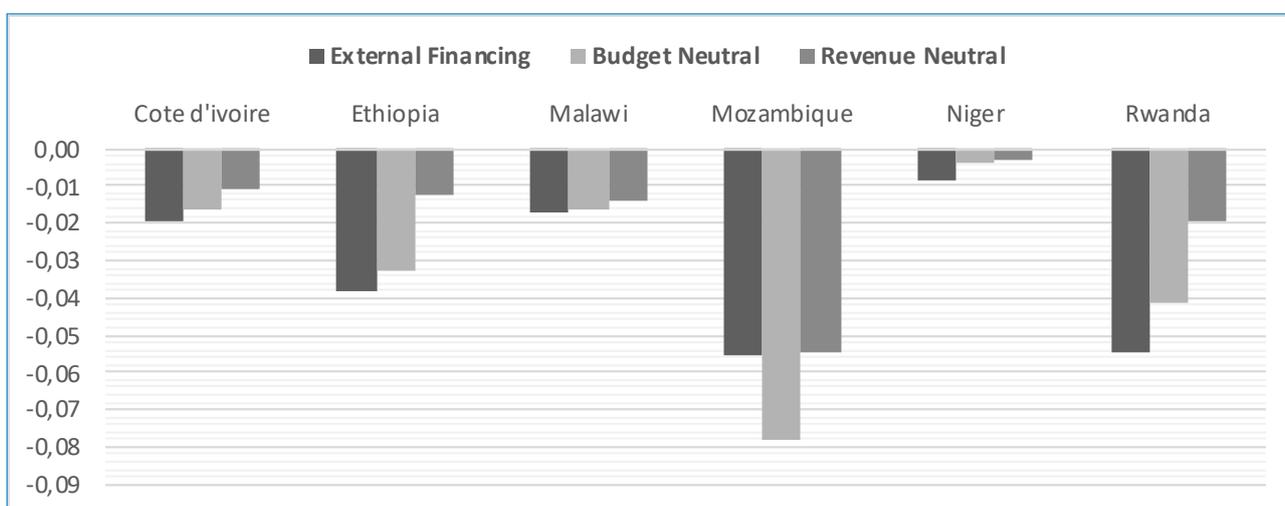


Figure 12: Effects of financing options on poverty reduction



6. Conclusion

The social and economic need for sustainable, resilient recovery from the pandemic is very clear. Recovery policies need to trigger investment and behavioral changes that will reduce the likelihood of future shocks and increase society's resilience to them when they do occur. Agriculture remains one of the most important economic sectors for Africa employing the majority of the population and accounting for 14% of the GDP in countries south of the Sahara. Financial recovery packages to address the effects of the pandemic are likely to be substantial and there is a need for evidence to design and direct policy measures. In this paper, we have developed an Integrated Results Framework linking CAADP/Malabo objectives with selected SDGs and Agenda 2063 objectives. We have also used an economy-wide CGE model linked with a micro-economic simulation model and data for Côte d'Ivoire, Ethiopia, Malawi, Mozambique, Niger and Rwanda to translate these objectives into tangible outcomes. We have subsequently simulated these

outcomes under a business-as-usual scenario (2015-2025 and 2015-2035) and under implementation of a country's NAIP.

Our results reveal that under the BaU scenario the six countries will make progress towards meeting only a few commitments of the various agendas. Côte d'Ivoire may be able to achieve the CAADP target of 6% agricultural growth rate by 2025 but objectives related to poverty and inequality reduction are out of reach under the BaU scenario. Niger would only achieve a very limited number of the objectives and targets under the different agendas. Should current trends continue, Rwanda would be off-track to meet CAADP targets while poverty and inequality reduction objectives would not be met under the BaU scenario. Ethiopia would be off-track to meet CAADP targets although the country would meet the goal of increasing private agricultural investment and agricultural productivity. Mozambique is off-track with regards to agricultural GDP growth and

reduction of poverty targets. Malawi is also off-track with an agricultural GDP growth of 2.3%, indicative of little progress made towards the CAADP/Malabo target of 6% growth by 2025. As far as the SDGs are concerned, the country will be completely off track on all goals considered by the study under the BaU scenario. Although progress will be made in reducing inequality (SDG10), the poverty and hunger outcomes remain poor.

In contrast, with the implementation of the agriculture investment program, all countries will meet the CAADP's target of 6% agricultural growth rate. With the exception of Niger, the implementation of the NAIPs will enable countries to meet the SDG 2 target of doubling food producer income by 2030. When compared to the business-as-usual scenario, the food import dependency ratio in Côte d'Ivoire, Ethiopia, Mozambique and Rwanda is significantly reduced under the NAIP scenario. Côte d'Ivoire, Ethiopia, and Rwanda will also achieve the CAADP goal of doubling agricultural total factor productivity (TFP) by 2035. Furthermore, as climate change is expected to reduce yields, increases in agricultural TFP and agricultural labor productivity

would mean that countries would be more resilient. The findings also show that NAIP implementation would increase smallholder incomes, reduce reliance on food imports, and reduce rural-urban inequality in comparison to the business-as-usual scenario. Significant poverty rate reductions would also be recorded, primarily in Malawi and Niger, putting countries on track to halve poverty by 2030 or even end poverty by 2035. We also find that the agricultural sector in all six countries contributes more than the industry and services sectors in terms of number of jobs created, economic growth and poverty reduction. Our results reveal that external financing and the budget constrained scenarios have the most consistent positive impacts on socio-economic objectives compared to the baseline scenario. To conclude, in the wake of the COVID-19 pandemic and with the increasing threat of climate change, an agriculture-led investment strategy appears to be the most promising to eradicate hunger, reduce poverty and inequality while also building the resilience of rural households.

Annexes

Table A1: Selected CAADP Malabo Commitments and Goals

Goal	Indicator	Target
Increase in agriculture investment (Goal II)		
Enhance investment finance, both public and private, to agriculture	Share of Government agriculture expenditures in total Government expenditures (%)	10
	Private investment in agriculture, variation (%)	>
End Hunger by 2025 (Goal III)		
End extreme poverty and hunger	Extreme poverty level, at the national food poverty line, variation (%)	-95
Increase agricultural productivity and production levels	Growth rate of agricultural value added per agricultural worker (%)	100
	Growth rate of agricultural value added per hectare of arable land (%)	100
Halve the current levels of Post-Harvest Losses, by the year 2025	Growth rate of agricultural post-production value added per worker (%)	50
Integrate measures for increased agricultural productivity with social protection initiatives	Gini coefficient, variation (%)	<
	Share of the poorest 40% quintile in food expenditures, variation (%)	>
Halve poverty by 2025 through inclusive agricultural growth and transformation (Goal IV)		
Increased economic opportunities and reduced poverty levels	Poverty level, at the national poverty line, variation (%)	-50
	Household final consumption expenditure per capita at constant 2010 local currency, variation (%)	>
Ensure agricultural-led growth and poverty reduction target	Agricultural GDP, annual variation (%)	6
	Agricultural contribution to GDP growth (%)	50
Promote Intra-Africa Trade in Agricultural Commodities (Goal V)		
Increased intra-African regional trade and better functioning of national & regional markets	Growth rate of the value of agricultural commodities traded with Africa, in constant values (%)	200

Table A2: Selected SDGs

Goal	Indicators	Target
Halving poverty (SDG 1)		
Eradicate extreme poverty	Proportion of population below the international poverty line of \$1.25 a day PPP (%)	-95
Reduce by at least half the proportion of population living in poverty	Proportion of population living below the national poverty line (%)	-50
Implement nationally appropriate social protection systems and measures	Proportion of population covered by social protection floors/systems (%)	>
End hunger (SDG 2)		
End hunger and ensure access to safe, nutritious and sufficient food	Poverty level at national food poverty line (%) (Prevalence of undernourishment if data available)	-95
Double the agricultural productivity and incomes of small-scale food producers	Volume of agricultural production per labor	100
	Average income of food producers	100

Goal	Indicators	Target
Promote inclusive and sustainable economic growth (SDG 8)		
Sustain per capita economic growth	Annual growth rate of real GDP per capita	>
	Annual growth rate of real GDP	7
	Annual growth rate of real GDP per employed person	>
Achieve full and productive employment and decent work	Average hourly earnings	>
	Unemployment rate	< 5
Industry, innovation and infrastructure (SDG 9)		
Promote inclusive and sustainable industrialization	Manufacturing value added as a proportion of GDP and per capita	100
	Manufacturing employment as a proportion of total employment	100
Reduced inequalities (SDG 10)		
Achieve and sustain income growth of the bottom 40 per cent of the population	Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population	>
Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality	Labor earning share of GDP	>

Table A3: Selected goals from Agenda 2063

Goal	Indicator	Target
A high standard of living, quality of life and wellbeing for all citizens (Goal 1)		
Poverty reduction	The proportion of population below the international poverty line of \$1.90 a day PPP (%)	-95.0
	The proportion of the population living below the national poverty line (%)	
Hunger eradication	Food Import Dependency Ratio	-70.0
Inequality reduction	Rural-to-urban income ratio	50.0
Employment and incomes	Unemployment rate	6.0
	Per capita income growth	>
Transformed economies (Goal 4)		
Inclusive Economic Growth	GDP, Annual Growth	7.0
Intra-African Trade	Value of intra-Africa Trade	500.0
Modern agriculture for increased productivity and production (Goal 5)		
Productivity growth	Agricultural TFP	120.0

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AKADEMIYA

Headquarters

Kicukiro/Niboye KK 341 St 22
KIGALI - RWANDA

Mailing address

P. O. Box 1855
hq-office@akademiya2063.org

Telephone

t: +221 77 761 73 02
t: +250 788 318 315

website

www.akademiya2063.org

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