ReSAKSS
Regional Strategic Analysis and Knowledge Support System
Facilitated by IFPRI

Annual Trends and Outlook Report 2014

CHAPTER 2
Africa in the Global Agricultural Economy in 2030 and 2050

BEYOND A MIDDLE INCOME AFRICA:
Transforming African Economies for Sustained Growth with Rising Employment and Incomes

Edited by
Ousmane Badiane
Tsitsi Makombe

Editors

Ousmane Badiane and Tsitsi Makombe

About ReSAKSS | *www.resakss.org*

Established in 2006 under the Comprehensive Africa Agriculture Development Programme (CAADP), the Regional Strategic Analysis and Knowledge Support System (ReSAKSS) supports efforts to promote evidence and outcome-based policy planning and implementation. In particular, ReSAKSS provides data and related analytical and knowledge products to facilitate benchmarking, review, and mutual learning processes. The International Food Policy Research Institute (IFPRI) facilitates the overall work of ReSAKSS in partnership with the African Union Commission, the NEPAD Planning and Coordinating Agency (NPCA), leading regional economic communities (RECs), and Africa-based CGIAR centers. The Africa-based CGIAR centers and the RECs include: the International Institute of Tropical Agriculture (IITA) and the Economic Community of West African States (ECOWAS) for ReSAKSS–WA; the International Livestock Research Institute (ILRI) and the Common Market for Eastern and Southern Africa (COMESA) for ReSAKSS–ECA; and the International Water Management Institute (IWMI) and the Southern African Development Community (SADC) for ReSAKSS–SA.

ReSAKSS is funded by the United States Agency for International Development (USAID), the Bill and Melinda Gates Foundation, the International Fund for Agricultural Development (IFAD), and the Ministry of Foreign Affairs of Netherlands (MFAN). Earlier, ReSAKSS also received funding from the UK Department for International Development (DFID), and the Swedish International Development Cooperation Agency (SIDA).

DOI: http://dx.doi.org/10.2499/9780896298927

ISBN: 978-0-89629-892-7

Citation

Badiane, O. and T. Makombe. 2015. *Beyond a Middle Income Africa: Transforming African Economies for Sustained Growth with Rising Employment and Incomes.* ReSAKSS Annual Trends and Outlook Report 2014. International Food Policy Research Institute (IFPRI).

Chapter 2 Contributors:

Timothy B. Sulser, Scientist, Environment and Production Technology Division, IFPRI
Daniel Mason-D'Croz, Research Analyst, Environment and Production Technology Division, IFPRI
Shahnila Islam, Research Analyst, Environment and Production Technology Division, IFPRI
Sherman Robinson, Senior Research Fellow, Environment and Production Technology Division, IFPRI
Keith Wiebe, Senior Research Fellow, Environment and Production Technology Division, IFPRI
Mark W. Rosegrant, Division Director, Environment and Production Technology Division, IFPRI

CHAPTER 2

Africa in the Global Agricultural Economy in 2030 and 2050[1]

Timothy B. Sulser, Daniel Mason-D'Croz, Shahnila Islam,
Sherman Robinson, Keith Wiebe, and Mark W. Rosegrant

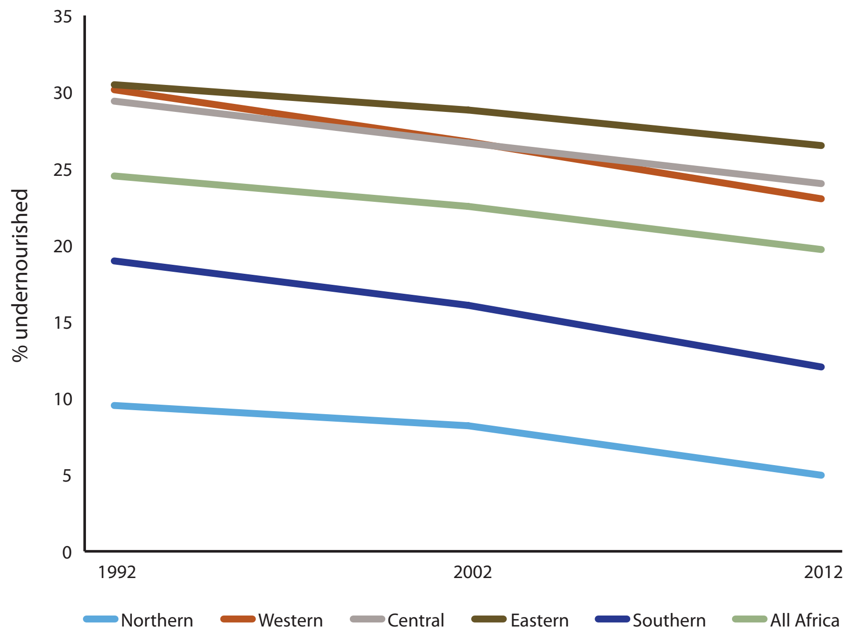
[1] Data for—and therefore discussion of—Somalia and South Sudan are generally unavailable and not included in this chapter; also, small island nations are not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe).

Africa on the Rise

Africa has managed to maintain a favorable environment for growth and poverty reduction in the face of the series of global economic crises in the past couple decades. Part of this is due to Africa's level of isolation from the global economy, but it is also testament to the resilience of African economies even if they are not experiencing the extraordinary growth seen in South and East Asia (AfDB, OECD, and UNDP 2015). Per capita gross domestic product (GDP) grew at a solid 2 percent per year in the decade leading up to 2012 across all of Africa, with western Africa leading at more than 4 percent growth (ReSAKSS database 2015). This growth has put the average per capita GDP for all of Africa at the threshold of middle-income classification according to the World Bank's World Development Indicators. Eastern and central Africa lag behind a bit with many low-income nations, while the northern and southern regions are mostly represented by stronger middle-income economies.

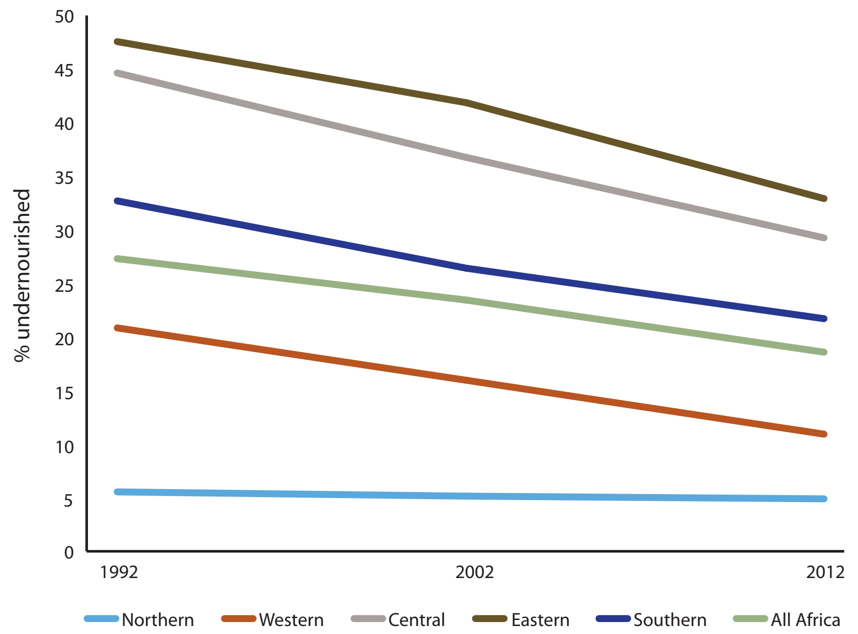
Indicative of the health of the entire economy are the advances Africa has made in reducing the prevalence of undernourishment in children and in the general population. While northern and southern Africa have effectively achieved the Millennium Development Goal (MDG) of halving

FIGURE 2.1—DECLINE IN PREVALENCE OF UNDERNOURISHED CHILDREN IN RESAKSS REGIONS



Source: ReSAKSS database (2015).

FIGURE 2.2—DECLINE IN PREVALENCE OF UNDERNOURISHED POPULATION IN RESAKSS REGIONS



Source: ReSAKSS database (2015).

the prevalence of undernourished children (age 5 and under, by weight), the other regions have been dealing with persistent challenges in this regard and keep the average across Africa at about 20 percent, still four-fifths of the prevalence two decades prior (Figure 2.1). Better progress can be found in the general population, however, with much steeper declines found in the trends, which are losing about a 0.5 percentage point off the prevalence rate per year in the decade leading up to 2012 across most African regions (Figure 2.2). Transitioning from progress made on the MDGs to a unified Common African Position regarding the Post-2015 Development Agenda, as put forth by the African Union, is a critical step in the process for advancing economic prosperity for the region (UNECA et al. 2014).

Broad growth and development in Africa will necessarily rely upon expansion across all economic sectors and a more equitable and considered approach to policymaking and investments across all domains of society. A balance must be made across genders and the youth, economic strata, urban–rural populations, and productive domains. Many of these topics are covered in subsequent chapters and other resources such as AfDB, OECD, and UNDP (2015); UNECA et al. (2014); and UNDP (2014).

Growth in African economies is rooted in a strong expansion of the agriculture sector, the reason for the focus on agricultural development by Comprehensive Africa Agriculture Development Programme (CAADP) and the Regional Strategic Analysis Knowledge Support System (ReSAKSS). Total value-added growth for agriculture has been in the 3–5 percent range for the five ReSAKSS regions[2] for the 2003–2012 period and more than 5 percent across Africa. This is nearly reaching the CAADP target of 6 percent growth for the sector in aggregate (Table 2.1). The performance varies quite a bit at the country level, however, from as low as –4 percent up to +13 percent annual growth (ReSAKSS database 2015).

TABLE 2.1—HISTORY OF AGRICULTURE VALUE-ADDED GROWTH RATE (%) BY RESAKSS REGION

	Decade ending in	
	2002	2012
North	5.7	5.2
West	7.5	5.5
Central	1.9	2.8
East	4.0	4.8
Southern	6.4	4.8
All Africa	6.0	5.1

Source: ReSAKSS database (2015).
Note: Based on World Bank's World Development Indicators definition of agriculture value added. More explanation included with Figure 2.3.

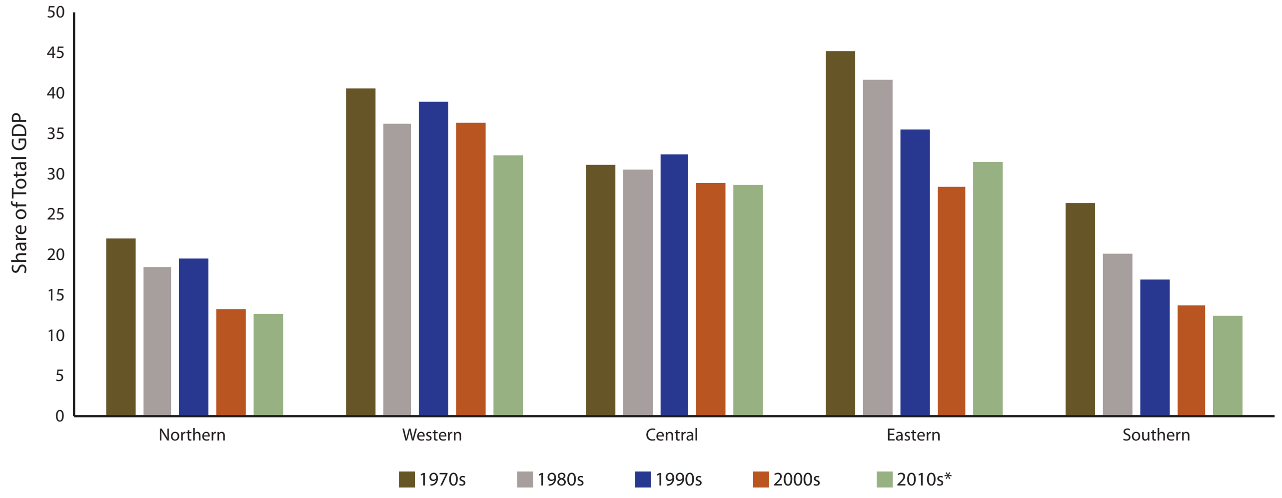
While the agriculture sector is contributing a decreasing share to the African economy as a whole, it remains an essential cornerstone for advances and development of the region. Indeed, without a strong basis in agriculture, it is difficult for developing economies to establish momentum for improving living standards (UNDP 2014). The trends in the shares of agricultural value added in total GDP are declining but leveling off (Figure 2.3). However, this aggregate picture hides the diverse country-level trends that can be effectively flat (for example, Algeria, Benin, Guinea, and Zimbabwe) or even increasing in a few cases (for example, Chad, Central African Republic, and Sierra Leone). Also, decreasing contribution of agriculture to GDP may simply be a reporting issue as developing agro-industries often are counted as part of the industrial sector as they become more consolidated. Regardless, as countries

2 ReSAKSS follows the African Union's classification of Africa's five geographic regions (central, eastern, northern, southern, and western). ReSAKSS data and methodology are described in Benin et al. (2010).

develop, the agriculture sector maintains its magnitude of importance for rural regions where the majority of the poor reside. An equitable development strategy will maintain the profile of agriculture in the mix of economic growth for a country or region. Also, maintaining a flexible rural and agricultural economy that can absorb and support urban populations and the industrial and service sectors as they face increased exposure to global markets (and therefore its crises) has proven essential for developing economies of Southeast Asia, for example, which is a lesson that can be used to enhance Africa's resilience.

Primary growth of Africa's agricultural sector in aggregate has also been steady through the past several decades (Figure 2.4). The agriculture production index for Africa has been adding almost 4 percentage points per year on average in the decade leading up to 2012. This is effectively a doubling of the rate from the previous decade. Again, this varies across ReSAKSS regions, with the strongest

FIGURE 2.3—RESAKSS REGIONAL TRENDS OF COUNTRY AVERAGES FOR VALUE-ADDED AGRICULTURAL GDP AS SHARE OF TOTAL GDP

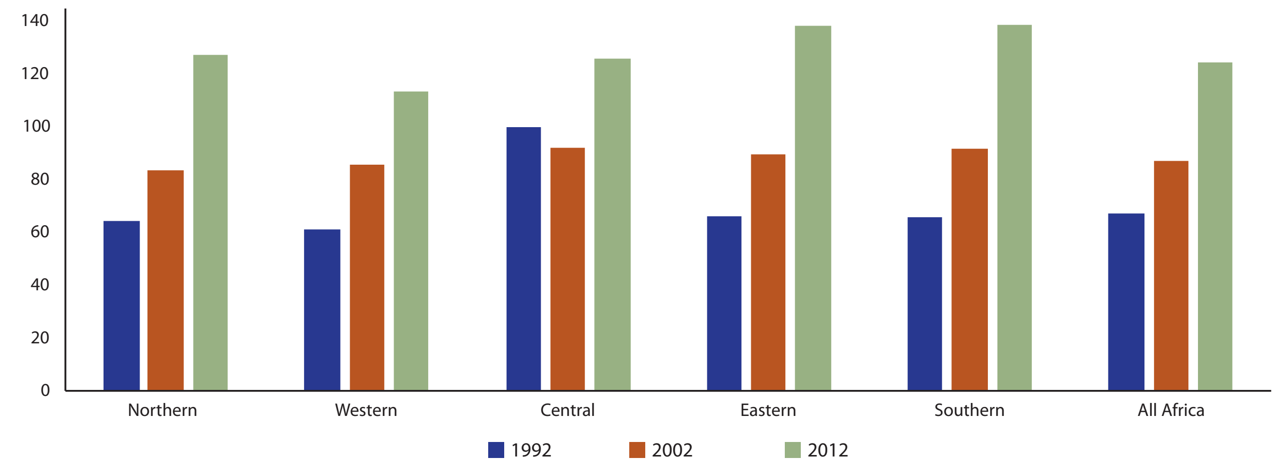


Source: World Bank (2015).

*Including latest available data.

Note on meaning of value-added: Agriculture corresponds to ISIC divisions 1–5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3

FIGURE 2.4—DEVELOPMENT IN RESAKSS REGIONAL AGRICULTURAL PRODUCTION INDEXES



Source: ReSAKSS database (2015).

growth in eastern and southern Africa. Central Africa made an important rebound from a decline in their production index in the previous decade.

Africa Moving Forward

Africa has a promising outlook for agricultural and economic development for the coming decades. To understand future prospects better, however, it is helpful to employ quantitative models that focus on setting a framework for foresight into key trends and developments over the medium and long term. Several types of these quantitative models can be used; this analysis uses the International Food Policy Research Institute's (IFPRI's) International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) (Rosegrant et al. 2012; Robinson et al. 2015), which is well established in the field of foresight work focused on the agricultural sector (Nelson et al. 2014; von Lampe et al. 2014).

IMPACT is a partial equilibrium agriculture sector model designed to examine alternative futures for global food supply, demand, trade, prices, and food security. The IMPACT model allows IFPRI to provide both fundamental, global baseline projections of agricultural commodity production and trade and malnutrition outcomes along with cutting-edge research results on quickly evolving topics such as bioenergy, climate change, changing diet and food preferences, and many other themes. A brief explanation of the IMPACT model is included in Box 2.1, but extensive documentation on the model and its application in the

BOX 2.1—THE INTERNATIONAL MODEL FOR POLICY ANALYSIS OF AGRICULTURAL COMMODITIES AND TRADE (IMPACT)

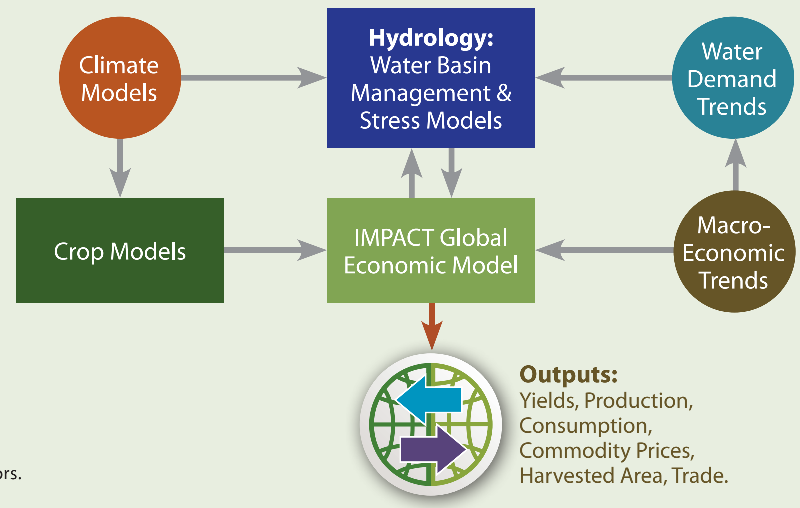
IMPACT models 62 agricultural commodity markets covering the majority of food consumed in the world, including varieties of grains, meat and dairy, roots and tubers, pulses, oils, fruits, and vegetables along with several cash crops. Irrigated and rainfed crop production is spatially disaggregated and modeled at the subnational level in 159 countries crossed with 154 major water basins to comprise 320 food production units (FPUs) around the globe.

Commodity production is driven by both economic and environmental factors and has both extensive and intensive components (area x yield) along with accounting for the presence of irrigation (irrigated and rainfed production) and exogenous technological change. Water use and climate change are modeled via coupled models that represent these complex components with extraordinary detail. World food prices are determined annually at levels that clear international commodity markets using iterative, year-by-year demand and supply equilibration while tracking details on physical use of land and water.

Demand is decomposed into major consumption sectors (food, feed, biofuels, and other). Food demand is a function of commodity prices, income, and population, while feed demand depends on the level of livestock production, feed prices, and feeding efficiencies. Biofuel demand is an exogenous calculation of demand for feedstock from different commodities to meet mandates in major consuming and producing countries. Other demand, mostly from the industrial sector, changes proportionally to food and feed demand and in line with growth in country GDP.

Scenario analysis of alternative futures relevant for informing the policymaking process can be done along nearly any dimension that is explicitly defined within IMPACT. Output indicators available for analysis across the baseline and alternative scenarios include calorie availability, malnutrition measures, share at risk of hunger, and water consumption along with the standard components of production, consumption, and trade from the agricultural sector.

FIGURE 2B.1—IMPACT MODEL SCHEMATIC



Source: Authors.

future scenarios analysis can be found in Rosegrant et al. (2012), Robinson et al. (2015), and via the IMPACT website (http:// http://www.ifpri.org/program/impact-model).

Baseline

The foundation of analysis in the IMPACT model is in the baseline that is aligned and calibrated with the latest outlooks on demand and supply in agricultural and related sectors. Key drivers of the demand side include population and income (and the subsequent per capita GDP) that IMPACT takes as exogenous assumptions from the SSP2[3] specification commonly used by modeling groups around the world to represent an "average" progression of current and expected trends. The demand side represented in IMPACT includes commodity-specific elasticities that evolve the consumption patterns in line with trends in income, price trajectories, and changes in tastes and preferences at the country level.

One of the IMPACT model's most important features is the extraordinary detail represented in the technical coefficients across several dimensions for production and supply of agricultural commodities. The baseline includes a "business-as-usual," plausible outlook of trends that affect supply according to yield and area growth; explicit modeling of water availability in agricultural systems and water use by the various sectors of society; and climate effects on crop productivity, among other elements.

One of the key questions addressed in this report is focused on the progression toward a middle-income Africa. In Table 2.2 is the breakdown by global and African regions of the expected trends in per capita GDP to 2030 and 2050. The exceptional growth in per capita GDP in South and East Asia

TABLE 2.2—BASELINE (SSP2) PER CAPITA GDP TRENDS, US$1,000, CONSTANT YEAR 2005

	2010	2030	2050
East Asia & Pacific	8.81	22.34	35.41
South Asia	2.74	6.98	13.88
Middle East & North Africa	9.96	17.09	26.04
SSA	1.97	3.81	7.79
Latin America & Caribbean	10.01	16.94	25.85
Former Soviet Union	10.23	21.38	32.40
Europe	27.23	36.24	48.15
North America	41.49	56.72	66.52
World	9.82	17.29	25.19
ReSAKSS-North	6.23	12.26	22.16
ReSAKSS-West	1.70	3.88	8.60
ReSAKSS-Central	1.22	2.35	5.63
ReSAKSS-East	1.22	2.59	6.13
ReSAKSS-Southern	4.79	7.94	12.00
AMU	6.87	13.15	21.89
CENSAD	2.65	5.34	10.70
COMESA	2.05	3.97	8.25
EAC	1.23	2.69	6.26
ECCAS	1.72	2.99	5.90
ECOWAS	1.70	3.88	8.60
IGAD	1.26	2.63	6.19
SADC	2.83	4.71	8.10

Source: IIASA (2015).
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

3 SSP2: Shared socioeconomic pathways are coordinated sets of projection for GDP and population growth used in the economic modeling community for foresight analysis (Chateau et al. 2012; O'Neill et al. 2014).

TABLE 2.3—BASELINE (SSP2) PER CAPITA GDP CLASSIFICATION AND TRANSITIONS

Region	Country	2010	2030	2050
ReSAKSS-North	Mauritania	L-Mid	L-Mid	U-Mid
	Morocco	L-Mid	U-Mid	U-Mid
	Algeria	U-Mid	U-Mid	U-Mid
	Egypt	U-Mid	U-Mid	U-Mid
	Tunisia	U-Mid	U-Mid	High
	Libya	U-Mid	High	High
ReSAKSS-West	Liberia	Low	Low	L-Mid
	Mali	Low	Low	L-Mid
	Niger	Low	Low	L-Mid
	Sierra Leone	Low	Low	L-Mid
	Togo	Low	Low	L-Mid
	Benin	Low	L-Mid	L-Mid
	Burkina Faso	Low	L-Mid	U-Mid
	Ghana	Low	L-Mid	U-Mid
	Guinea	Low	L-Mid	U-Mid
	Guinea-Bissau	Low	L-Mid	U-Mid
	Senegal	Low	L-Mid	U-Mid
	The Gambia	Low	L-Mid	U-Mid
	Côte d'Ivoire	Low	U-Mid	U-Mid
	Nigeria	L-Mid	L-Mid	U-Mid
ReSAKSS-Central	Burundi	Low	Low	L-Mid
	Central African Rep.	Low	Low	L-Mid
	Congo, Dem. Rep.	Low	Low	L-Mid
	Cameroon	Low	L-Mid	U-Mid
	Chad	Low	L-Mid	U-Mid
	Congo, Republic	L-Mid	U-Mid	U-Mid
	Gabon	U-Mid	U-Mid	High
	Equatorial Guinea	High	High	High
ReSAKSS-East	Eritrea	Low	Low	Low
	Madagascar	Low	Low	L-Mid
	Ethiopia	Low	L-Mid	U-Mid
	Kenya	Low	L-Mid	U-Mid
	Rwanda	Low	L-Mid	U-Mid
	Sudan	Low	L-Mid	U-Mid
	Tanzania	Low	L-Mid	U-Mid
	Uganda	Low	L-Mid	U-Mid
	Djibouti	L-Mid	L-Mid	U-Mid
ReSAKSS-Southern	Malawi	Low	Low	L-Mid
	Zimbabwe	Low	Low	L-Mid
	Lesotho	Low	L-Mid	U-Mid
	Mozambique	Low	L-Mid	U-Mid
	Zambia	Low	L-Mid	U-Mid
	Angola	L-Mid	U-Mid	U-Mid
	Swaziland	L-Mid	U-Mid	U-Mid
	Namibia	U-Mid	U-Mid	U-Mid
	Botswana	U-Mid	U-Mid	High
	South Africa	U-Mid	U-Mid	High

Source: IIASA (2015) and World Bank (2015) income level classifications.
Note: L-Mid= Lower-middle income, U-Mid= Upper-middle income.

will sharply decline over the latter half of the projection period, while Africa will see a more sustained growth—if at a lower rate—throughout the modeled time horizon. Table 2.3 shows the evolution of African nations through the modeled time horizon from low to lower-middle, upper-middle, and high-income classifications. Northern Africa is already fully middle income, while half of the southern African countries are in a similar state. The majority of nations in western, central, and eastern Africa are currently low income. Even in this baseline SSP2 specification, however, most of the countries currently of low-income status will graduate to middle income by 2030, and all except Eritrea will achieve this by 2050. We have included here a quick scenario assessment of increased GDP growth that would accelerate African income growth (see below).

Climate Change to 2050

It is important to note that calibration of the baseline happens in an environment absent of climate change effects (referred to as NoCC). The NoCC environment serves as a base that helps in the assessment of climate change impacts on production activities. However, given that previous assumptions about the impacts of climate change are already being seen in real-world results, the NoCC scenario is clearly implausible. Nonetheless, NoCC remains a useful reference case of interest to policymakers who often need to address the issue of mitigating climate impacts with stakeholders. However, this analysis employs four updated climate change representations—used widely in the modeling community—as major drivers for calculating a primary, plausible reference scenario, the *baseline climate change* (BSLN-CC).[4] The BSLN-CC shows the average climate impacts across these core climate change scenarios. There is significant uncertainty involved in the science of determining future climate scenarios, which necessitates the use of a suite of climate representations such as the one used here. Across the climate models, however, a few take-home messages are clear:

The climate is warming, which means:

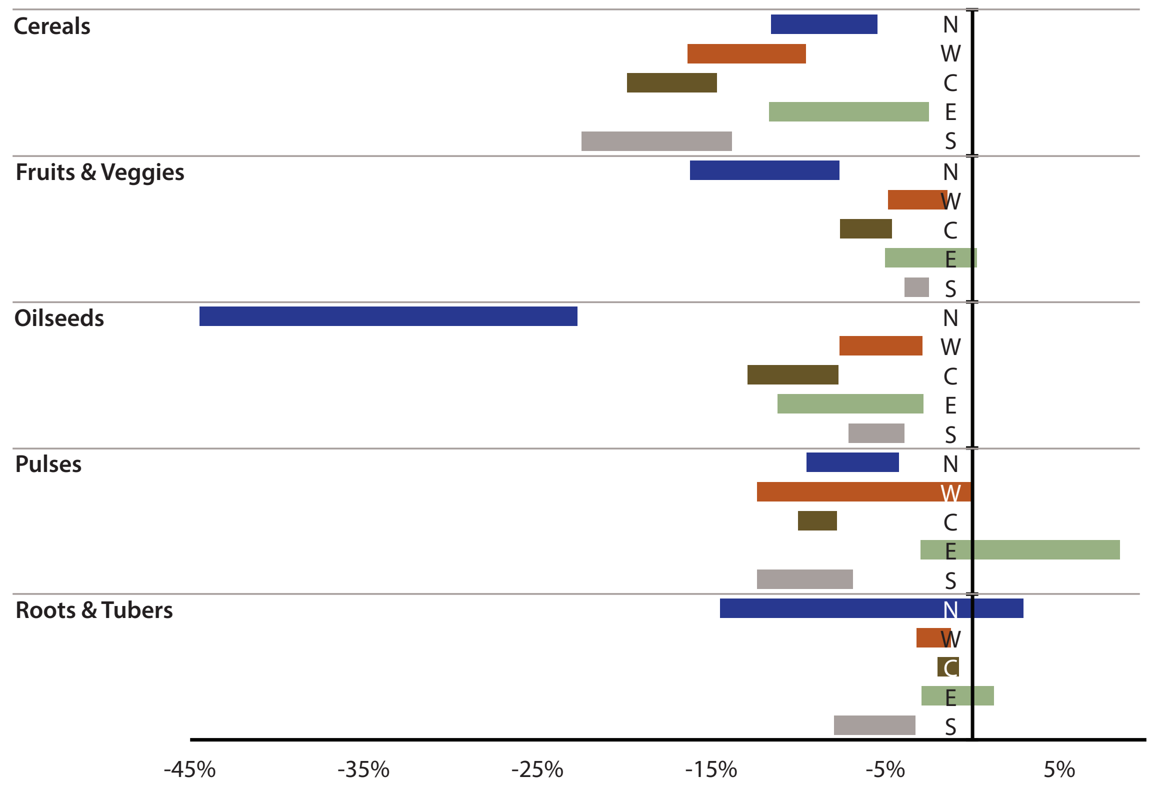
1. increased moisture in the atmosphere and therefore increased rainfall on average across the global landscape;
2. this rainfall will occur in more intensive events and not necessarily according to previous seasonal patterns (the precise effects at any given location, however, may fall anywhere on the drier-to-wetter or warmer-to-cooler spectra); and finally,
3. the general trends indicate that temperate regions may benefit slightly from climate change while the tropics are expected to suffer worsening conditions (Nelson et al. 2010).

The primary effect of climate change in the IMPACT model is through changes in crop yields. These impacts are estimated through a set of linked biophysical crop models that simulate crop growth in the baseline suite of five climates (NoCC plus four CC). The repercussions of climate change on crop yields in Africa are predominantly negative. As an indication of this, Figure 2.5 shows the range of yield impacts on rainfed systems across the baseline climate change scenarios for the five ReSAKSS-Africa regions.

North Africa will see the broadest range of impacts with potentially positive yield changes for roots and tubers or the extreme negative impact on rainfed oilseed production. West, central, and southern Africa see consistently negative yield impacts across all crops, while eastern Africa has the potential to see some positive yield impacts in roots and tubers and, in

[4] The four climate scenarios follow the Representative Concentration Pathway (RCP) 8.5 in four general circulation models (GCMs) that are used as a common basis for representing climate change in global analyses. GCMs used are the HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, and GFDL-ESM2M; all are described in Andrews et al. (2012).

FIGURE 2.5—RANGE OF CLIMATE CHANGE IMPACTS ON AGGREGATE COMMODITY YIELDS FOR RESAKSS REGIONS



Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: For North (N), West (W), Central (C), East (E), and Southern (S) ReSAKSS regions.

particular, pulses. Cereals are projected to see the most consistent decline in yields across Africa (approximately –5 to –20 percent compared with NoCC in 2050). Oilseeds and fruits and vegetables are also consistently negatively impacted across Africa, but the ranges of effects depend on the region. Except for East Africa, pulses will see up to a –10 percent decline in rainfed yields by 2050 compared with a world without climate change. The types of impacts on irrigated systems is similar but strongly depends on whether the source of irrigation water is surface or pumped groundwater. Surface water is more immediately affected, while groundwater will experience more lagged effects.

Water stress is also affected by climate change and has important implications for crop yields. As the different climate models show varied patterns of changes in precipitation (Rosegrant et al. 2014), the effects on crop productivity are quite mixed for crops across the African landscape depending on location-specific details. Rainfed agriculture, being more dominant than irrigated production in Africa, shows a more widespread and dramatic effect of water stress due to the inability to smooth out water consumption as is possible in irrigated systems. In a few selected irrigated production systems, however, water stress will be so great that production will be severely curtailed unless there is a significant adjustment to production practices (for example, irrigated cereals in Morocco).

A limitation of this modeling framework is that changes in production areas due to climate change are relatively imperfect due to the coarse scale at which the model operates. This could be especially important for the regions in Africa where agricultural production relies on marginal lands, such as in and near the Sahel. While the IMPACT model is especially detailed at a high-resolution geography compared with other global modeling efforts, capturing the dynamics of land use change is currently a topic of research and development in IMPACT. Also, climate effects on livestock production are currently modeled only via secondary effects in feed markets. In the majority of livestock-producing regions, where either or both the livestock and required productive inputs are fairly mobile, this is a workable representation. In Africa, this could be a strong limitation where livestock production activities are often isolated from alternative sources of feed, fodder, and other requirements. As it is with land use, IMPACT's livestock module is currently undergoing revision to include a much more precise representation of livestock production and its diversity across landscapes.

Outlook to 2030 and 2050

Combining the extensive set of modules for the IMPACT model and running them forward produces a set of projections for plausible outcomes for global and African agriculture supply and demand (along with associated food security metrics) out to 2030 and 2050. This establishes a strong foundation for strategic foresight analysis that can inform the policymaking process and help push regions further along the path of human development.

Production

Cereal production in Africa will continue to grow strongly at about 2 percent annually until 2030 but will then slow to just over 1 percent per year in the last half of the projection period to 2050 (Table 2.4). This is important fundamental growth for both East and West Africa, where most of cereals are produced, even if Africa's share of global production remains at less than 10 percent. Climate impacts on cereals will reduce total production by between 6 and 12 percent by 2050 in the ReSAKSS-Africa regions except in East Africa, which could see a slight increase. In the global balance, Africa's share of total production will remain effectively the same under climate change, given that temperate regions will see more beneficial environments for cereal production while tropical zones suffer.

Africa currently produces one-tenth of global fruit and vegetable produce and will increase their share by more than 5 percentage points by 2050 (Table 2.5). This is quite an important subsector for Africa's own consumption and export earnings. This includes bananas and plantains in West and East Africa along with produce for export from North Africa. Growth is quite strong over the first half of the projection period (more than 3 percent annually) and remains relatively strong from 2030 to 2050. Climate change impacts, in terms of how much total African production is reduced, are projected to be a little less than half of impacts on cereals.

West Africa produces most of the oilseeds in the region and is actually looking at a future of slightly increased production due to climate change (Table 2.6), while Africa remains a relatively minor player in the global oilseed markets (less than 10 percent of global production). At the same time, West Africa is also the leading African producer of pulses and roots and tubers (Tables 2.7 and 2.8). In these two aggregate commodities, Africa is a much more important global player. It produces about 20 percent and 30 percent of total global production for pulses and roots and tubers, respectively, though most of the production is consumed in Africa and is not exported. Africa will also increase its shares of global production to almost 25 percent for pulses and more than 40 percent for roots and tubers. Climate change will hardly affect pulse production in Africa (less than a 1 percent decline) but could impede production of roots and tubers a bit more (more than 2 percent decline). For reasons outlined above, climate effects are rather muted in Africa's livestock sector (Table 2.9). Africa currently produces 5 percent of meat consumed globally and should increase that share to nearly 10 percent by 2050, which is due to relatively slower growth in meat demand outside of Africa.

TABLE 2.4—BASELINE PRODUCTION OF AGGREGATE CEREALS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE IMPACT (%) OF CLIMATE CHANGE

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	580.6	691.4	753.9	–3.0%	–6.1%
South Asia	279.0	385.7	460.3	–10.4%	–18.5%
Middle East & North Africa	114.5	152.6	174.1	0.3%	2.7%
SSA	114.2	178.4	237.1	–2.9%	–5.1%
Latin America & Caribbean	164.4	245.2	323.8	–5.3%	–10.0%
Former Soviet Union	157.2	206.3	243.1	7.1%	14.1%
Europe	310.9	319.1	333.7	1.2%	6.0%
North America	436.3	573.1	711.7	–6.1%	–11.2%
World	2157.0	2751.8	3237.8	–3.4%	–6.1%
ReSAKSS-North	36.5	45.7	49.9	–4.8%	–9.4%
ReSAKSS-West	49.0	78.3	108.3	–2.5%	–6.0%
ReSAKSS-Central	6.4	11.2	15.8	–5.9%	–11.1%
ReSAKSS-East	38.1	56.9	74.4	–0.6%	0.8%
ReSAKSS-Southern	20.6	32.0	38.6	–6.7%	–11.7%
AMU	16.6	21.7	22.6	–9.3%	–20.3%
CENSAD	93.9	138.3	177.3	–4.0%	–8.2%
COMESA	59.0	86.2	110.6	–1.3%	–0.2%
EAC	13.5	19.5	21.1	1.3%	1.3%
ECCAS	7.6	12.9	18.2	–4.3%	–9.0%
ECOWAS	49.0	78.3	108.3	–2.5%	–6.0%
IGAD	28.2	42.4	56.4	–1.7%	–0.3%
SADC	31.9	48.8	59.7	–4.0%	–6.8%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.5—BASELINE PRODUCTION OF AGGREGATE FRUITS AND VEGETABLES (million metric tonnes) IN NOCC SCENARIO AND AVERAGE IMPACT (%) OF CLIMATE CHANGE

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	707.6	920.9	1058.8	1.4%	3.0%
South Asia	156.2	309.7	440.0	–8.0%	–15.2%
Middle East & North Africa	147.2	260.0	362.4	0.8%	1.1%
SSA	101.4	187.4	293.7	–0.3%	–0.1%
Latin America & Caribbean	164.1	235.1	294.7	–2.7%	–4.7%
Former Soviet Union	62.0	80.4	91.9	5.9%	11.1%
Europe	155.9	204.2	244.8	–3.0%	–5.9%
North America	90.9	112.6	139.7	–0.8%	–0.9%
World	1585.4	2310.2	2926.2	–0.8%	–1.7%
ReSAKSS-North	52.7	110.1	161.2	–3.4%	–6.4%
ReSAKSS-West	40.1	73.9	116.5	–2.0%	–3.9%
ReSAKSS-Central	11.1	20.2	30.8	–2.0%	–4.1%
ReSAKSS-East	36.3	70.1	113.8	2.9%	6.1%
ReSAKSS-Southern	13.7	23.0	32.5	–3.2%	–4.7%
AMU	22.1	41.2	65.6	–8.8%	–14.3%
CENSAD	96.7	192.4	291.4	–1.6%	–2.6%
COMESA	69.8	145.4	220.5	1.0%	2.1%
EAC	28.9	56.9	96.3	3.5%	7.0%
ECCAS	15.5	28.4	43.1	–1.0%	–2.2%
ECOWAS	40.1	73.9	116.5	–2.0%	–3.9%
IGAD	25.6	52.2	89.6	3.9%	7.3%
SADC	23.1	38.5	53.5	–2.5%	–3.6%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara

TABLE 2.6—BASELINE PRODUCTION OF AGGREGATE OILSEEDS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE IMPACT (%) OF CLIMATE CHANGE

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	280.6	487.6	667.2	–0.9%	–1.6%
South Asia	41.0	52.3	56.8	–3.9%	–8.7%
Middle East & North Africa	8.5	11.6	13.7	–2.8%	–5.0%
SSA	52.9	90.0	113.9	0.3%	1.0%
Latin America & Caribbean	125.6	183.2	214.8	–1.0%	–1.6%
Former Soviet Union	14.5	18.7	22.2	4.1%	7.7%
Europe	40.3	53.3	60.4	–1.0%	–2.7%
North America	109.6	138.9	154.7	–1.6%	–4.2%
World	673.1	1035.6	1303.6	–1.0%	–1.9%
ReSAKSS-North	3.1	4.3	5.2	–8.0%	–14.2%
ReSAKSS-West	42.7	74.8	95.0	0.6%	1.6%
ReSAKSS-Central	3.5	5.8	7.5	–1.5%	–4.1%
ReSAKSS-East	4.0	5.8	7.3	–0.9%	0.3%
ReSAKSS-Southern	2.6	3.6	4.1	–1.2%	–2.2%
AMU	2.3	3.1	3.8	–10.8%	–18.2%
CENSAD	47.6	81.8	103.5	0.1%	0.6%
COMESA	4.8	7.1	8.8	–2.2%	–3.6%
EAC	2.2	3.1	4.0	0.6%	3.4%
ECCAS	3.9	6.5	8.1	–1.2%	–3.5%
ECOWAS	42.7	74.8	95.0	0.6%	1.6%
IGAD	2.6	3.8	4.4	–0.8%	0.7%
SADC	4.4	6.5	8.4	–1.8%	–3.0%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.7—BASELINE PRODUCTION OF AGGREGATE PULSES (million metric tonnes) IN NOCC SCENARIO AND AVERAGE IMPACT (%) OF CLIMATE CHANGE

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	12.7	16.3	19.7	–1.4%	–1.9%
South Asia	15.6	20.7	24.1	–2.8%	–6.0%
Middle East & North Africa	4.0	5.8	7.2	–5.8%	–10.6%
SSA	11.6	18.2	27.5	0.0%	0.0%
Latin America & Caribbean	6.9	11.1	16.0	–6.9%	–12.0%
Former Soviet Union	3.3	4.2	5.2	2.9%	6.0%
Europe	5.2	7.3	9.1	3.9%	6.2%
North America	6.9	9.7	12.1	3.0%	5.3%
World	66.3	93.3	121.1	–1.3%	–2.5%
ReSAKSS-North	1.0	1.4	1.9	–7.7%	–11.8%
ReSAKSS-West	5.3	9.3	15.3	–1.8%	–3.3%
ReSAKSS-Central	1.1	1.7	2.5	–3.0%	–6.3%
ReSAKSS-East	4.4	5.9	7.7	5.9%	12.7%
ReSAKSS-Southern	0.8	1.3	2.0	–9.6%	–16.1%
AMU	0.6	0.8	1.1	–4.3%	–7.0%
CENSAD	7.2	12.3	19.3	–1.0%	–1.1%
COMESA	4.6	6.4	8.6	4.3%	9.2%
EAC	2.8	4.1	5.3	3.5%	8.3%
ECCAS	1.5	2.2	3.2	0.0%	–2.3%
ECOWAS	5.3	9.3	15.3	–1.8%	–3.3%
IGAD	2.9	3.8	5.0	10.7%	23.3%
SADC	2.2	3.4	4.8	–7.9%	–14.0%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.8—BASELINE PRODUCTION OF AGGREGATE ROOTS AND TUBERS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE IMPACT (%) OF CLIMATE CHANGE

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	248.1	273.9	257.7	0.8%	1.7%
South Asia	50.3	75.1	103.4	–0.5%	–1.0%
Middle East & North Africa	21.2	28.1	34.1	–6.7%	–12.0%
SSA	224.0	346.6	483.2	–1.0%	–1.7%
Latin America & Caribbean	59.9	83.4	98.5	0.5%	1.8%
Former Soviet Union	82.3	88.2	82.9	1.8%	0.4%
Europe	67.9	77.2	82.6	–21.5%	–37.2%
North America	26.2	29.6	33.0	3.5%	6.6%
World	779.8	1002.1	1175.4	–1.7%	–3.0%
ReSAKSS-North	8.4	12.7	15.9	–10.9%	–17.8%
ReSAKSS-West	133.2	206.0	293.9	–0.6%	–1.0%
ReSAKSS-Central	26.8	45.6	65.3	–1.4%	–2.4%
ReSAKSS-East	34.5	56.6	81.2	–1.0%	–1.4%
ReSAKSS-Southern	29.5	38.3	42.7	–2.9%	–5.3%
AMU	5.0	6.9	7.8	–3.7%	–2.2%
CENSAD	144.3	224.4	318.9	–1.1%	–1.7%
COMESA	54.8	88.3	120.6	–2.9%	–4.9%
EAC	25.2	42.3	61.4	–0.9%	–1.3%
ECCAS	42.2	66.9	89.7	–1.6%	–2.9%
ECOWAS	133.2	206.0	293.9	–0.6%	–1.0%
IGAD	19.3	32.1	44.8	–0.9%	–1.8%
SADC	57.8	85.0	111.4	–2.1%	–3.2%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.9—BASELINE PRODUCTION OF AGGREGATE MEAT (million metric tonnes) IN NOCC SCENARIO AND AVERAGE IMPACT (%) OF CLIMATE CHANGE

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	99.0	130.4	135.3	–0.6%	–1.0%
South Asia	9.9	19.1	30.7	0.1%	0.0%
Middle East & North Africa	10.8	19.5	31.2	–0.3%	–0.7%
SSA	10.8	20.4	34.4	–0.1%	–0.1%
Latin America & Caribbean	44.0	66.4	84.3	–0.3%	–0.6%
Former Soviet Union	10.0	12.4	13.5	0.2%	–0.1%
Europe	44.2	51.8	55.8	0.1%	–0.2%
North America	45.2	60.7	72.9	–0.3%	–1.0%
World	274.0	380.7	458.0	–0.3%	–0.6%
ReSAKSS-North	3.5	6.5	10.7	–0.2%	–0.5%
ReSAKSS-West	2.8	5.6	10.4	–0.2%	–0.3%
ReSAKSS-Central	0.7	1.3	2.3	–0.1%	0.0%
ReSAKSS-East	4.2	8.1	14.4	0.0%	0.2%
ReSAKSS-Southern	3.2	5.4	7.4	0.0%	–0.3%
AMU	1.9	3.4	5.1	–0.2%	–0.7%
CENSAD	8.2	16.1	28.8	–0.1%	–0.2%
COMESA	5.9	11.3	19.8	0.0%	0.0%
EAC	1.5	2.7	4.2	0.0%	0.2%
ECCAS	0.9	1.6	2.6	0.0%	0.1%
ECOWAS	2.8	5.6	10.4	–0.2%	–0.3%
IGAD	3.4	6.6	11.8	0.0%	0.2%
SADC	4.0	7.0	10.3	0.0%	–0.2%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

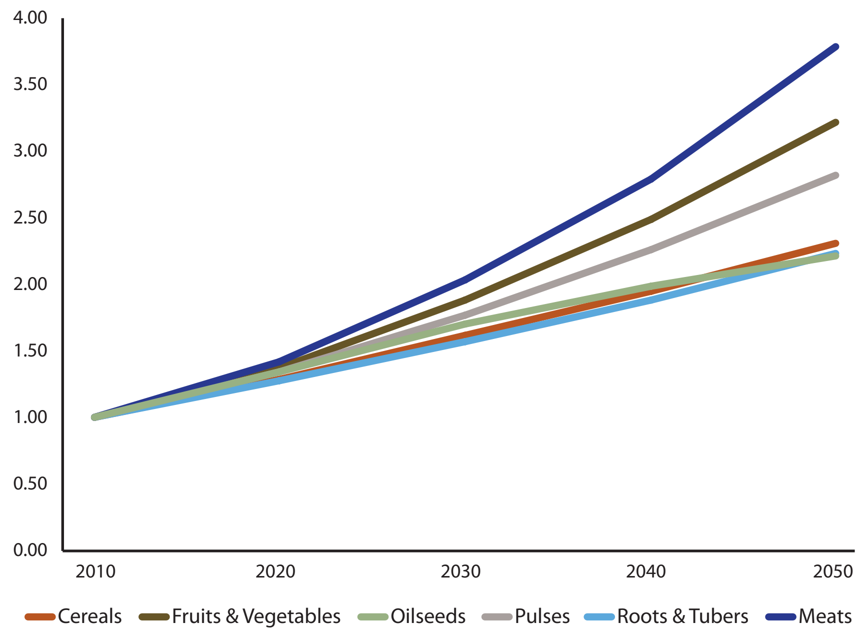
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

Demand

Total demand for commodities in Africa is increasing significantly over the coming decades (Figure 2.6), in line with increasing per capita incomes and population. Demand for cereals, oilseeds, and roots and tubers will more than double by 2050, while total consumption of pulses and fruits and vegetables will be in the range of tripling. Meat demand in Africa, starting from a relatively low base in 2010, will nearly quadruple by 2050. This has important implications for nutrition and food security, which are detailed below.

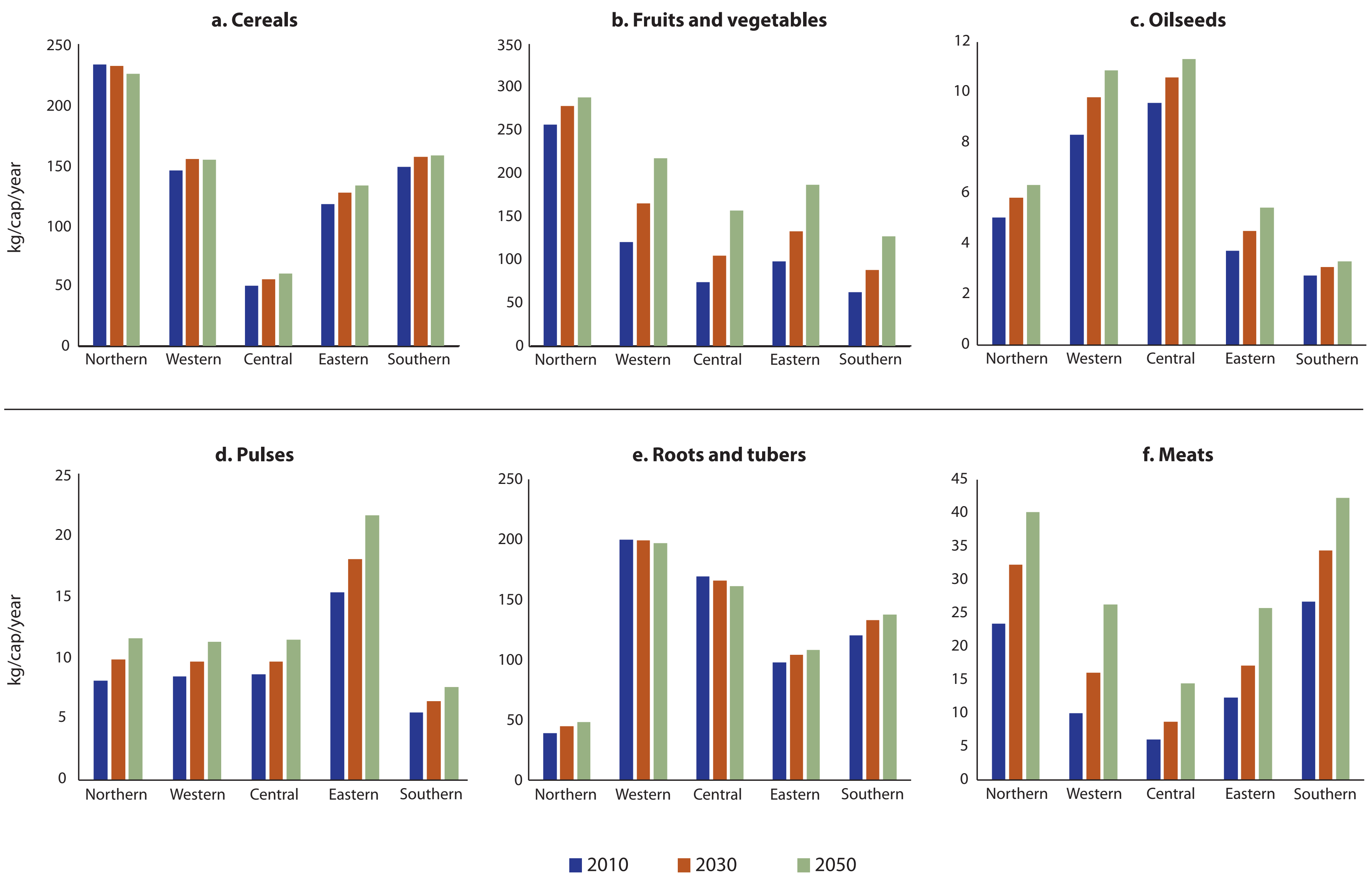
Looking more closely at per capita food consumption broken out on a regional basis for these aggregate commodities shows a picture of how tastes and preferences both differ and are shifting across Africa (Figure 2.7). Consumption of staples is seeing differentiated preferences across Africa, while nonstaples are consistently experiencing increasing per capita demands. Cereal consumption is declining in the North and apparently leveling off at about 150 kilograms per capita per year in western and southern Africa. In the Central and East ReSAKSS regions, where per capita levels are lower, preferences are still to continue increasing consumption. The other source of major staples, root and tubers, is seeing declining consumption in the regions where per capita demands have been higher in the past (western and central Africa) and on the rise in regions where it may be representing a diversification of dietary habits (northern, eastern, and southern). Fruits and vegetables, oilseeds, pulses, and meat are all strongly increasing at the per capita level, which is a phenomenon common across many other regions as they develop and experience increasing per capita incomes.

FIGURE 2.6—INDEXED TOTAL DEMAND TRAJECTORIES FOR AFRICA (BSLN-CC)



Source: ReSAKSS database (2015).

FIGURE 2.7—BSLN-CC PER CAPITA CONSUMPTION, RESAKSS REGIONS



Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

Net Trade

In general, the expansion of productive capacity in the baseline suite of scenarios is not adequate to expand national supplies enough to meet increasing demands, which then must be met through net imports. This is especially the case for cereals (Table 2.10). Africa is already a major global importer of cereals and is projected to be a net importer of half of all available net exports from the world by 2050. In a limited number of cases, Africa's comparative advantage leads to consistent net export positions, such as fruits and vegetables from North Africa (for example, Egypt and Morocco) (Table 2.11).

Trade markets in oilseeds and pulses are thin from the Africa perspective (Tables 2.12 and 2.13). Though these two commodities may be locally important to particular sectors or regions, they are effectively nonexistent from the global point of view. Roots and tubers trade is spread more evenly across Africa by 2050 in the BSLN-CC set, with the exception of North Africa (Table 2.14). Each region is a net importer in the range of 6 to 9 million metric tonnes by 2050.

These aggregate net trade numbers can mask an extraordinary amount of trade that occurs at the local and subregional levels, which will often not be concerned with national boundaries. Meat trade at the aggregate level in Africa (Table 2.15) is about 12.5 million metric tonnes of imports in 2050, whereas the total amount of net imports summed across each country of Africa is 75 million metric tonnes.

Climate change impact ripples through to net trade with only relatively weak effects in Africa. Mostly, the net trade picture for the commodities presented here changes little in the BSLN-CC scenarios compared with NoCC. The one minor exception to this is roots and tubers in North Africa, but these differences are only slight.

TABLE 2.10—BASELINE NET TRADE OF AGGREGATE CEREALS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (million metric tonnes)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	–29.3	–50.2	–55.7	–27.4	4.3
South Asia	–3.1	–1.4	–39.0	–36.4	–103.9
Middle East & North Africa	–48.4	–78.8	–121.9	–77.2	–111.1
SSA	–28.3	–75.5	–155.8	–71.1	–139.6
Latin America & Caribbean	–22.2	–16.6	–2.5	–21.7	–54.2
Former Soviet Union	23.9	64.4	103.8	80.9	141.9
Europe	20.7	–13.3	–13.3	–11.1	2.8
North America	128.4	213.2	326.2	205.8	301.6
World	41.8	41.8	41.8	41.8	41.8
ReSAKSS-North	–24.8	–40.5	–61.6	–41.1	–60.1
ReSAKSS-West	–11.3	–32.3	–67.8	–30.2	–62.0
ReSAKSS-Central	–1.3	–4.0	–11.1	–4.0	–10.5
ReSAKSS-East	–7.2	–23.2	–48.2	–21.3	–40.4
ReSAKSS-Southern	–8.3	–15.8	–28.5	–15.4	–26.5
AMU	–13.6	–17.8	–23.4	–19.7	–27.3
CENSAD	–32.5	–70.8	–133.6	–70.0	–127.5
COMESA	–22.3	–48.8	–92.2	–45.8	–78.6
EAC	–3.6	–13.3	–32.5	–11.6	–27.3
ECCAS	–3.1	–8.0	–17.4	–8.0	–16.4
ECOWAS	–11.3	–32.3	–67.8	–30.2	–62.0
IGAD	–6.0	–17.0	–33.7	–16.5	–29.8
SADC	–9.5	–23.0	–46.6	–21.0	–40.0

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.11—BASELINE NET TRADE OF AGGREGATE FRUITS AND VEGETABLES (million metric tonnes) IN NOCC SCENARIO AND AVERAGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (million metric tonnes)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	–19.1	–41.9	112.1	–20.8	159.3
South Asia	–26.9	–88.6	–284.9	–108.5	–336.5
Middle East & North Africa	7.4	67.5	131.1	69.1	135.8
SSA	–3.1	–35.6	–126.6	–34.2	–120.2
Latin America & Caribbean	46.0	74.8	103.2	70.2	93.5
Former Soviet Union	1.0	4.5	9.2	9.7	21.6
Europe	–6.0	25.3	52.8	20.1	40.9
North America	2.4	–4.5	4.8	–4.1	7.3
World	1.6	1.6	1.6	1.6	1.6
ReSAKSS-North	4.5	44.6	84.1	40.3	73.3
ReSAKSS-West	–0.6	–15.1	–51.8	–15.7	–52.9
ReSAKSS-Central	0.6	–3.0	–15.2	–3.2	–15.6
ReSAKSS-East	–5.4	–18.7	–53.7	–16.3	–45.2
ReSAKSS-Southern	2.2	1.2	–6.0	0.9	–6.5
AMU	1.5	12.9	33.0	9.5	24.2
CENSAD	0.4	18.1	2.3	15.8	–1.7
COMESA	–2.2	12.4	–11.1	13.6	–5.2
EAC	–1.6	–9.1	–27.9	–7.0	–20.6
ECCAS	–0.6	–7.6	–25.9	–7.4	–25.6
ECOWAS	–0.6	–15.1	–51.8	–15.7	–52.9
IGAD	–4.2	–9.5	–23.8	–7.3	–16.7
SADC	1.3	–7.8	–37.0	–8.2	–36.9

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.12—BASELINE NET TRADE OF AGGREGATE OILSEEDS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (million metric tonnes)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	–33.4	–48.5	–50.1	–47.1	–47.2
South Asia	1.1	–3.4	–7.8	–3.9	–8.9
Middle East & North Africa	–5.7	–6.9	–7.9	–6.6	–7.4
SSA	0.5	–1.1	–5.8	–0.9	–4.7
Latin America & Caribbean	27.3	46.5	56.9	44.9	53.3
Former Soviet Union	0.1	1.0	1.9	1.3	2.7
Europe	–15.1	–14.1	–13.6	–13.6	–12.9
North America	36.5	42.3	45.5	41.6	43.9
World	11.3	15.9	19.1	15.8	18.9
ReSAKSS-North	–1.3	–1.4	–1.5	–1.4	–1.5
ReSAKSS-West	0.5	–0.3	–3.4	–0.2	–2.7
ReSAKSS-Central	0.2	0.2	0.1	0.2	0.0
ReSAKSS-East	0.0	–0.6	–2.0	–0.6	–1.7
ReSAKSS-Southern	–0.2	–0.3	–0.5	–0.3	–0.5
AMU	–0.6	–0.6	–0.6	–0.6	–0.6
CENSAD	–0.6	–1.7	–5.3	–1.6	–4.6
COMESA	–0.9	–1.7	–3.0	–1.6	–2.8
EAC	0.0	–0.7	–1.8	–0.5	–1.4
ECCAS	0.2	0.1	0.0	0.1	–0.1
ECOWAS	0.5	–0.3	–3.4	–0.2	–2.7
IGAD	0.0	–0.3	–1.3	–0.3	–1.1
SADC	–0.4	–0.9	–1.5	–0.8	–1.3

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.13—BASELINE NET TRADE OF AGGREGATE PULSES (million metric tonnes) IN NOCC SCENARIO AND AVERAGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (million metric tonnes)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	2.5	3.1	5.2	3.2	5.5
South Asia	–3.0	–6.2	–10.3	–6.4	–10.9
Middle East & North Africa	–0.7	–1.2	–1.7	–1.5	–2.4
SSA	–0.9	–4.5	–9.9	–4.2	–9.1
Latin America & Caribbean	–0.6	1.2	4.4	0.5	2.6
Former Soviet Union	0.6	1.5	2.5	1.6	3.0
Europe	–0.8	1.0	2.6	1.4	3.5
North America	4.3	6.6	8.5	6.9	9.2
World	1.5	1.5	1.5	1.5	1.5
ReSAKSS-North	–0.8	–1.2	–1.7	–1.3	–1.9
ReSAKSS-West	0.3	0.1	–0.4	0.1	–0.5
ReSAKSS-Central	0.0	–0.3	–0.6	–0.3	–0.7
ReSAKSS-East	–1.0	–4.0	–8.3	–3.6	–7.1
ReSAKSS-Southern	–0.2	–0.4	–0.6	–0.5	–0.8
AMU	–0.2	–0.2	–0.2	–0.3	–0.2
CENSAD	–0.7	–1.8	–3.4	–1.7	–3.1
COMESA	–1.6	–4.9	–9.4	–4.6	–8.3
EAC	–0.5	–2.0	–4.6	–1.8	–3.9
ECCAS	–0.2	–0.7	–1.4	–0.6	–1.3
ECOWAS	0.3	0.1	–0.4	0.1	–0.5
IGAD	–0.8	–3.1	–6.2	–2.6	–4.8
SADC	–0.3	–1.0	–2.2	–1.2	–2.7

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.14—BASELINE NET TRADE OF AGGREGATE ROOTS AND TUBERS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (million metric tonnes)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	1.2	–1.2	9.0	6.6	21.7
South Asia	–6.3	–23.7	–28.5	–21.1	–23.4
Middle East & North Africa	–0.5	–1.5	–1.2	–2.4	–4.0
SSA	–0.2	–10.9	–29.7	–11.3	–29.2
Latin America & Caribbean	0.2	13.1	23.4	15.4	29.1
Former Soviet Union	9.2	18.4	14.0	21.4	20.0
Europe	–0.5	9.5	16.3	–6.6	–14.0
North America	–0.5	–1.3	–0.8	0.4	2.3
World	2.5	2.5	2.5	2.5	2.5
ReSAKSS-North	0.3	0.7	0.9	–0.3	–1.4
ReSAKSS-West	2.0	–3.7	–11.2	–3.0	–8.7
ReSAKSS-Central	–1.2	–2.2	–7.0	–2.7	–8.5
ReSAKSS-East	–2.7	–5.4	–6.3	–5.3	–5.9
ReSAKSS-Southern	1.7	0.4	–5.1	–0.2	–6.1
AMU	0.1	–0.1	–0.2	–0.2	0.0
CENSAD	1.9	–3.0	–9.7	–3.1	–9.1
COMESA	–3.5	–10.3	–25.4	–11.9	–29.4
EAC	–1.4	–3.6	–5.6	–3.6	–5.3
ECCAS	0.8	1.2	–5.3	0.7	–7.0
ECOWAS	2.0	–3.7	–11.2	–3.0	–8.7
IGAD	–1.2	–2.2	–4.0	–2.2	–4.0
SADC	–0.6	–5.4	–16.7	–6.5	–18.9

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.15—BASELINE NET TRADE OF AGGREGATE MEATS (million metric tonnes) IN NOCC SCENARIO AND AVERAGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (million metric tonnes)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	–7.3	–22.8	–23.8	–23.2	–24.3
South Asia	0.3	–2.2	–9.8	–2.1	–9.5
Middle East & North Africa	–1.8	–1.6	1.8	–1.6	1.8
SSA	–0.4	–3.7	–13.9	–3.7	–13.6
Latin America & Caribbean	7.1	16.3	25.2	16.3	25.2
Former Soviet Union	–3.0	–3.3	–3.3	–3.3	–3.2
Europe	1.4	5.8	6.3	6.0	6.5
North America	4.1	12.0	17.9	11.9	17.4
World	0.4	0.4	0.4	0.4	0.4
ReSAKSS-North	–0.5	–0.4	1.0	–0.3	1.1
ReSAKSS-West	–0.3	–2.0	–7.4	–2.0	–7.3
ReSAKSS-Central	0.0	–0.3	–1.2	–0.3	–1.2
ReSAKSS-East	0.5	–0.1	–2.1	–0.1	–2.0
ReSAKSS-Southern	–0.6	–1.4	–3.0	–1.3	–3.0
AMU	–0.2	–0.1	0.7	–0.1	0.7
CENSAD	–0.1	–1.8	–6.5	–1.7	–6.3
COMESA	0.1	–0.6	–2.5	–0.6	–2.4
EAC	0.0	–0.7	–2.8	–0.7	–2.8
ECCAS	–0.4	–1.1	–2.5	–1.1	–2.4
ECOWAS	–0.3	–2.0	–7.4	–2.0	–7.3
IGAD	0.5	0.2	–0.8	0.3	–0.7
SADC	–0.6	–1.7	–4.7	–1.7	–4.6

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

Prices

At the intersection of production, consumption, and trade are global, commodity-level prices that help complete a picture of changing markets and the evolution of the agricultural sector. Indexed global commodity price trajectories for the NoCC and BSLN-CC scenarios are presented in Figure 2.8. The range of impacts found in the basic climate change scenarios described above are shown as gray bands around the BSLN-CC mean.

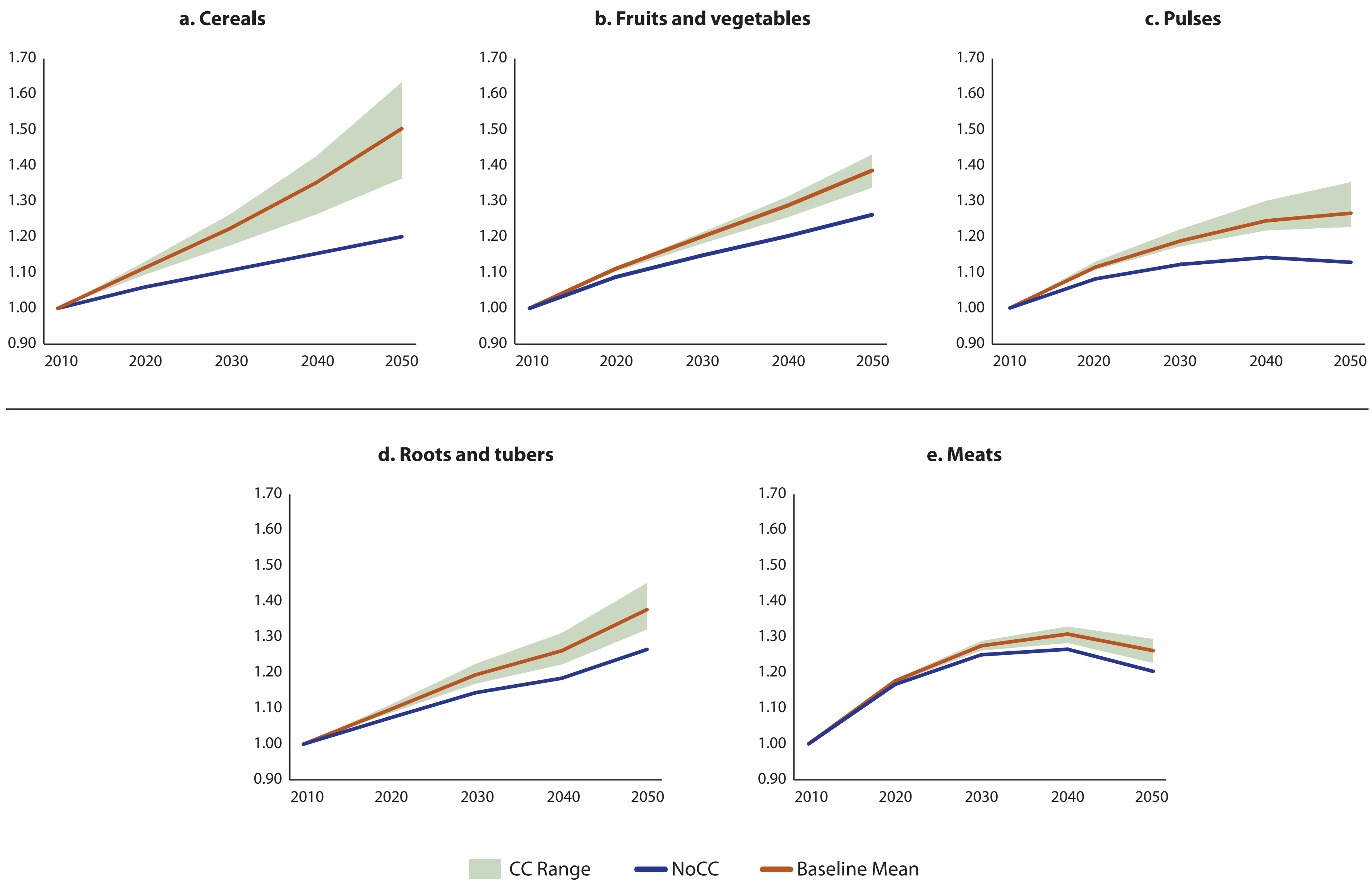
Cereals face the most severe global impacts of climate change on prices in the BSLN-CC compared with the NoCC. Aggregate cereal prices are about 25 percent higher under climate change in 2050 compared with a world without climate impacts. This is a price level 50 percent higher than 2010 levels. Fruits and vegetables, pulses, and roots and tubers see a 9–12 percent increase in global commodity-level prices compared with no climate change, which are about 26–38 percent higher than their 2010 prices. Meat markets see only a relatively modest impact of climate change on aggregate commodity-level prices (5 percent).

The importance of these price changes for Africa will greatly depend on the level of integration with world markets. Price increases certainly represent an opportunity for producers who can manage to supply global markets, but could be a severe challenge for net consumers of these commodities. Currently, much of Africa is relatively isolated from these global commodity markets, but this will change as incomes increase and markets become more integrated.

Food Security

Indicators of food security key off of the per capita calorie availability implied by the trajectories of food availability at the country level. Other assumptions also come into play, as detailed in the IMPACT model documentation. The two metrics used here in addition to per capita calories are the number of malnourished children (ages 0 to 5, by weight) and the share of the general population at risk of hunger.

FIGURE 2.8—NOCC AND BSLN-CC RANGE OF INDEXED WORLD PRICES TRAJECTORIES



Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

Table 2.16 shows consistent increasing calorie availability in the NoCC baseline and a clear negative impact of climate change across the globe (decreased yields, leading to increased prices and in turn decreased availability of food for consumption). Central Africa is projected to make marked improvements in the baseline calorie consumption, which is critical given the low starting point in 2010 just at 2,000 kcal per capita. North Africa is already consuming nearly at the same level of the developed world and therefore sees little increase in calories. Other parts of Africa see about a 12 percent increase in calories by 2030 and a 25 percent increase by 2050 compared with 2010. While the impact of climate change on calorie consumption in Africa (and elsewhere in the world) seems relatively modest at 1–2 percent and 2–3 percent reductions by 2030 and 2050, respectively, this has crucial repercussions on the hungry and undernourished.

While Africa as a whole is managing to reduce the number of undernourished children (ages 0 to 5, by weight) by 8 million in 2050 compared with 2010 in the NoCC scenario, a few regions, such as West Africa, are struggling to make advances (Table 2.17). This is largely an issue of fast population growth, but also of other stagnating conditions that constrain the potential for progress. The improvements across Africa seem to take hold only in the latter half of the projection period, which is a sign of persistent challenges that Africa faces in advancing human development. Climate change makes this problem worse by keeping 2 million more children malnourished.

The picture for hunger in the general population shows a more optimistic future in Africa (Table 2.18). The share at risk of hunger in North Africa is already at the minimum estimate (about 4 percent), while the rest of Africa shows a strong improvement by cutting the shares approximately in half by 2030 in Africa south of the Sahara, with the Central ReSAKSS region leading the way. In the NoCC scenario, all of Africa is at the lower threshold of this metric, between 4 and 6 percent by the end of the projection period, though eastern and southern Africa lag behind slightly.

Climate change impacts in the agriculture sector keep an important percentage of the population at risk of hunger. North Africa's ability to maintain access to calories means that their exposure to this risk increases only little, on par with developed regions in North America and Europe. West Africa sees a moderate increase in the share at risk of hunger, but roughly the same as other middle-income economies around the globe at 0.4 to 0.6 percentage points. The rest of Africa (central, eastern, and southern) sees relatively stronger impacts of climate change on hunger, between 1 and 2 percentage points above the NoCC projections.

TABLE 2.16—BASELINE PER CAPITA KILOCALORIE AVAILABILITY (KCAL/capita/day) IN NOCC SCENARIO AND AVERAGE IMPACT OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (%)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	2,881	3,309	3,435	–1.2%	–2.7%
South Asia	2,354	2,624	2,846	–1.3%	–2.9%
Middle East & North Africa	3,145	3,256	3,372	–0.8%	–2.1%
SSA	2,380	2,710	3,079	–1.9%	–3.5%
Latin America & Caribbean	2,882	3,040	3,185	–1.3%	–2.5%
Former Soviet Union	3,094	3,326	3,429	–0.5%	–1.5%
Europe	3,436	3,485	3,573	–0.5%	–1.3%
North America	3,717	3,732	3,743	–0.6%	–1.5%
World	2,805	3,049	3,212	–1.2%	–2.6%
ReSAKSS-North	3,261	3,468	3,655	–1.0%	–2.4%
ReSAKSS-West	2,664	2,986	3,265	–2.0%	–3.5%
ReSAKSS-Central	2,042	2,554	3,293	–1.6%	–2.7%
ReSAKSS-East	2,178	2,467	2,825	–1.8%	–3.3%
ReSAKSS-Southern	2,492	2,775	3,020	–2.5%	–4.6%
AMU	3,133	3,349	3,507	–0.7%	–1.9%
CENSAD	2,711	2,975	3,258	–1.7%	–3.3%
COMESA	2,376	2,678	3,104	–1.7%	–3.2%
EAC	2,215	2,589	2,992	–2.4%	–4.2%
ECCAS	2,101	2,583	3,210	–1.6%	–2.9%
ECOWAS	2,664	2,986	3,265	–2.0%	–3.5%
IGAD	2,193	2,469	2,825	–1.5%	–2.8%
SADC	2,278	2,635	3,073	–2.3%	–4.0%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.17—BASELINE NUMBER OF UNDERNOURISHED CHILDREN (millions, ages 0–5, by weight) IN NOCC SCENARIO AND AVERAGE IMPACT OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (%)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	21.8	11.3	7.8	3.4%	4.6%
South Asia	77.3	64.6	52.0	0.8%	2.1%
Middle East & North Africa	4.0	2.7	1.9	3.0%	6.4%
SSA	40.6	41.1	33.5	2.0%	4.9%
Latin America & Caribbean	4.3	2.8	1.5	5.6%	16.0%
Former Soviet Union	1.4	1.1	1.3	1.7%	4.4%
Europe	0.4	0.2	0.2	0.8%	1.8%
North America	—	—	—	—	—
World	149.8	124.0	98.2	1.6%	3.6%
ReSAKSS-North	1.0	0.4	0.2	10.2%	19.9%
ReSAKSS-West	14.5	15.8	15.1	2.0%	4.5%
ReSAKSS-Central	5.6	5.1	3.1	1.8%	5.2%
ReSAKSS-East	16.0	16.0	12.6	1.7%	4.1%
ReSAKSS-Southern	4.4	4.2	2.7	3.8%	10.7%
AMU	0.7	0.3	0.2	3.6%	19.0%
CENSAD	21.2	21.4	18.9	2.2%	4.7%
COMESA	19.3	18.6	13.4	2.0%	4.8%
EAC	5.8	5.3	4.0	3.4%	8.8%
ECCAS	6.9	6.4	4.2	1.9%	5.3%
ECOWAS	14.5	15.8	15.1	2.1%	4.5%
IGAD	12.2	12.1	9.4	1.4%	3.3%
SADC	11.4	11.0	7.5	2.8%	7.5%

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

TABLE 2.18—BASELINE SHARE OF POPULATION AT RISK OF HUNGER (%) IN NOCC SCENARIO AND AVERAGE CHANGE OF FOUR BASELINE CLIMATE CHANGE SCENARIOS (percentage points)

	NoCC			Climate Change	
	2010	2030	2050	2030	2050
East Asia & Pacific	12.7	5.3	4.5	0.38	0.68
South Asia	18.4	8.6	4.9	1.02	0.57
Middle East & North Africa	7.7	7.7	7.2	0.14	0.42
SSA	23.2	11.8	6.8	1.22	1.19
Latin America & Caribbean	9.0	6.4	4.6	0.51	0.69
Former Soviet Union	6.4	4.0	3.4	0.08	0.08
Europe	4.7	4.3	3.8	0.08	0.39
North America	3.2	3.2	3.0	0.01	0.16
World	13.4	7.2	5.1	0.62	0.67
ReSAKSS-North	4.0	3.5	3.4	0.05	0.08
ReSAKSS-West	12.0	6.0	4.3	0.49	0.59
ReSAKSS-Central	34.7	9.8	4.5	1.35	0.65
ReSAKSS-East	29.8	17.6	9.4	1.62	1.63
ReSAKSS-Southern	23.8	13.8	9.0	1.93	2.22
AMU	5.0	4.1	3.9	0.09	0.16
CENSAD	13.5	7.9	4.8	0.65	0.69
COMESA	26.5	13.2	6.9	1.41	1.11
EAC	30.6	15.2	8.3	2.02	1.49
ECCAS	33.0	10.6	5.7	1.32	0.94
ECOWAS	12.0	6.0	4.3	0.49	0.59
IGAD	27.0	15.7	8.1	1.25	1.04
SADC	30.3	14.4	8.9	1.98	2.04

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.
Note: Small island nations not included (for example, Cape Verde, Comoros, Mauritius, Seychelles, São Tomé and Príncipe); AMU = Arab Maghreb Union, CENSAD = Community of Sahel-Saharan States, COMESA = Common Market for Eastern and Southern Africa, EAC = East African Community, ECCAS = Economic Community of Central African States, ECOWAS = Economic Community of West African States, IGAD = Intergovernmental Authority on Development, SADC = Southern African Development Community, SSA = Africa south of the Sahara.

A Possible Alternative Outcome

The baseline presented here shows that the basic underlying trends and drivers of agriculture and the economy in general in Africa are largely positive and represent an important innate capacity for advancement across the continent. The outcomes of climate change scenarios, however, indicate vulnerabilities that need to be addressed. Fortunately, several pathways are feasible for directing Africa away from these roadblocks and for realizing a fuller potential. The CAADP pillars are key guideposts that help greatly in this regard, but other important complementary developments in education, infrastructure, healthcare, and government services, among others, will lead Africa to a stronger and healthier middle-income status (see, for example, topics covered in the following chapters).

A quick scenario analysis of an alternative future with accelerated growth in GDP gives an indication of Africa's potential. In IMPACT we use multipliers on national incomes to achieve middle-income status for nearly all nations by 2030 (with only Zimbabwe and Eritrea lagging, but they would achieve middle-income status if accelerated GDP growth would continue past 2030). In this scenario, countries currently still low income by 2030 in SSP2 see a 50 percent increase in the growth rate of national GDP; countries of low-middle income by 2030 see a 10 percent increase in their GDP growth rate; and countries of upper-middle income see a 5 percent increase in GDP growth rate. Achievement of this level of accelerated GDP growth would be challenging but is within the realm of possibility with focused and targeted investments in the lesser-developed regions of Africa. Agriculture sector growth could partially meet this development, but it would have to rely on a combination of several sectors performing well.

The impacts of such a scenario show increases in consumption in line with expanding household incomes. This augmented consumption in the absence of other sector developments is met mostly through increased imports (Table 2.19), which may or may not be in the national interests of different countries. More importantly, this alternative scenario more than compensates for the impacts of climate change compared with a scenario without climate effects—except in North Africa where the scenario posited only a slight increase in income. Per capita calorie availability increases beyond the levels found in the NoCC environment, while the number of malnourished children in Africa is reduced by 3.3 million when compared with BSLN-CC. The share at risk of hunger is also reduced below the levels of the NoCC scenario.

TABLE 2.19—INCREASED GDP SCENARIO INCREASES (compared to BSLN-CC) IN AGGREGATE COMMODITY NET IMPORTS FOR AFRICA (million metric tonnes)

	2030	2050
Cereals	–14	–14
Fruits & vegetables	–23	–44
Oilseeds	–1	–1
Pulses	–1	–1
Roots & tubers	–4	–5
Meat	–4	–8

Source: Authors, IMPACT Baseline Projections 3.2, July 2015.

Conclusions

Many examples of agriculture sector development that will help spur accelerated growth of national incomes can be found within the CAADP work programs. AgInvest Africa (www.aginvestafrica.org) from ReSAKSS, in particular, houses documentation on an extraordinary diversity of opportunities for investment that can be expanded or adapted to broader geographies. With the drive toward greater mutual accountability with the 2014 Malabo Declaration, there is an opportunity to build the CAADP and ReSAKSS efforts into more established pathways for transfer of technologies and lessons learned. Deeper and longer-term analysis of particular alternatives, such as in Hachigonta et al. (2013), Jalloh et al. (2013), Rosegrant et al. (2014), You et al. (2011), and Waithaka et al. (2013), can also help inform policymaking in agriculture sector investment. The scope of investments includes crop variety development (particularly for certain climate-adaptive traits, such as drought and heat), improved nutrient and soil management, irrigation development, road and communications infrastructure, and access to improved financial markets. In combination with targeted investments and evidence-based policymaking in a broad spectrum of sectors of the African economy, these types of developments will lead Africa into a more stable and food-secure future with advancing levels of human development.

Acknowledgments

This paper was supported by the Global Futures & Strategic Foresight (GFSF) project. GFSF is a CGIAR initiative led by IFPRI and funded by the Bill and Melinda Gates Foundation; the CGIAR Research Program on Policies, Institutions, and Markets (PIM); and the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS).

Many researchers beyond those listed as authors have contributed to the development, updating, and maintenance of the IMPACT model, without which this analysis would not be possible. The water components in IMPACT are managed by Tingju Zhu, Gauthier Pitois, and Claudia Ringler. Crop modeling is managed by Richard Robertson.

References

AfDB (African Development Bank); OECD (Organization for Economic Co-operation and Development); and UNDP (United Nations Development Programme). 2015. *African Economic Outlook 2015: Regional Development and Spatial Inclusion*. Paris: OECD Publishing.

Andrews, T., J. M. Gregory, M. J. Webb, and K. E. Taylor. 2012. "Forcing, Feedbacks and Climate Sensitivity in CMIP5 Coupled Atmosphere-Ocean Climate Models." *Geophysical Research Letters* 39: 1944–8007. dx.doi.org/10.1029/2012GL051607

Benin, S., Kennedy, A., Lambert, M., McBride, L. 2010. *Monitoring African agricultural development processes and performance: A comparative anaylsis*. ReSAKSS Annual Trends and Outlook Report 2010. International Food Policy Research Institute (IFPRI).

Chateau, J., R. Dellink, E. Lanzi, and B. Magné. 2012. *Long-Term Economic Growth and Environmental Pressure: Reference Scenarios for Future Global Projections*. OECD Environment Directorate Working Papers ENV/EPOC/WPCID (2012)6. Paris: OECD.

Hachigonta, S., G. C. Nelson, T. S. Thomas, and L. M. Sibanda, eds. 2013. *Southern African Agriculture and Climate Change: A Comprehensive Analysis*. IFPRI Research Monograph. Washington, DC: International Food Policy Research Institute. dx.doi.org/10.2499/9780896292086

IIASA (International Institute for Applied Systems Analysis). 2015. SSP Database: Version 1.0 www.iiasa.ac.at/web/home/research/researchPrograms/Energy/SSP_Scenario_Database.html. Accessed July 15, 2015.

Jalloh, A., G. C. Nelson, T. S. Thomas, R. Zougmoré, and H. Roy-Macauley, eds. 2013. *West African Agriculture and Climate Change: A Comprehensive Analysis*. Research Monograph. Washington, DC: International Food Policy Research Institute. dx.doi.org/10.2499/9780896292048

Nelson, G. C., M. W. Rosegrant, A. Palazzo, I. Gray, C. Ingersoll, R. Robertson, S. Tokgoz, T. Zhu, T. B. Sulser, C. Ringler, S. Msangi, and L. You. 2010. *Food Security, Farming, and Climate Change to 2050: Scenarios, Results, and Policy Options*. Research Monograph. Washington, DC: International Food Policy Research Institute. dx.doi.org/10.2499/9780896291867

Nelson, G. C., H. Valin, R. D. Sands, P. Havlík, H. Ahammad, D. Deryng, J. Elliott, S. Fujimori, T. Hasegawa, E. Heyhoe, P. Kyle, M. Von Lampe, H. Lotze-Campen, D. Mason-D'Croz, H. van Meijl, D. van der Mensbrugghe, C. Müller, A. Popp, R. Robertson, S. Robinson, E. Schmid, C. Schmitz, A. Tabeau, and D. Willenbockel. 2014. "Climate Change Effects on Agriculture: Economic Responses to Biophysical Shocks." *Proceedings of the National Academy of Sciences* 111: 3274–3279. dx.doi.org/10.1073/pnas.1222465110

O'Neill, B. C., E. Kriegler, K. Riahi, K. L. Ebi, S. Hallegatte, T. R. Carter, R. Mathur, and D. P. van Vuuren. 2014. "A New Scenario Framework for Climate Change Research: The Concept of Shared Socioeconomic Pathways." *Climatic Change* 122:387–400. dx.doi.org/10.1007/s10584-013-0905-2

ReSAKSS database (www.resakss.org/map/). 2015. Accessed April 28, 2015.

Robinson, S., D. Mason-D'Croz, S. Islam, T. B. Sulser, A. Gueneau, G. Pitois, and M. W. Rosegrant. 2015 (forthcoming). *The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description for Version 3.2*. Washington, DC: International Food Policy Research Institute.

Rosegrant, M. W., and the IMPACT Development Team. 2012. *International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description*. Washington, DC: International Food Policy Research Institute.

Rosegrant, M. W., J. Koo, N. Cenacchi, C. Ringler, R. Robertson, M. Fisher, C. Cox, K. Garrett, N. D. Perez, and P. Sabbagh. 2014. *Food Security in a World of Natural Resource Scarcity: The Role of Agricultural Technologies*. IFPRI Research Monograph. Washington, DC: International Food Policy Research Institute. dx.doi.org/10.2499/9780896298477

UNDP (United Nations Development Programme). 2014. *Human Development Report 2014—Sustaining Progress: Reducing Vulnerabilities and Building Resilience*. New York.

UNECA (United Nations Economic Commission for Africa), African Union Commission (AUC), African Development Bank (AfDB), and United Nations Development Programme (UNDP). 2014. *MDG Report 2014: Assessing Progress in Africa toward the Millennium Development Goals*. Addis Ababa, Ethiopia: UNECA Publications.

von Lampe, M., D. Willenbockel, H. Ahammad, E. Blanc, Y. Cai, K. Calvin, S. Fujimori, T. Hasegawa, P. Havlik, E. Heyhoe, P. Kyle, H. Lotze-Campen, D. Mason-D'Croz, G. C. Nelson, R. D. Sands, C. Schmitz, A. Tabeau, H. Valin, D. van der Mensbrugghe, and H. van Meijl. 2014. "Why Do Global Long-Term Scenarios for Agriculture Differ? An Overview of the AgMIP Global Economic Model Intercomparison." *Agricultural Economics* 45: 1574–0862. dx.doi.org/10.1111/agec.12086

Waithaka, M., G. C. Nelson, T. S. Thomas, and M. Kyotalimye (eds). 2013. *East African Agriculture and Climate Change: A Comprehensive Analysis*. IFPRI Research Monograph. Washington, DC: International Food Policy Research Institute. dx.doi.org/10.2499/9780896292055

References

World Bank. 2015. *World Development Indicators*. (data.worldbank.org/data-catalog/world-development-indicators, updated April 14, 2015). Accessed April 28, 2015.

You, L., C. Ringler, U. Wood-Sichra, R. Robertson, S. Wood, T. Zhu, G. C. Nelson, Z. Guo, Y. Sun. 2011. "What Is the Irrigation Potential for Africa? A Combined Biophysical and Socioeconomic Approach." *Food Policy* 36 (6):770–782.

Regional Strategic Analysis and Knowledge Support System
International Food Policy Research Institute
2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: + 1 202.862.4662
Fax: +1 202.467.4439
Email: resakss-africa@cgiar.org
www.resakss.org

978-0-89629-892-7