Ending Hunger in Africa

THE ELIMINATION OF HUNGER AND FOOD INSECURITY ON THE AFRICAN CONTINENT BY 2025

- Conditions for Success -

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Forward Acknowledgements

FOREWORD

Africa's Agenda 2063 endorsed by the January 2015 AU Summit is an articulation of the continent's renewed resolve and determination to accelerate broad-based and sustainable economic growth and inclusive development. This is a presentation of the Continent's political agenda in terms of ambitions, goals and targets driven by the growing urge to ensure action is leading to tangible and measureable results and impact. With both the Agenda 2063 and the SDGs now in place, attention is shifting, and rightly so, towards IMPLEMENTATION, i.e. securing and aligning necessary capacity and systems to deliver on the set goals and targets. The commitment to results and impact implies it is not enough "just to do things". Also in the context of accountability, it is critical that ACTION is effective and efficient, reflecting the best-use-of-the- resources to deliver on the set targets.

This will require careful and in many cases highly elaborate examination of key decision points including policies, investment structures, institutional arrangements and capacity as well as partnerships and alliances. This also in many instances will imply making difficulty decisions in terms of trade-off between "now" and the "future" or between one section of the population compared to another.

This study, undertaken jointly between the NEPAD Agency and the University of Denver's

Frederick S. Pardee Center for International Futures is meant to give access to policy and programme leaders expert information and knowledge to enable evidence-based dialogue and consultations in determining national specific pathways and enhance key milestones in the efforts to realise the growth and development targets agreed in Agenda 2063 and the SDGs. The study presents new original perspectives on key conditions and drivers necessary to realise set Agenda 2063 goals. The focus of the study is on the target to "Zero Hunger by 2025" which is also a key goal and target in the African Union's Malabo Declaration on agriculture transformation (June 2014).

Bringing out the multi-sectoriality and inter-disciplinary nature of addressing food security and nutrition, the study helps to put in perspective the magnitude of the task "to zero hunger by 2025". What does this target mean given anticipated numbers of people? What amounts and quality of food and hence what policies, investments, technologies as well as human skills and capacity would be necessary to sustain desired levels of supply? What about access to quality food for all populations and therefore zero hunger?

The study report, hence, will support government dialogue and consultations to examine, determine and navigate economic growth and inclusive development pathways, which are realistically built on local circumstances and driven by local and regional-continental ambitions. In this regard, the analysis also presents the current pathways on food security and hunger with an almost obvious conclusion that business-as-usual will not deliver "eliminating hunger and food insecurity by 2025"

The NEPAD Agency and the University of Denver's Pardee Center are pleased to put this study report in the hands of Governments and regional bodies to inform, stimulate and possibly guide national level critical analysis and determination of national pathways that will work to eliminate hunger and food insecurity by 2025

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The Report "Ending Hunger in Africa - Conditions for Success" was prepared by a joint task team within the long-standing collaboration between the NEPAD Agency and the Pardee Center, University of Denver. The NEPAD Agency and the Pardee Center, University of Denver continued to collaborate in generating evidence-based analytical foresight on key issues in fostering implementation and desired impact in Africa's socio-economic advances.

The study was undertaken under the overall guidance and intellectual leadership of Dr Ibrahim Mayaki, CEO, NEPAD Agency and Dr Barry B. Hughes, Pardee Center, University of Denver.

The Report specially, trigged by the expressed questions by member states through the NEPAD organs is a direct effort to inform the political and policy discourse on key factors and trends in determining locally appropriate pathways to eliminate hunger and food insecurity by 2025

From framing of the study scope through the actual review and analysis to the preparation and production of the report, the work benefited immensely from the knowhow and valuable insights and critical input of staff in the NEPAD Agency and the Pardee Centre staff. We here express heartfelt gratitude to all that contributed in one way of the other to the study and production of this report. Special mention in this regard is Jonathan D. Moyer and Lisa Filholm

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EXECUTIVE SUMMARY

The African Union has set a target to "eliminate hunger and food insecurity by 2025." Both Agenda 2063 and the African Union Summit decision on Accelerated Agricultural Growth and Transformation have reaffirmed this commitment (African Union, 2014, 2015). Unfortunately, Africa is not currently on track to meet these targets. Immediate, mutually reinforcing interventions are required to bring the continent closer to eliminating hunger and food insecurity.

The purposes of this report are (1) to describe the path that Africa has been on with respect to reducing hunger and pursuing food security, (2) to show where that path would likely lead in the coming years without significant change in policy, and (3) to outline the conditions and actions necessary to put Africa on track to eliminating hunger and food insecurity as soon as possible.

The Food and Agricultural Organization of the United Nations (FAO) defines hunger, or undernourishment, as an inability to acquire enough food to satisfy dietary energy requirements. Food security is a situation where all people at all times have access to food and is composed of four dimensions: food availability, economic and physical access to food, food utilization, and stability over time. This report will mainly focus on the prevalence of undernourishment and net dependence on imports as the two indicators of hunger and food security, respectively.1

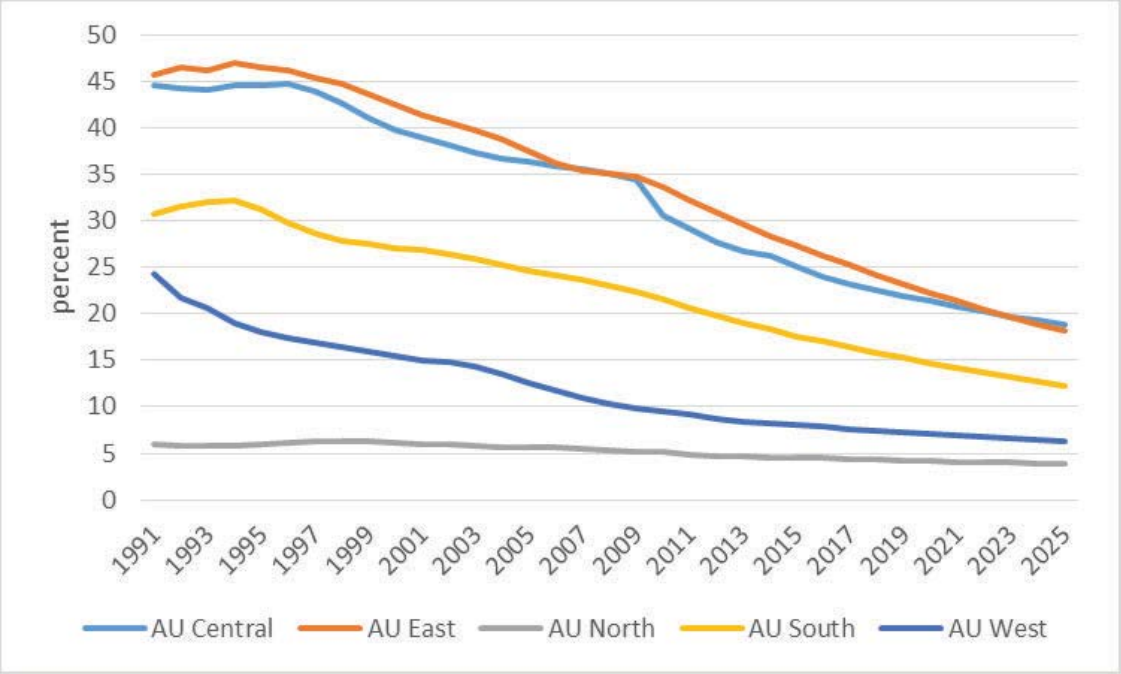
Nearly one in five people living in Africa is hungry.2 That rate has decreased steadily since the mid- 1990s, with the fastest decline in West Africa and the lowest undernourishment rate in Northern Africa. Unfortunately, the total number of undernourished Africans has climbed since 1991, largely driven by increasing population. East Africa has the highest levels of hunger in terms of both prevalence and absolute numbers—about half of the total undernourished population of the continent is in its Eastern region.

On the supply side, Africa was not producing enough food to feed its own population adequately in the early 1990s, but its exports and imports of agricultural goods were both relatively small and in balance. Imports have since grown to be over four times the level of exports (in tons), and net imports are now about 14 percent of total agricultural demand.

To analyze whether or not Africa is on track to eliminate hunger and food insecurity by 2025, this research uses the International Futures (IFs) forecasting system. IFs, and this research, draws heavily on data from the FAO and other international sources. The Base Case scenario of IFs considers historical patterns to explore the dynamic future path of Africa.

Looking at the path going forward, without substantial change in the dynamics of demand and supply, the portion of Africans who are undernourished will fall from about 17 percent in 2015 to about 12 percent in 2025. Over the same period, the import dependence of Africa will rise from 14 percent of total demand to 25 percent. Africa is not on track to eliminate hunger and food insecurity by 2025.

Figure Summary 1: Undernourished people as a percent of total population for regions in Africa.

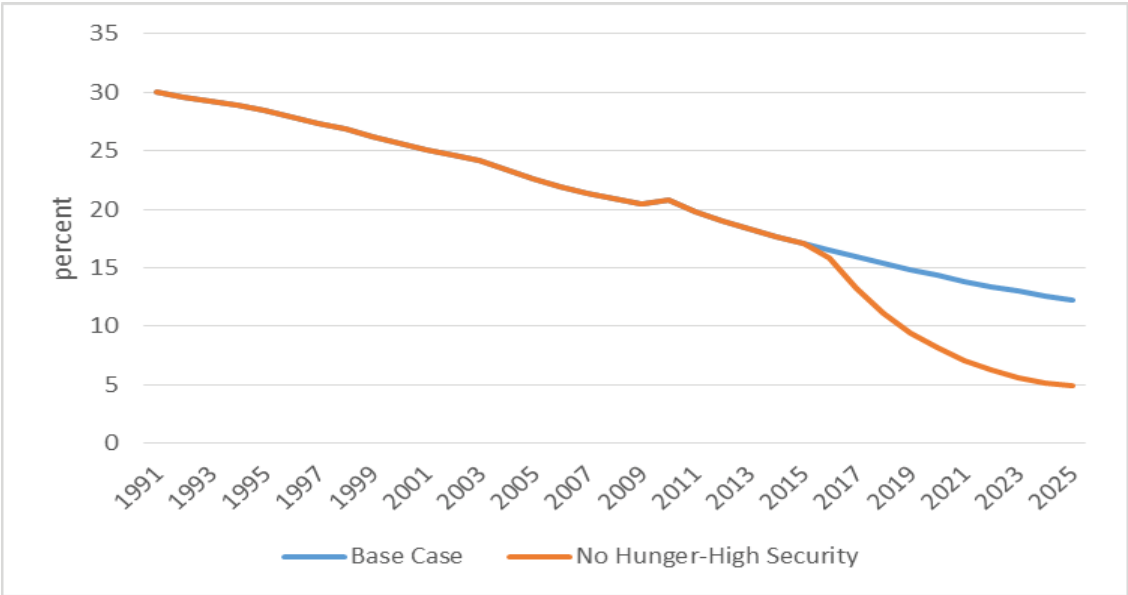


Source IFs version 7.19, decrease in Central Africa due to lack of data for the Democratic Republic of the Congo. Interpolation used to fill some data holes.

How can the goals of Agenda 2063 and the Malabo Declaration be met? Where is the greatest leverage to solve these problems? The short answer is that the challenge is very great and requires a wide range of actions by many different actors.

To determine the conditions and actions necessary to eliminate hunger and food insecurity by 2025, this paper presents a No Hunger-High Security scenario. In this scenario, food access increases to the levels required by 2025 to reduce hunger to below 5 percent on the continent. At the same time, African food production increases in this scenario to the levels required to meet this demand and to reduce import dependence.

Figure Summary 2: The malnourished portion of African population, Base Case and No Hunger-High Security scenarios



Source: IFs version 7.19. Interpolation used to fill some data holes.

Average calorie consumption per capita per day would need to be about 18 percent higher than it was in 2015 to eliminate hunger without considerable redistribution of consumption patterns. To put such changes in context, China increased calories per capita per day by 17 percent in the 10 years between 1980 and 1990 and went on to increase it 12 percent more by 2000.

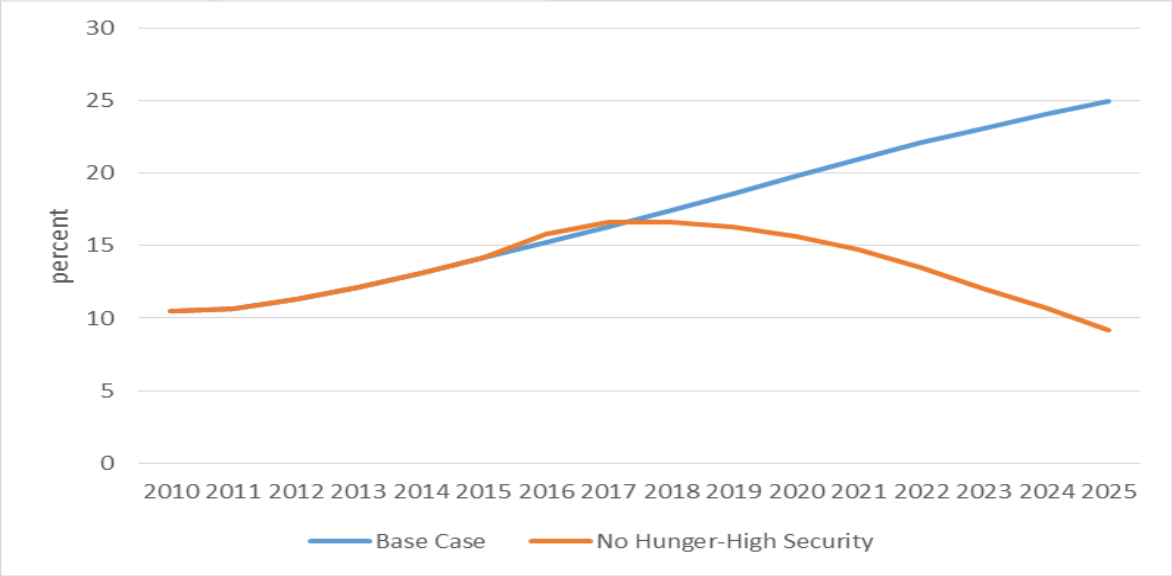
This increase in calorie consumption would require that effective food demand increase by 473 million metric tons (mmt) by 2025, or 47 percent of current (2015) demand. To meet this increased demand, while simultaneously decreasing net imports, agricultural production in Africa will need to increase by 525 million metric tons and loss will need to decrease significantly.3 This change in production would be 38 percent above the forecasted levels in 2025, or 61 percent above 2015 levels. This level of production is not impossible, but it will require an expansion of cropland and extraordinary improvements in crop yields similar to the Green Revolution in Asia in the 1960s and 1970s.

In the No Hunger-High Security scenario, cropland increases by 1.5 percent per year, and crop yields increase by 3.2 percent per year, compared to historical rates between 2001 and 2011 of 1.4 percent and 1.9 percent, respectively. This would require expanding cropland by 39 million hectares, about the size of Zimbabwe. Further, as incomes and calorie intakes rise, there will be progressive change in the type of food desired, for instance, from cereals and vegetables to meat and fish. Livestock herd size would also need to grow by at least 5.8 percent each year.

To put such changes in context, during the Green Revolution yields grew in India by 3.6 percent annually between 1980 and 2000, and cropland in Brazil expanded by 2 percent annually between 1961 and 2010 as it utilized land from both the rain forests and the Cerrado (the Brazilian Savanna).

Thus on the supply side, Africa could produce enough food to meet no-hunger level needs by 2025 with very aggressive increases in food production through increased yields and land expansion similar to those experienced by Asian and Latin America countries during the Green Revolution, along with aggressive reductions in food loss. This level of production can also reduce net reliance on imports.

Figure Summary 3: *Net Agricultural imports of Africa as percentage of demand (import dependence), Base Case and No Hunger* - High Security scenarios



Source: IFs version 7.19.

On the demand side however, it will be very difficult for Africa to create the effective demand necessary for a no-hunger future without measures to supplement increases in average calorie gyer-High Security scenarios consumption. For example, caloric-intake levels associated with eliminating hunger have historically required levels of GDP per capita about three times as high as the African average. While increases in agricultural production contributed to the reduction of hunger in China, India, and Viet Nam since 1990, all three of these countries at least tripled their GDP per capita over the same time horizon (China's increased by nearly 800% from 1990 to 2015). Increased production alone is not enough to eliminate hunger and food insecurity: the hungry must have access to the food.

Increasing levels of access to food can come from interventions aimed at producers or consumers. Targeted food subsidy programs including conditional transfers could help direct food toward the undernourished and assist in increasing access. On the production side, helping farmers overcome both hard constraints like poor soil quality and low rainfall, and soft constraints like limited financial and human capital and access to information and markets could increase food production and reduce its price. Because 95 percent of Sub-Saharan African (SSA) farms are smaller than five hectares and they collectively utilize most of the land, agricultural interventions would need to support not just larger-scale farms, but also small-scale, subsistence farmers (Lowder, Skoet, & Singh, 2014).

This analysis suggests that it is theoretically possible, but practically will be extremely difficult, for a No Hunger-High Security scenario to provide the food access and availability to meet the goals.

There are of course great uncertainties that extend beyond the policy environment. For instance, climate change could put downward pressure on yields and water resources. Most such pressure will occur later in the century, but by 2025, the continental-wide impact of climate change on crop yields relative to 1990 will generate a net cumulative drag on production of 2.5 percent.

This report measures the magnitude of the challenge of eliminating hunger and ensuring universal food security by 2025 and outlines the conditions necessary to overcome that challenge. The expertise, resolve, and commitment of policymakers must generate the action. Implementing the policies necessary to achieve the goals of the AU will also require expertise that goes beyond the forecasting of this report. Further, the best policies to increase production and access will differ by region and country.

INTRODUCTION

1.1. Motivations for Report

Hunger and food security pose enormous obstacles to human and economic development in Africa. Nearly one in five people living in Africa is undernourished, the highest prevalence of all world regions (FAO- Food and Agriculture Organization of the United Nations, 2015). Eliminating hunger and food insecurity will require coherent analysis of past trends and aggressive but reasonable interventions. There is no simple solution to achieving these targets: the interventions must be multi-sectoral and will require the collaboration of multiple government ministries, as well as actors in civil society and the private sector.

Recognizing the importance of food security, Agenda 2063 and the African Union Summit decision on Accelerated Agricultural Growth and Transformation (i.e. Malabo Declaration on CAADP, June 2014) affirm Africa's resolve and commitment to "Eliminate hunger and food insecurity by 2025." In addition, all African countries will be addressing the second Sustainable Development Goal (SDG) to 'End hunger, achieve food security and improved nutrition, and promote sustainable agriculture (SDG II).'

The purposes of this report are (1) to describe the path that Africa has been on with respect to reducing hunger and pursuing food security, (2) to show where that path would likely lead in the coming years without significant change in policy, and (3) to outline the conditions and actions necessary to put Africa on track to eliminate hunger and food insecurity as soon as possible.

Unfortunately, this report will show that while hunger has been decreasing in all of its regions, Africa is not currently on track to end hunger by 2025. The undernourished population has declined by 11 percentage points over the past 22 years —from 30 percent in 1991 to 19 percent in 2013.4 While this decline in undernourishment is commendable, the rate of decline has been uneven across regions of the continent. Western and Northern regions of Africa for example, have had much more success in reducing hunger than Eastern and Central regions. Our Base Case forecasts show that Africa as a whole is not on track to achieve the additional 14 percentage-point decrease needed to reach 5 percent undernourishment in 2025.5

Progress towards eliminating the prevalence of underweight children has been even slower. The portion of children in Africa who are underweight decreased from 24 percent in 1991 to 19 percent in 2014. Again, progress varies across regions—Southern Africa has one of the lowest rates of underweight children, largely due to high levels of access to water and sanitation facilities. Northern Africa, on the other hand, has the lowest rates of both undernourishment and underweight children but the highest level of dependency on food imports, another dimension of food insecurity.

More generally, agricultural imports have been growing. Net imports to the continent from the rest of the world have now reached approximately 15 percent of total demand (in tons of all production, including crops, meat, and fish). Food instability, in terms of net import dependence, is increasing.

All of this is not to say that reaching the goals of eliminating hunger and food insecurity across Africa is impossible. This report will identify some of the major focal points for action needed to accomplish the goals, ideally by 2025, but if not then, as soon thereafter as possible. This report will analyze the leverage available and the kinds of action necessary push toward the critically important goals of Agenda 2063 and the Malabo Declaration.

1.2. Plan of Report

Section 2 is an overview of the definitions of hunger and food insecurity and the main drivers of these indicators. Clear definitions and explanations of these concepts are necessary to assess Africa's progress in achieving the hunger targets.

Section 3 provides an overview of the current food balance of Africa.

Section 4 is an explanation of the current path, the Base Case, of hunger and food security in Africa. This section shows how hunger and food security have changed over time and how they are likely to change in the future. This report uses the International Futures (IFs) forecasting software to explore and understand the current path and the dynamic relationships between different development sectors. IFs is able to forecast many, but not all, of the variables used to assess hunger and food insecurity. This section will determine the extent to which Africa is on track to meet the targets set out in Agenda 2063 and the Malabo Declaration

Section 5 outlines the levers of action required in terms of both increasing access and availability to reduce hunger and food insecurity.

Section 6 presents the No Hunger-High Security scenario, a future where all of the interventions are implemented successfully and hunger and food insecurity are eliminated by 2025. This section explains the conditions necessary for reaching this target.

Section 7 is the conclusion and summarizes the feasibility of the No Hunger-High Security scenario.

KEY CONCEPTS

2.1. Defining and Measuring Hunger and Food Insecurity

The United Nation's Food and Agricultural Organization (FAO) provides standard definitions of hunger and food insecurity (see Box 2.1). The FAO definition of hunger-facilitated assessment of progress toward achieving the 1996 World Food Summit (WFS) goal is "to eradicate hunger, in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015" 6, and the Millennium Development Goal (MDG) 1.C is to "halve, between 1990 and 2015, the proportion of people who suffer from hunger."7 The definition will also be used with respect to the target of the new Sustainable Development Goal (SDG) 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.[8]

Box 2.1: FAO Definitions of Hunger and Food Insecurity

Hunger (Synonymous with undernourishment): A state, lasting for at least one year, of inability to acquire enough food, defined as a level of food intake insufficient to meet dietary energy requirements.

Food insecurity: *A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution or inadequate use of food at the household level. Food insecurity, poor conditions of health and sanitation and inappropriate care and feeding practices are the major causes of poor nutritional status. Food insecurity may be chronic, seasonal or transitory.*

In order to assess progress towards these goals and targets, the definitions need to be translated into specific, measurable indicators. With respect to hunger, the two standard indicators are: 1) prevalence of undernourishment (PoU) for the general population and 2) prevalence of children underweight.10

The two measures of hunger differ in one important aspect. Prevalence of undernourishment depends on food intake: "the probability that a randomly selected individual from the reference population is found to consume less than his/her calorie requirement for an active and healthy life".11 The second measure, the prevalence of underweight children under five years of age, reflects both food intake and food utilization (i.e. the ability of the body to absorb nutrients from food). Thus, underweight measures can reflect not only calorie deficiency, but also protein deficiency and factors such as "poor hygiene, disease, or limited access to clean water."12 This is important to keep in mind when comparing the trends of these two indicators and Appendix 3 gives some special attention to child undernutrition and its drivers. However, this report will focus on total population undernourishment and therefore on caloric intake.

Definition and therefore measurement of food insecurity is more complex, as the definition in Box 2.1 suggests. The FAO specifies four dimensions of food insecurity: 1) availability, 2) access, 3) stability, and 4) utilization, and uses a suite of food- security indicator sets (see Appendix 1).13 This report will be looking at a variety of indicators across the four dimensions, but with respect to food insecurity, we will look primarily at supply or production of food and the extent to which Africa's food needs can be met regularly with its own production (and the extent to which African regions can meet their own needs). Because exports of higher value agricultural goods and import of lower value ones is a logical strategy, this report will more specifically look at the ability of Africa to produce the food it needs with a low or negligible level of net imports.

2.2. Determinants of Hunger and Food Insecurity

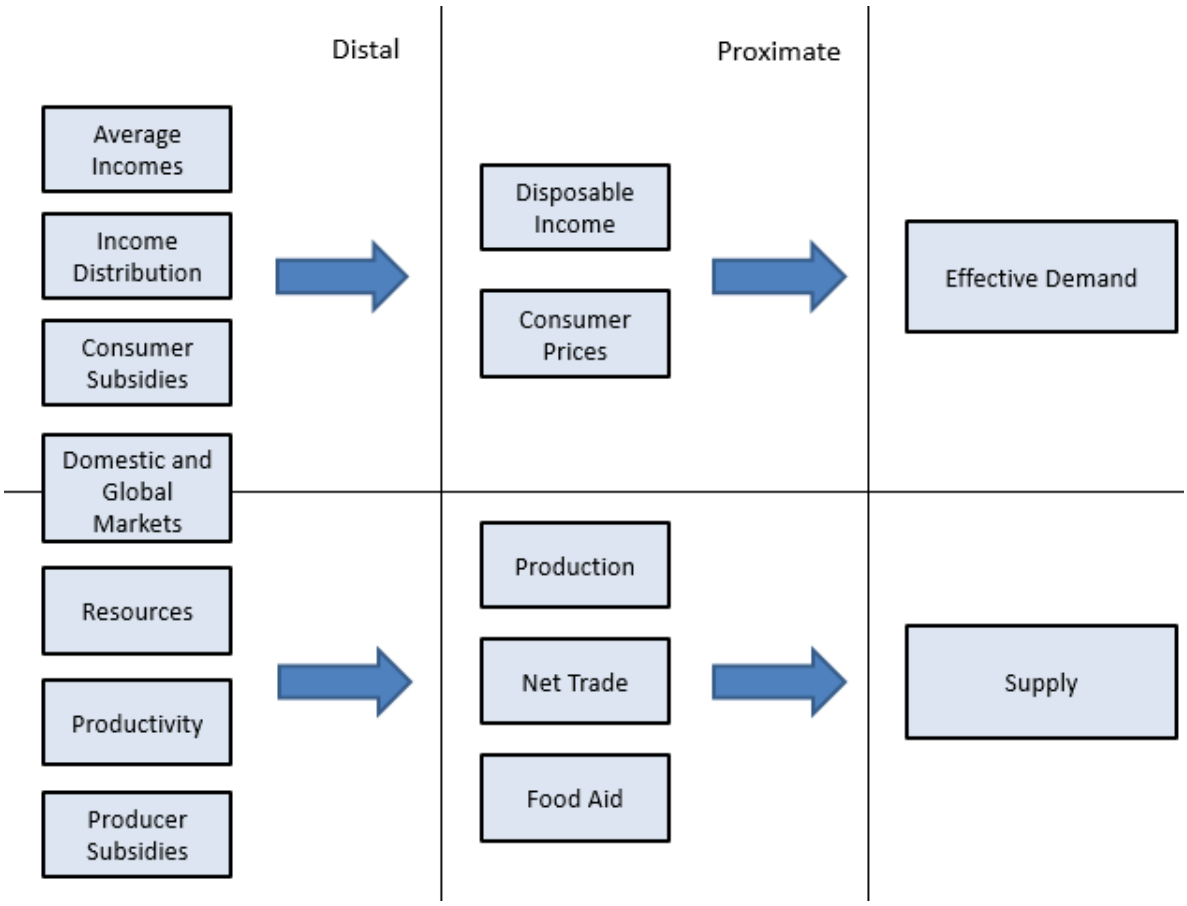
Eliminating hunger and food insecurity requires understanding their determinants. The FAO highlights five general drivers: 1) economic growth, 2) the role of family farming and smallholder agriculture, 3) international trade, 4) social protection systems, and 5) avoiding protracted crises.14

It is useful to think about these and other factors from the perspective of how they affect the demand and supply of food. The demand side relates to people's ability to access and utilize food and therefore avoid hunger; the supply side relates to the availability, and especially the proximate and stable availability, of food. There are, of course, important interactions between the two, reflected in such factors as the price of food.

Furthermore, we need to consider both proximate and distal drivers. The former are variables that directly impact the supply or demand of food; the latter affect food supply and demand more indirectly.

Figure 2.1 presents a stylized picture of the key drivers of hunger and food insecurity, distinguishing the demand and supply sides, as well as proximate and distal drivers. The main proximate drivers on the demand side are disposable income and food prices faced by the consumer. At the distal level, these are driven by factors including average incomes, income distribution, consumer subsidies and other government transfers (including social protection systems), and domestic and world markets.

Figure 2.1: *Distal and proximate drivers of food supply and demand.*



Source: Authors' conceptualization.

On the supply side, the main proximate drivers are food production, net trade, and other sources of food, such as direct food aid. These are affected by distal factors including resources (e.g. land, capital, labor, water, energy, fertilizers, and pesticides), agricultural productivity (including consideration of on-farm loss), producer subsidies, and domestic and world markets.

Of some particular concern is the ability of the continent to meet its hunger and food security goals in a sustainable fashion primarily from domestic production. Although imports can provide an adequate supply of food (city-states such as Hong Kong and Singapore import nearly all their food), domestic production of all or at least most food helps assure security against two outside factors. First, the balance of trade and current account difficulties may hinder ability to finance adequate imports. Second, disruptions to external supply related to global price increases, transport problems, or other factors can threaten food security. Most studies suggest that Africa has the physical capability of achieving this more extended conceptualization of food security.

Deeper and more macro-level factors such as population growth, economic growth, and broader social and technological change underlie all these demand- and supply- related variables. The FAO highlights, "good governance, political stability and the rule of law, and the absence of conflict and civil strife" as important drivers of food supply (FAO- Food and Agriculture Organization of the United Nations, 2015).15

2.3. Methodology

The remainder of this report will use many of the concepts of Figure 2.1 and the discussion above to explore Africa's recent past and possible near-term future as it relates to hunger and food insecurity. The primary tool used for the analyses presented in this report is the International Futures system (IFs). IFs comprises both a large database and an integrated assessment model that represents demographic, economic, energy, education, health, agriculture, infrastructure, socio-political and environment sub-models for 186 countries. Thus, the IFs system is an integrated system across many issue areas—the forecasts are influenced by a rich array of interacting factors (including actors such as global markets, prices, and governance)—even when we cannot provide elaborate detail on all of them. See Appendix 2 for a survey of that system.

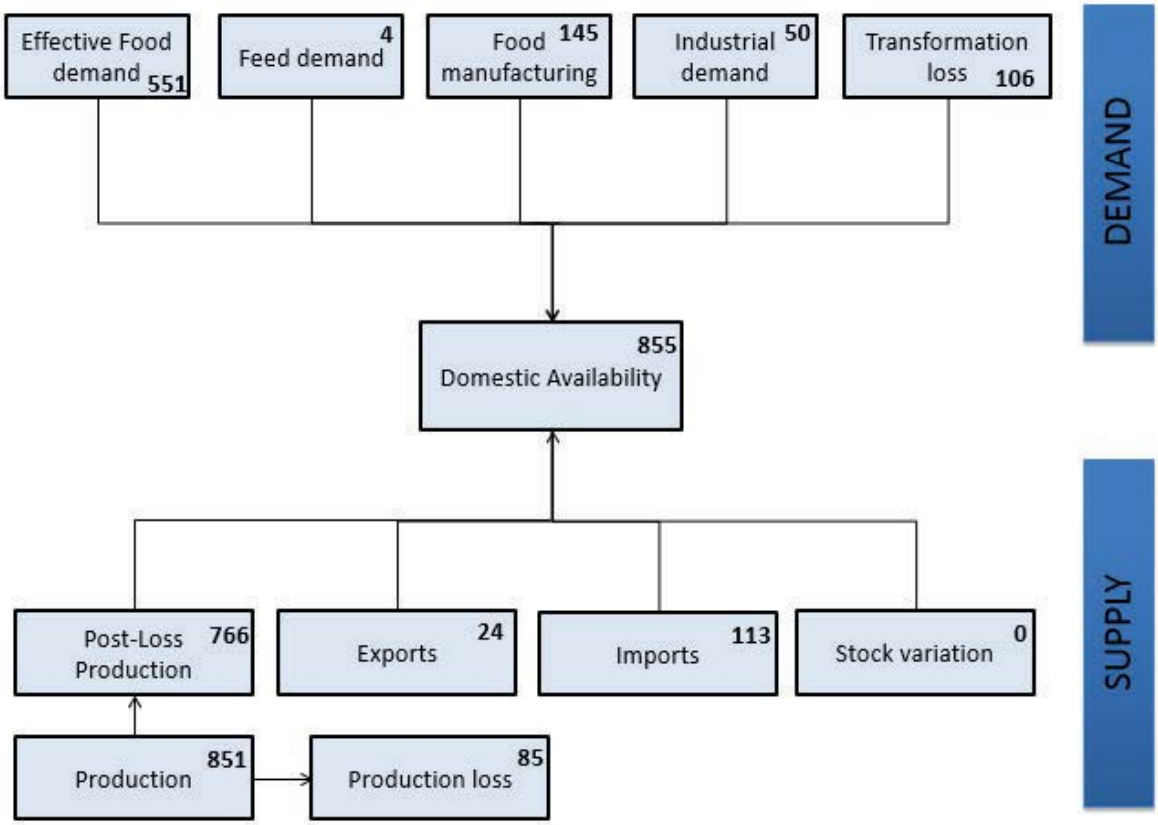
SNAPSHOT OF THE CONTEMPORARY AFRICAN AGRICULTURAL BALANCE

Figure 3.1 provides an overview of the macro-level supply/demand balance for Africa in the year 2010 (based primarily on data from the FAO). The numbers, in million metric tons, are sums across crops, meat, and fish. Please note that the demand reflects actual consumption, or "effective" demand, which takes into account constraints such as disposable income. True underlying demand, i.e., that which would be desired for the full satisfaction of nutritional needs, is much larger. An estimate, explained in section 4.6, suggests that the additional food required to reduce the size of the undernourished population on the continent to under five percent (a common operationalization of eliminating hunger) would be about 47 percent of current food demand. Other possible sources of providing this extra food could come from reducing losses, both at the production and transformation stages, or increasing imports. Of course, there are limits to what is feasible in terms of reducing losses. In addition, increasing imports is not necessarily desirable from a food security perspective.

Because of the way, the FAO provides the data used in IFs, the trade numbers of Figure 3.1 include all exports from and imports to countries in Africa, including exports to and imports from other African countries. Still, they show that the continent as a whole is a net importer of agricultural commodities. Even if all 24 million metric tons exported were destined for other African countries, this would leave 89 million metric tons, or more than 10 percent of total domestic availability, that are imported from outside the continent (in 2010—our forecasts indicate that the level has been increasing since then).

This report will explore the issues around demand, production, and trade in section 5 of this report. The next section (4) explores the recent history and trends related to hunger and food insecurity in Africa, provides information from our Base Case forecast, and determines the degree to which the continent, on the current path, might fall short of the goals of eliminating hunger and assuring food security by 2025.

Figure 3.1: *Agricultural balance for African Union in 2010.*

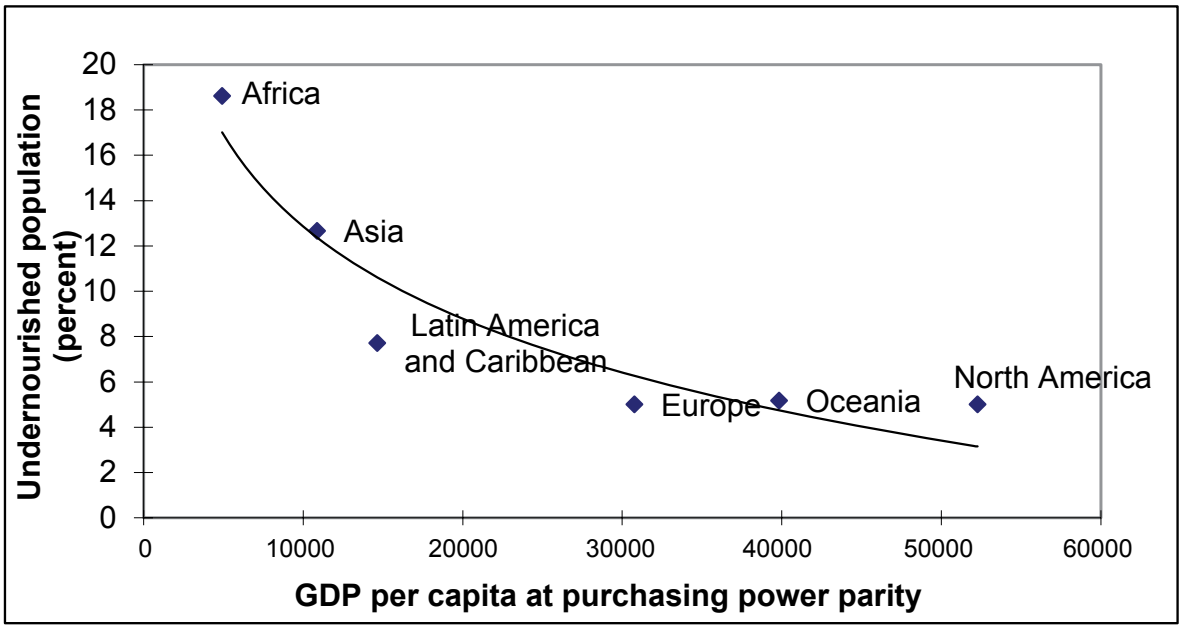


Source: Authors' conceptualization based on IFs model. Values (in million metric tons) from *FAOSTAT and FishStatJ as processed in IFs v 7.19 (Note: stock variation is initialized as zero in the first year by IFs).*

HUNGER IN AFRICA – THE CURRENT PATH

Nearly one in five people living in Africa is undernourished—hungry (Figure 4.1).16 This is the highest prevalence of undernourishment of all world regions. More than 29 percent of all undernourished people in the world live in Africa.

Figure 4.1: Undernourished people as a percent of total population



Source: IFs version 7.18. Undernourished population data from the World Bank, World Development Indicators (WDI), 2013. GDP per capita data from the WDI, 2015.

Africa both imports and exports agricultural commodities, but the continent's net imports are about 15% of its total current demand. The continent as a whole does not have food security.

While the rate of undernourishment has been falling, import dependence has been rising. This section will trace historical patterns of these variables as well as Base Case forecasts using IFs to understand how far from goals the continent's historical and current path might leave it in 2025. The next section will then elaborate the immediate determinants of those patterns, for instance, population size and caloric consumption levels on the demand side and growth in total agricultural production on the supply side.

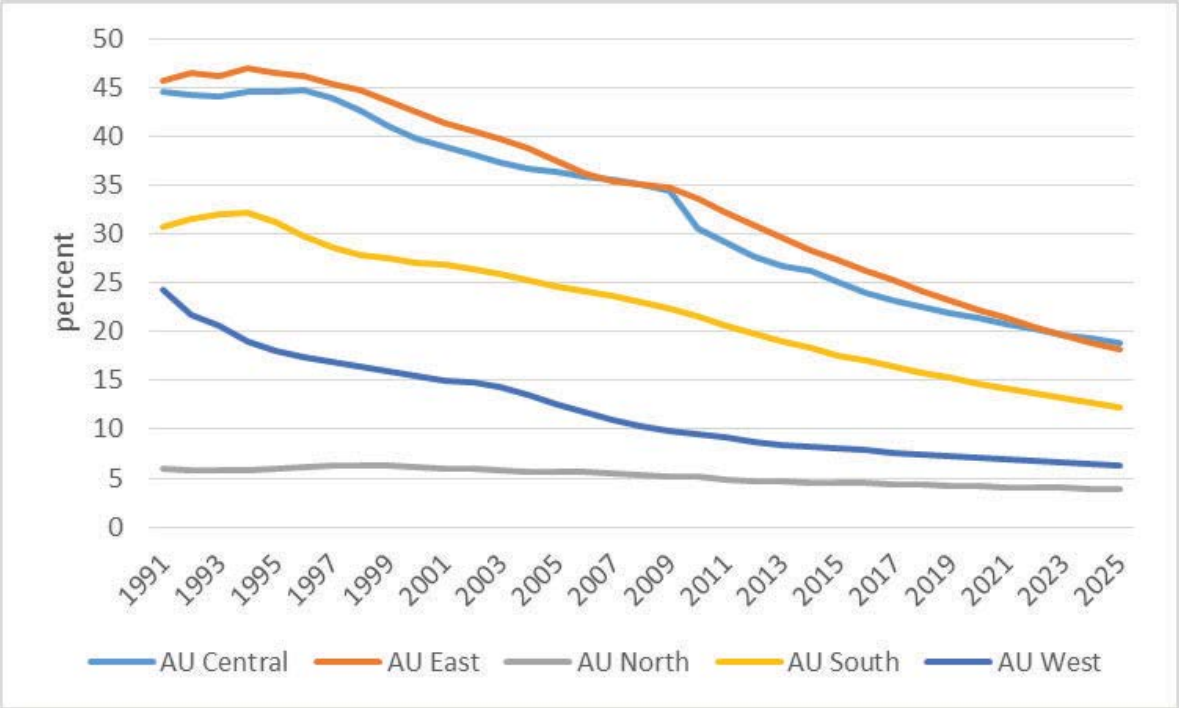
Section 4 will conclude by summarizing the need to increase effective food demand by 10 percent above that of the Base Case forecast in 2025 and to increase food production by 38 percent above the Base Case in 2025.

The next sections will turn to discussion of the levers and possible alternative scenarios that might eliminate hunger and create continental food security.

4.1 Hunger: Food Access

Since 1990, the prevalence of undernourishment has been decreasing in Africa as a whole and in all African regions. The Base Case forecast of IFs anticipates considerable further reduction by 2025 (see Figure 4.2). For the AU as a whole, undernourishment declined from 30 percent in 1991 to 19 percent in 2013, and is on its way to 12 percent by 2025.17 Some regions, especially Northern and Western Africa, have come closer to hunger elimination than others have. Only seven African countries have achieved both the Millennium Development Goal (MDG) and the World Food Summit (WFS) goal related to hunger: Angola, Cameroon, Djibouti, Gabon, Ghana, Mali, and Sao Tome and Principe.[18]

Figure 4.2: Undernourished people as a percent of total population for regions in Africa.



Source IFs version 7.19, decrease in Central Africa due to lack of data for the Democratic Republic of the Congo. Interpolation used to fill some data holes.

Some countries in the Central African region—Cameroon and Sao Tome and Principe, for example— have made drastic reductions in hunger. Other Central African countries, like The Central African Republic, The Republic of the Congo, and Chad, have not been as successful.

Western Africa as a whole has been very successful at making progress toward eliminating undernourishment. In addition to Ghana and Mali achieving the MDG and WFS targets, Nigeria has dramatically reduced hunger as well. Undernourishment in Nigeria decreased from 21% in 1991 to just over six percent in 2013. This is no small feat given that the Nigerian population increased by 76% over this same period.

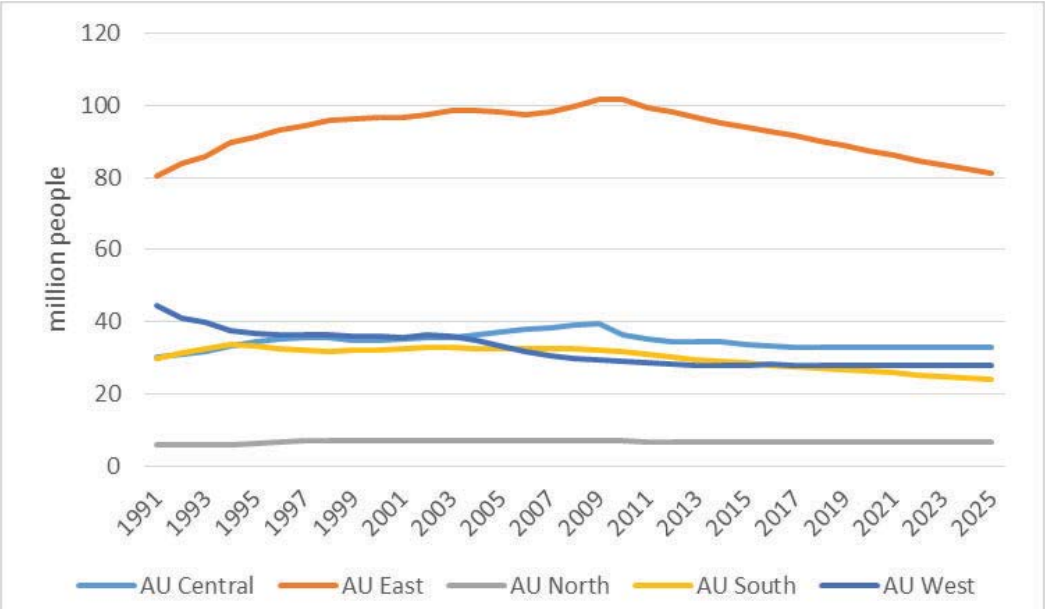
Eastern Africa has not been able to achieve similar reductions in hunger. No country in the East African Community (EAC) has met either the MDG or the WFS goal related to hunger. Prevalence of undernourishment has increased in Burundi, Tanzania, and Uganda since 1990 and remains high in Kenya and Rwanda. Due to population growth and a failure to reduce prevalence, hunger in Tanzania has nearly tripled in absolute numbers since 1990, an increase of over ten million undernourished people.

Besides Angola, Southern Africa has not seen drastic reductions in hunger, though this is partially because South Africa, the most populous country in Southern Africa, has already met the target. Zambia has experienced an increase in the prevalence of undernourishment. Meanwhile, Northern African has seen widespread reductions in hunger except for an increase in Algeria in the 1990s.

While the prevalence of undernourishment has decreased in Africa as a whole and for most countries, due to rapid population growth the number of undernourished people in Africa, in absolute terms, has actually increased since 1991 (see Figure 4.3). There were 205 million undernourished people in Africa in 2013 compared to 180 million in 1991.[19]

East Africa is home to the most undernourished people; about half of all undernourished people in Africa live in Eastern Africa. About one-third of the nearly 100 million undernourished people in East Africa in 2013 were in Ethiopia, followed by Tanzania with 16%.[20]

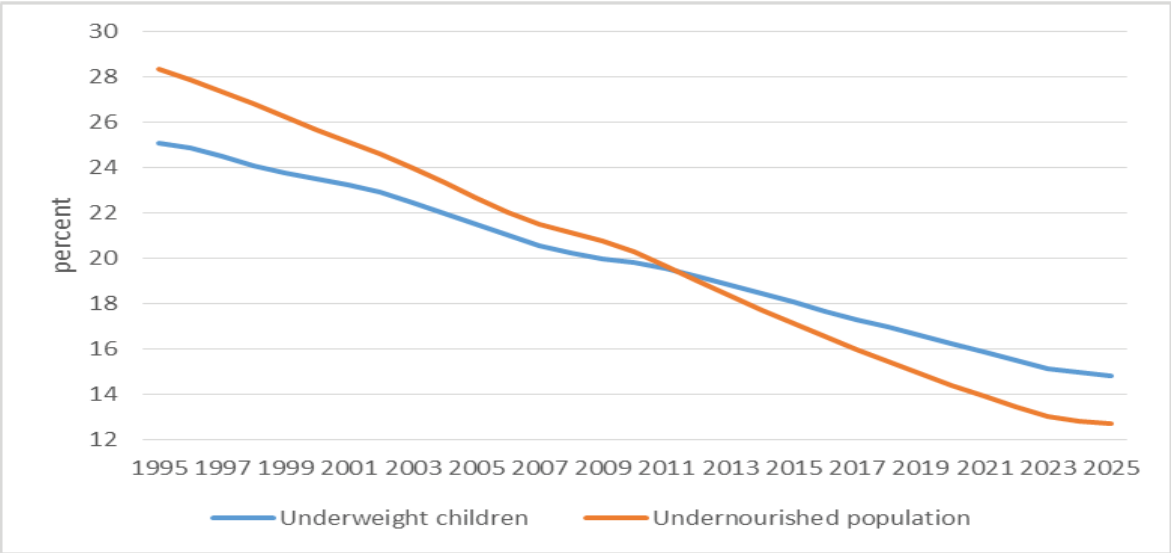
Figure 4.3: *Million undernourished people in regions in Africa*



Source: IFs version 7.19, using FAO data for history. Interpolation used to fill some data holes.

Although we focus in this report on the total extent of hunger in Africa, underweight children is an additional, separate challenge. Figure 4.4 shows that the rates of both have been decreasing at a similar pace, but it is quite possible that the rate of underweight children will be greater than that of the total African population in 2025. A major reason is that the drivers of the two variables are somewhat different. As discussed earlier, the prevalence of underweight children under five years of age reflects both food intake and food utilization (i.e. the ability of the body to absorb nutrients from food). Factors such as protein deficiency and limited access to clean water can limit effective utilization even when calories are available. Appendix 3 elaborates the drivers and prospects of the prevalence of underweight children.

Figure 4.4: *Percent of African population and children who are undernourished.*

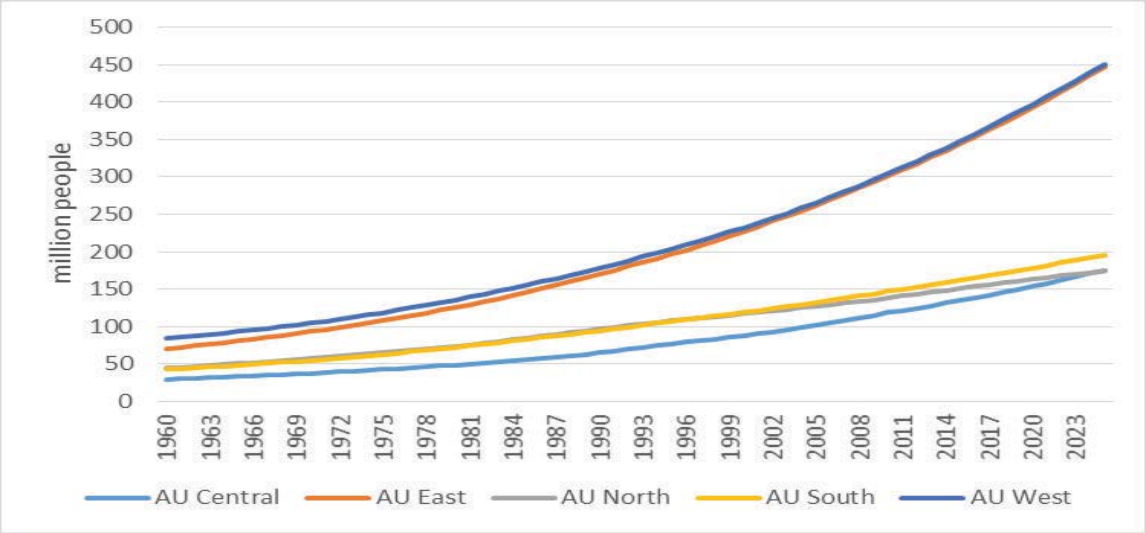


Source: IFs version 7.19, using WDI data for history. Interpolation used to fill some data holes. Five-year moving average.

4.2 Immediate Hunger Determinants: Population and Calorie Consumption

The immediate (proximate) determinants of hunger are the size of the population, the average calories consumed by that population, and the distribution of those calories across the population. Figure 4.5 shows the historical and forecast growth of African regional populations. The slower growth of Northern and Southern Africa relative to other regions is evident. Population is growing more rapidly in Eastern, Western, and (although smaller in number) Central Africa, the three regions where, according to data and analysis from the United Nations Population Division (2015 Revision), fertility reduction has relatively stalled. Clearly, this faster growth will also require more rapid growth in food supplies to reduce hunger. See Appendix 4.

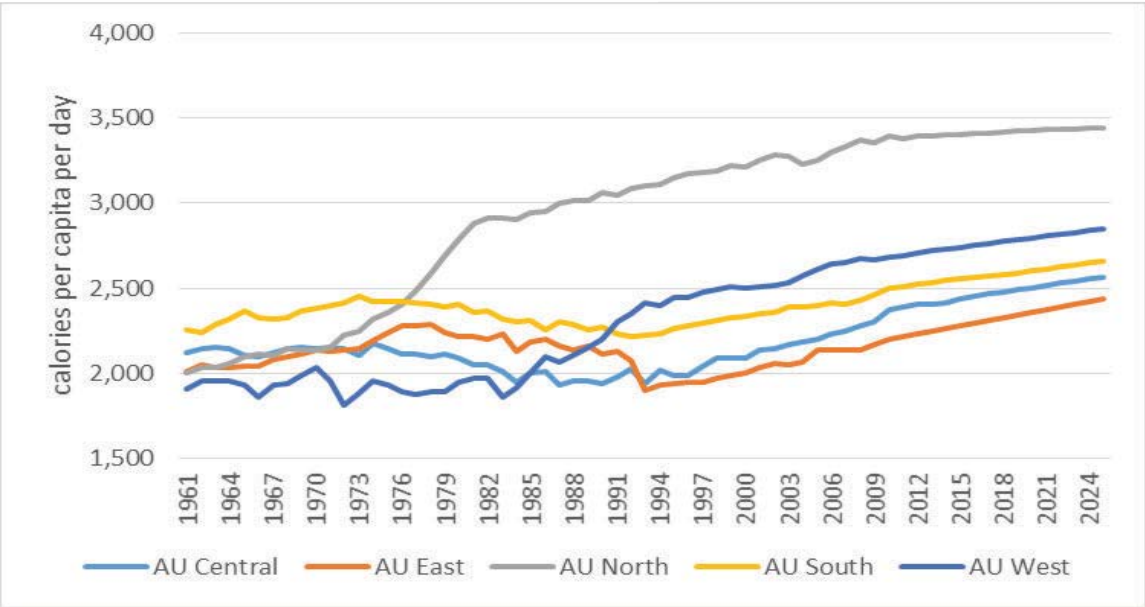
Figure 4.5: *Population in African regions*



Source: IFs version 7.19, using data from UN population division.

Rapidly growing population growth means that increasing calories per capita will be difficult, but not impossible. Increasing calories per capita contributed to the success in reducing undernourishment in Western Africa (see Figure 4.6). This increase in calories per capita occurred in spite of rapid population growth.

Figure 4.6: *Calories per capita per day for African regions.*



Source: Data from FAO, forecast from IFs v7.19.

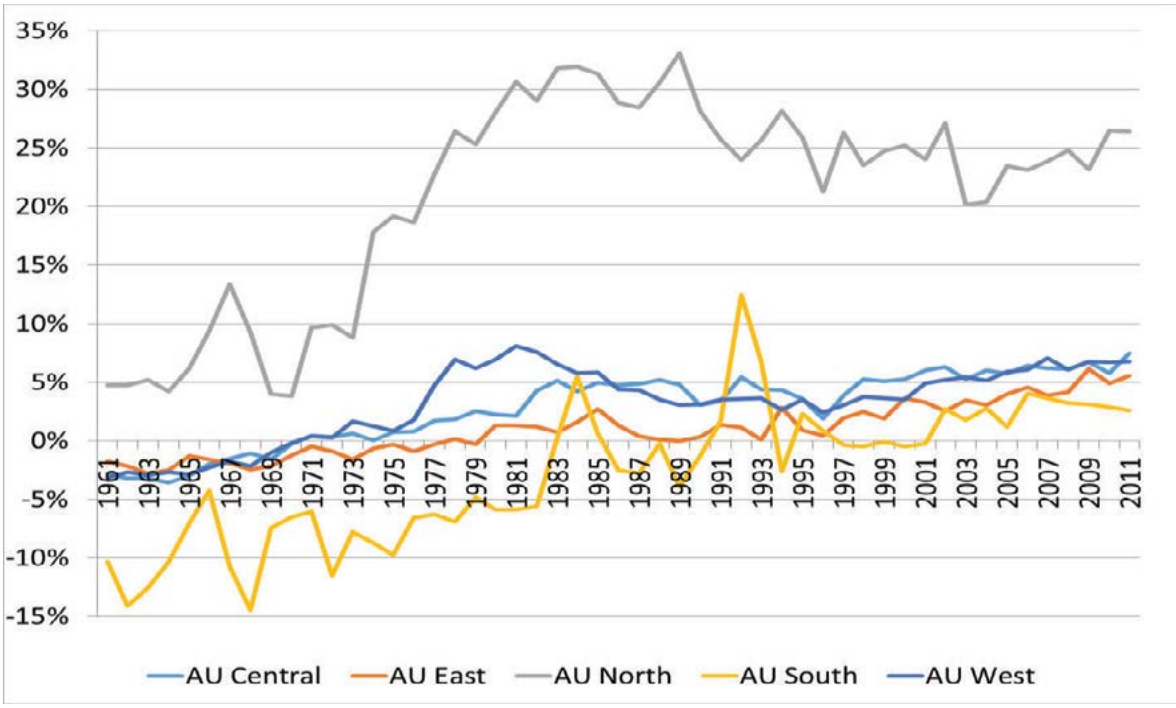
Since calories per capita are the most direct determinant of the level of hunger, an increase in calories (all else remaining equal) will decrease hunger. A final proximate factor is the distribution within countries of access to calories. Section 5 will return to the deeper or more distal drivers of these determinants of hunger.

4.3 Food Security: Availability

Africa produces most of its own food (see again Figure 3.1). While most African countries are net importers of agricultural products, only nine African countries rely on imports for more than a third of their demand and over half of all African countries rely on imports for less than eight percent of their demand.21

Agricultural net imports (imports minus exports) have been rising in most African countries and in Africa as a whole. The region with the highest historical dependency on imports for food is Northern Africa (Figure 4.7). High levels of dependence on imports can complicate balancing the current account; it also leaves countries more vulnerable to disruptions in external supply related to global price increases, transport problems, or other factors.

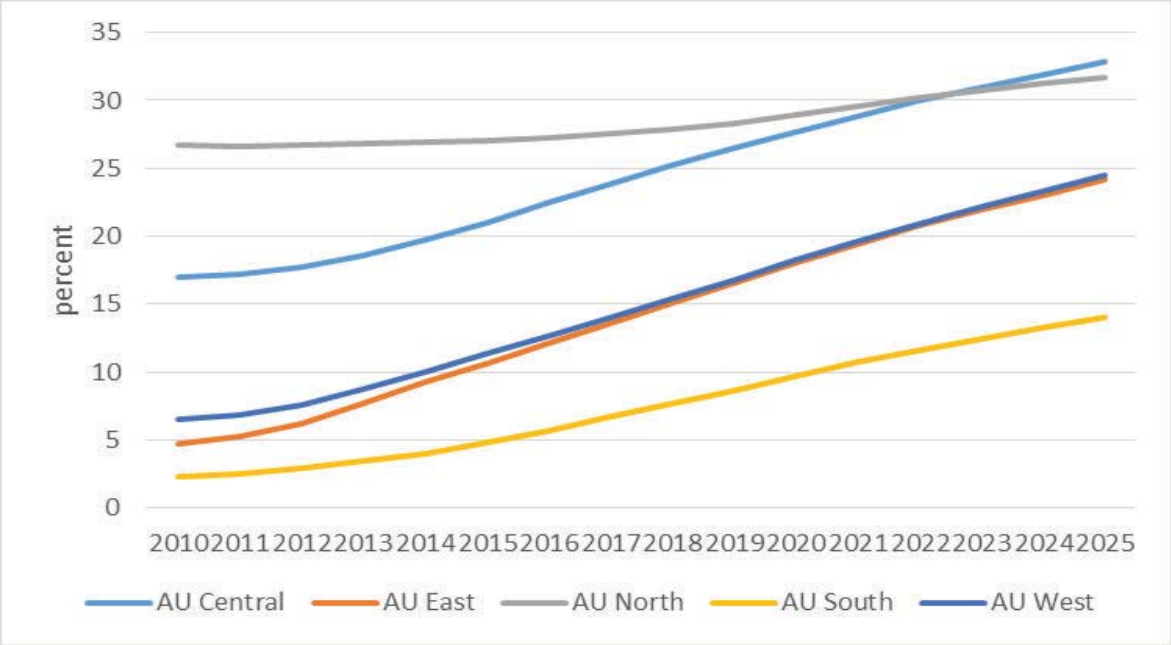
Figure 4.7: *Historical Import Dependence (Net Imports as a percentage of Total Domestic Supply)*



Source: IFs version 7.19, using FAO data.

Because historical food domestic supply data is difficult to reconcile with the IFs forecasts for effective demand, Figure 4.7 focused on import dependence relative to production. The forecast below (Figure 4.8) is of import dependence as a percent of demand because the ultimate goal of continental food security is to be able to satisfy almost all demand without net food imports. Figure 8 shows, however, that Africa is on a path—in the IFs Base Case scenario as well as the historical pattern—toward greater import dependence. While historically Northern Africa has had the greatest dependence, other regions with rapid population growth, especially Eastern, Western, and Central Africa, could come to change the dependence level of Northern Africa. Overall, African net dependence on external agriculture could rise from about 14 percent of demand in 2015 to about 25 percent by 2025.

Figure 4.8: Forecast of Import Dependence (Net Imports as a percentage of Total Domestic Demand)



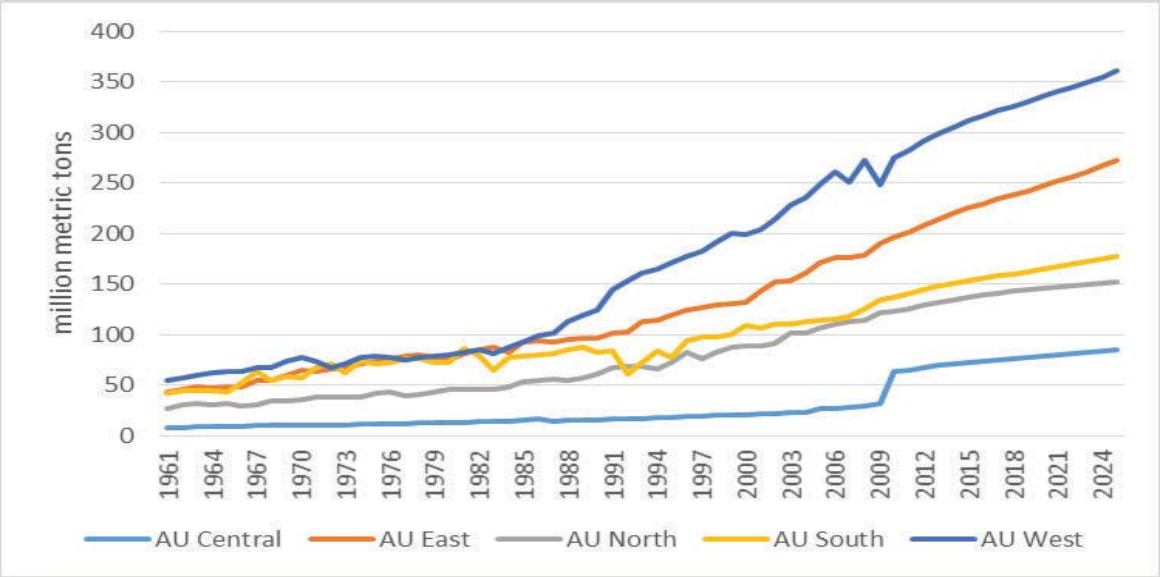
Source: IFs Version 7.19.

4.4 Immediate Determinants of Food Security: Demand and Production

Demand for food will grow with population and, if hunger is to be reduced, also with average levels of calorie consumption. Production in Africa must grow with that demand and still faster to reduce net dependence on imports. We know that production can grow rapidly. Agricultural production in Western Africa has more than doubled since 1990, and 58% of this increase came from Nigeria.

The IFs Base Case forecasts that African agricultural production will increase by 15% from 2016 to 2025 (Figure 4.9). However, as we have seen, that would not be enough to keep up with demand and to reduce import dependence.

Figure 4.9: Agricultural production in African regions.



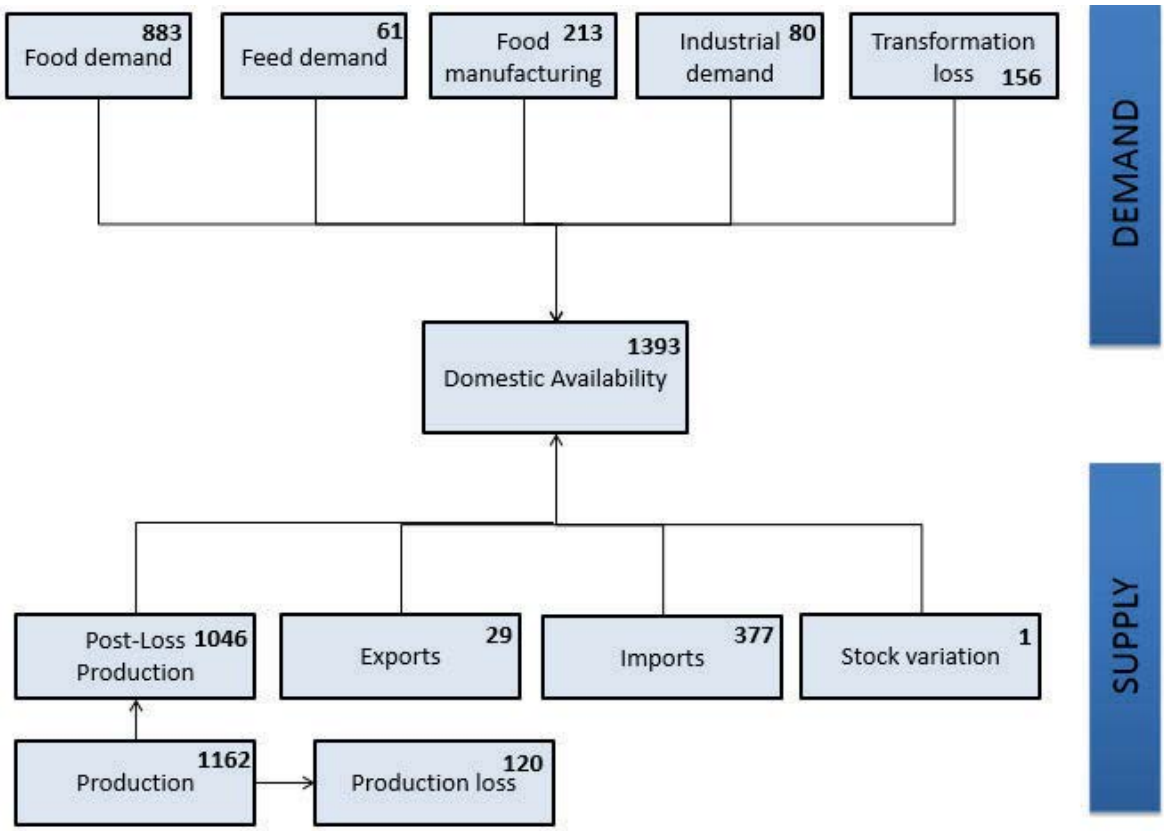
Source: IFs version 7.19, using data from FAO. Increase in Central Africa in 2012 is from countries for which no historical data exists (Burundi, DRC, and Equatorial Guinea), but we still forecast production. Interpolation used to fill some data holes.

4.5 Summarizing Prospective Food Demand and Supply in 2025

The IFs Base Case is not a simple extrapolation of past trends, but rather a dynamic scenario that represents a general continuation of technological improvement, policy investment choices, and natural-resource availability as they have evolved over the decades since the end of the Cold War. It is a plausible scenario for global human development that does not contain any radical transformation (technological or otherwise) and is a reference point for establishing expectations about continuity and change within and across systems and countries. The IFs Base Case is a generally optimistic scenario, with much improvement in human development occurring across Africa and other developing regions.

Figure 4.10 is a comprehensive visualization of the food balance for Africa in 2025 from the Base Case. Agricultural production, (effective) demand, and imports all increase compared with 2010 (see Figure 3.1 for comparison).

Figure 4.10: *Agriculture food balance for African Union in 2025.*



Source: The Base Case scenario of the IFs model.

Unfortunately, according to the Base Case (see Figure 4.7), North Africa is the only region on track to have eliminated hunger by 2025 (as, in fact, it already has). Western Africa comes close, using prevalence at or below 5% as the measure of elimination.22 Nine countries in the AU are set to eliminate undernourishment by 2025: Gabon, South Africa, Mauritius, Algeria, Tunisia, Egypt, Nigeria, Ghana, and Libya.

4.6 Requirements for Eliminating Hunger and Creating Food Security

Eliminating hunger and creating food security in Africa will require significant increases in both food access (effective demand) and food availability (production). What will be required to achieve these goals?

The degree to which effective demand will have to increase to eliminate hunger in Africa by 2025 will depend on the distribution of the available food. If an increase in food production is consumed by the hungry (see Box 4.1 for a discussion related to targeted redistribution), then hunger can be eliminated much more easily than if the food is distributed along current trends.

If the distribution of food in Africa remains roughly unchanged, effective agricultural demand would need to increase 47% (473 million metric tons) above 2015 levels by 2025 to eliminate hunger. Another way of looking at this is that the average daily caloric intake in Africa would have to rise from 2,620 in 2015 to 3,102 in 2025 (compared to the 2,726 of the IFs Base Case). These volumes of food demand are nearly 10 percent higher than the Base Case. Levels of caloric intake are 14 percent higher than the Base Case forecast for Africa in 2025.

Box 4.1 Targeted Minimum Food Subsidies to Eliminate Undernourishment

Theoretically, if the additional food could be targeted to those suffering from undernourishment, it would be possible to eliminate hunger with considerably lower increases of food relative to the Base Case scenario. The UN Food and Agricultural Organization (FAO) calculates each countries' Prevalence of Undernutrition based on four parameters: "the mean level of dietary energy consumption (DEC); a cut-off point defined as the Minimum Dietary Energy Requirement (MDER); the coefficient of variation (CV) as a parameter accounting for inequality in food consumption; and a skewness (SK) parameter accounting for asymmetry in the distribution" (FAO, 2014a, p. 4). The MDER threshold is "associated with a representative individual of the population, of average age, sex, stature and physical activity level" and therefore varies by country (FAO, 2014a, p. 5). The global average value for MDER estimated for 2014-16 is 1844 calories per person per day, with a slightly smaller value of 1755 calories per person per day for Africa.23 Using the more conservative global value, if food were directed only to those living on less than that, and only in the amounts needed to raise calories to that level, our calculations are that undernourishment in Africa could have been eliminated in 2015 with a subvention to the hungry equal of only 1.1 percent of total continental consumption in that year. Given anticipated rises in incomes and effective demand, that subvention might be as low as 0.4 percent in 2025. Again, theoretically, conditional cash transfers or outright provision of food to the hungry could accomplish that increase in consumption. In reality, of course, no public policy system could be sufficiently efficient (or harsh in terms of enforcement of limits) to accomplish that level of specific targeting. We will focus primarily on the higher level described above in our analysis while recognizing that redistribution could reduce the target need.

Given that level of need (No Hunger-High Security), is it possible for Africa to increase domestic production of food to meet the demand while reducing net imports? We have already noted that even in the Base Case, in which undernourishment remains, net imports rise to about one quarter of demand. Increasing production without a complementary increase in demand will lead to an increase in net import dependence.

Thus we know the extent of the challenge: to raise effective demand by about 10 percent relative to the Base Case Scenario (the path we are on) value in 2025 and raise production by about 38 percent relative to the Base Case value in 2025.

Section 5 will outline the different levers of action that might help make elimination of hunger and achievement of food security by 2025 possible. It will also discuss aggressive but reasonable levels of movement of those levers. Section 6 will then look at the impact of the levers individually and in combination to determine the feasibility of eliminating hunger and achieving continental food security.

5 LEVERS FOR ACTION[24]

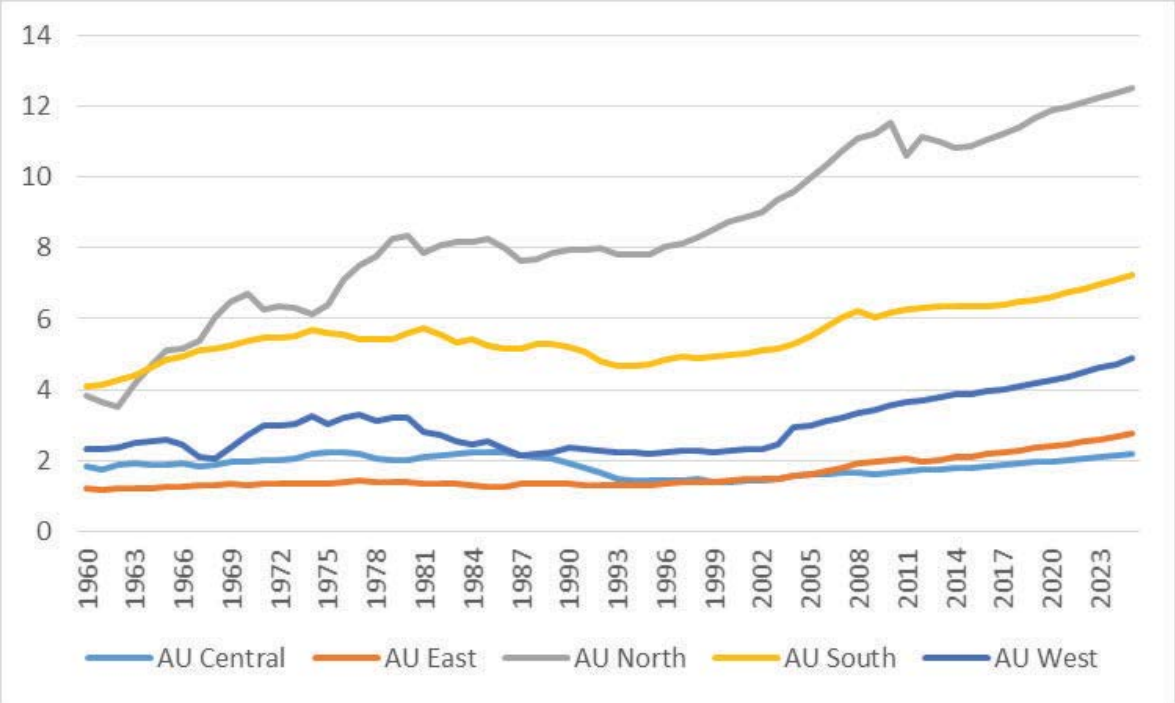
There is no single intervention, no silver bullet, which can eliminate hunger and establish food security in Africa. This section surveys a wide range of interventions that could contribute to the continent's hunger and food security goals. As in previous sections, we separate the analysis into drivers of effective demand, or food access, and drivers of supply, or food availability.

5.1 Effective Demand and Access

Eliminating hunger and food insecurity requires both assuring consistency in the available supply of food and an increase in the accessibility of food, or effective food demand. Effective food demand or food access (in FAO terms) is the individual or household consumption of food that is either purchased in the market or self-produced—it may or may not be enough to provide the calories per capita required to avoid undernourishment and hunger (Cirera & Masset, 2010).

Increased food access could result from better physical access to markets in terms of transportation, higher average incomes so that Africans can afford the food that is produced, or more equal distribution of income and food. Especially fundamental to income and therefore access to food is GDP per capita (Figure 5.1). While Northern Africa does not produce quite as much agricultural output per capita as Southern or Western Africa (more than Central or Eastern Africa), its relatively high GDP per capita means the region's countries are able to afford imported food.

Figure 5.1: *GDP per capita (at purchasing power parity) for African regions, history and forecast*



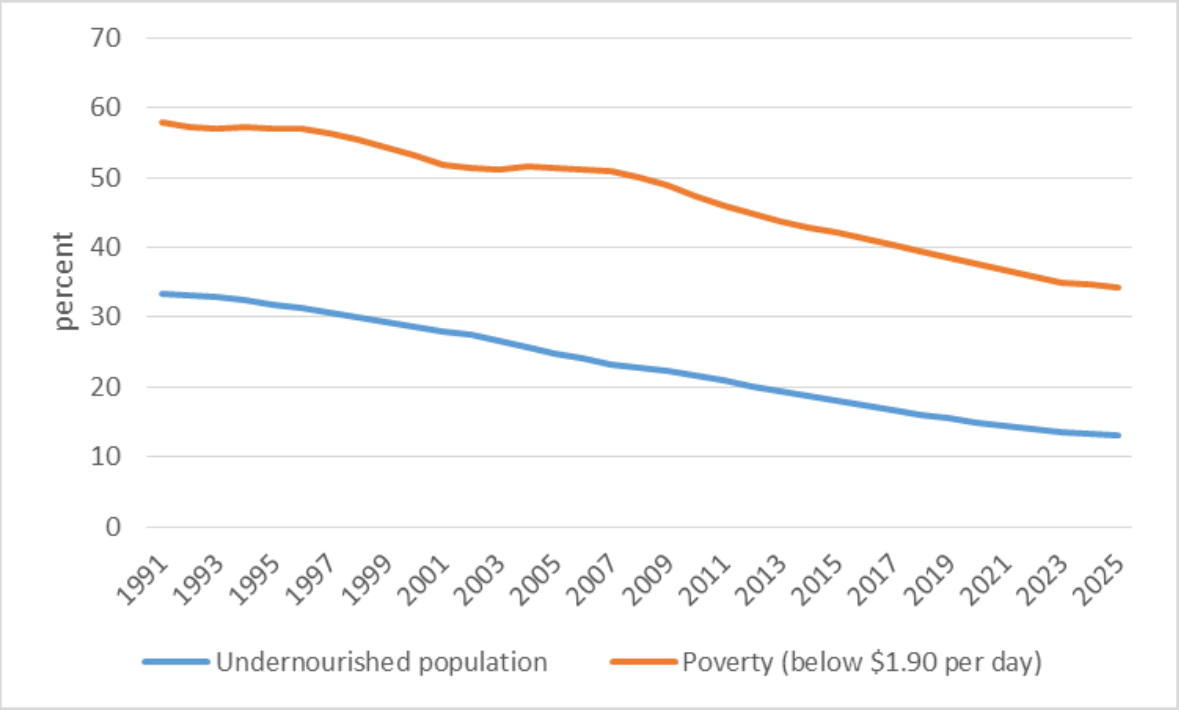
Source: IFs version 7.19, using data from World Bank's World Development Indicators. Interpolation used to fill some data holes.

Higher average income and calorie consumption are, of course, not enough to assure elimination of undernourishment. The title of the FAO's 2012 State of Food Insecurity in the World is "Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition."25 In other words, not all growth is inclusive—economic growth and a rise in GDP per capita will not necessarily reduce hunger among the poor.

There is significant overlap between poverty and hunger and these burdens reinforce each other. Those living in poverty are most affected by hunger and hunger is a constraint on productivity.26 The poor are often unable to contribute to and benefit from growth that requires capital or skills. As the 2015 SOFI states, "the greater the inequality in the distribution of assets, such as land, water, capital, education and health, the more difficult it is for the poor to improve their situation and the slower the progress in reducing undernourishment."27

While the IFs model forecasts that GDP per capita (PPP) in Africa will increase by 17 percent by 2025 (Figure 5.1), over one third of the people living in Sub-Saharan Africa will still live on less than $1.90 per day (see Figure 5.2).

Figure 5.2: *Portion of population living in poverty (less than $1.90 per day) and undernourishment in Sub-Saharan Africa, history and forecast*



Source: IFs version 7.19, using World Bank's World Development Indicators. Fluctuations in the poverty series over time reflect missing data points for different countries in different years. Interpolation used to fill some data holes. Five-year moving average.

Eliminating hunger is not just about producing more food. Since the hungry also often tend to be poor, increasing production without also increasing access will not necessarily reduce hunger. The next section will outline some of the possible interventions to increase access to food.

5.1.1 Government Transfers

One way directly to impact household incomes and thus access to food is through government transfers.

In addition to government consumption on military, education, health, R&D, and foreign aid, IFs also forecasts government expenditures on household transfers. The model forecasts transfers for pensions and general social welfare separately.

Due to the young populations of most African countries, pension spending as a percent of GDP is well below the global average. In Africa, the median age is less than 19, compared to the global average of 29. By 2025, the average African will still be less than 21 years old; the global average will be 32.5. Government spending on pensions in Africa is only 1.9 percent of GDP; the global average is 6.4 percent.28

Government spending on social welfare is 8 percent of GDP compared to the global average of 11.7 percent. While the populations of most African countries are likely to remain young over the next 10 years, there is certainly room to increase government spending on social welfare.

North and Southern Africa have the highest levels of government transfers at 15% and Eastern Africa has the lowest at 3%. In the IFs Base Case, government transfers as a percent of GDP for the AU decrease from about 9.5% to 9.1% by 2025. Since the average household income of unskilled labor is a direct driver of hunger, an increase in government transfers will decrease hunger. Thus, welfare-oriented transfers are a way to decrease hunger through the redistribution of income and food purchasing power rather than through an increase in average calorie consumption.

In the No Hunger-High Security scenario described throughout this section, government transfers as a percent of GDP for the AU increase to 11.6% by 2025. This would require increasing non-pension social transfers for unskilled labor from 124 billion USD (in the 2025 Base Case forecast) to 235 billion USD in 2025. Cumulatively, this sums to an extra 538 billion USD over the ten years.29

5.1.2 Poverty Reduction and Subsistence Farming

The portion of the African population living in extreme poverty (less than $1.90 per day in $2011) will decrease over the next decade, from about 37 percent in 2015 to 30 percent in 2025. Due to population growth, however, the number of people living in poverty, in absolute numbers, will slightly increase by 2025. Historically, the poorest have limited or no access to financial assets, education, and health care, leaving them particularly susceptible to hunger and food insecurity.30

Access to these types of resources is critical to engaging in high-growth sectors. For example, it is estimated that eight in ten members of the working poor are in the informal economy and do not benefit significantly from growth in the formal economy.31 Many researchers therefore point to the importance of addressing income distribution and "pro-poor growth", not just GDP per capita, in addressing food access.

Because of the overlap between hunger and poverty, increases in income have a much larger effect on food demand for the poor than the wealthy, a phenomenon known as Engel's Law (Cirera & Masset, 2010; Regmi & Meade, 2013). For example, one study found that an additional dollar in income led to a $.60 increase in food spending in the Democratic Republic of Congo and a $.42 increase in spending in Ghana, while in the US spending on food increased by only $.06 (Regmi & Meade, 2013).

Income distribution and access challenges are especially acute along geographic lines. As a 2013 NEPAD report put it, "food insecurity [is] essentially a rural phenomenon," which varies across seasons, and can be attributed largely to irregular income and instability of food markets.32 Eighty-five percent of Africa's farms are smaller than 2 hectares (only China is higher, at 95%), and nearly half the population relies on agriculture.33 While farming families produce some of their own food for consumption, most also engage in market activities, both as marketers and purchasers of food.34

Hunger also falls disproportionally on women. Women's labor produces most of the food people consumed worldwide, in some countries up to 90%. At the same time, women make up 60% of the world's chronically hungry. In Africa, women tend to be hungrier and more food insecure, in part, because they are far less likely to own and control land, leaving them with less incentive to invest in yields and fewer resources to leverage for income-generation. Numerous studies show that women's access to income and land significantly contribute to reducing hunger not only among women, but also among children (Giovarelli, Wamalwa, & Hannay, 2013).

Intervening through Agriculture

The prevalence of smallholder farming presents both opportunities for and limitations to increasing demand. On the opportunity side, in low-income countries agricultural growth can have a powerful effect on increasing income among those living in extreme poverty (Christiaensen, Demery, & Kuhl, 2010). Agricultural growth has an impact on poverty nearly three times greater than other sectors, and as high as eleven times greater in SSA.35 Agricultural growth is likewise an important complementary input to making an economic transition. In fact, for early industrializers, developing the agricultural sector, in part through trade protection, is seen by some as a key aspect of their success (Fan, Brzeska, Keyzer, & Halsema, 2013; Shafaeddin, 1998).

In addition, there is a strong inverse relationship between farm size and land productivity: smaller plots tend to generate higher yields (Fan et al., 2013). Some question whether this is a virtue, citing missed opportunities for mechanization and economies of scale, both of which are more available in large-scale commercial agriculture.36 However, other studies show that commercial agriculture is best for export-oriented crops, not food crops, which, unless commercial agriculture is accompanied with significant economic opportunity, is unlikely to have as large an effect on food security (Fan et al., 2013).

The impact of improving incomes through investment in agriculture will likely vary by region, depending upon the ratio of poor to extreme poor. For people who are under the poverty line rather than the extreme poverty line, growth in other sectors has a greater effect on poverty outcomes than agriculture (Christiaensen et al., 2010). This fact also has implications for future development: while investment in agriculture should significantly increase demand by 2025-in the long run economies still need to make an industrial transition to achieve widespread income growth.

Addressing Soft and Hard Constraints

In their 2013 report, "From Subsistence to Profit" Fan et al. present three categories of smallholder farmers: subsistence farmers with profit potential, subsistence farmers without profit potential, and commercialized smallholder farmers. These categories are determined based upon the types of constraints farmers face. While a farmer in any of these categories might face "soft" constraints, subsistence farmers without profit potential are likely to face both soft and "hard" constraints.

Soft constraints are defined in terms of lack of access to services such as markets and information, financial capital, infrastructure, technologies, and risk reduction tools such as insurance. Hard constraints tend to be geographic and include poor soil quality, low rainfall, high temperatures, remote location, and population density (Fan et al., 2013).

In agriculture-based countries, (most of SSA) interventions aimed at overcoming these soft constraints include: productive social safety nets; investment in infrastructure, research and extension; "innovative" finance; and technologies adapted to smallholders and for changing climates (Fan et al., 2013). For those subsistence farmers with profit potential, soft-constraint interventions can be enough to put them on the path to profitability. Those farms that come up against both soft and hard constraints, however, are unlikely to have profit potential—the opportunities for income-generation from farming are severely limited. Interventions aimed at addressing hard constraints overlap with strategies to increase yield, such as irrigation and fertilizer; these are addressed below.

5.2 Availability of Supply

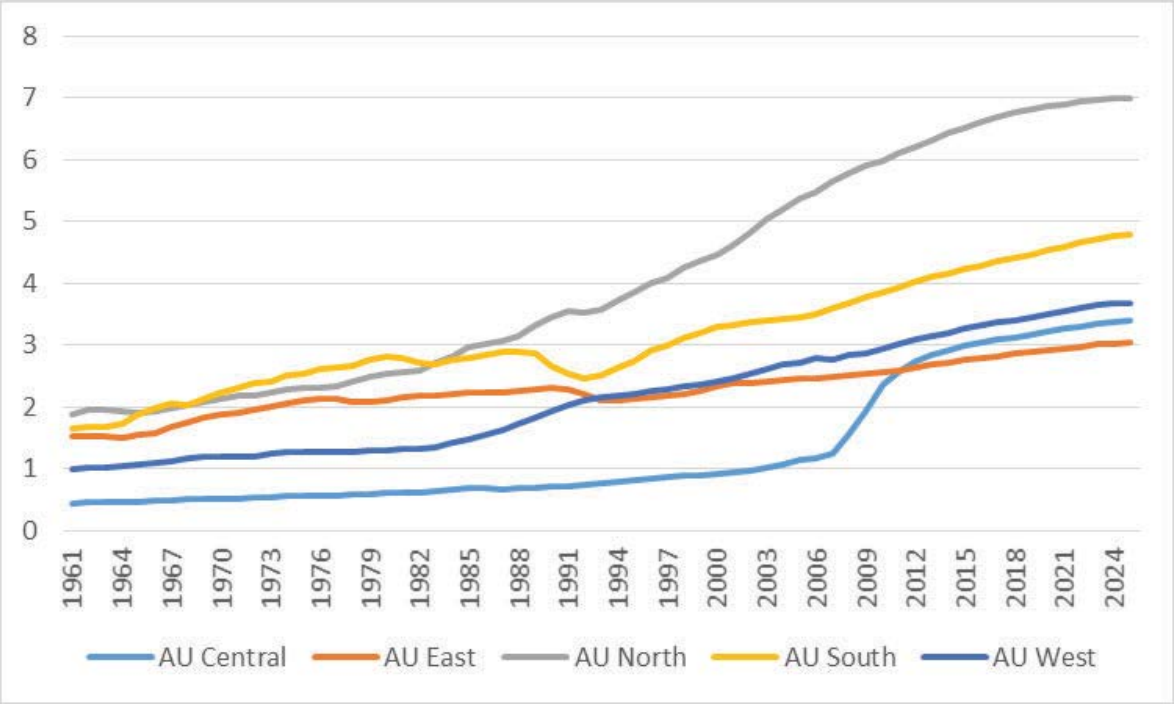
5.2.1 Yields

A key indicator of agricultural productivity, specifically for crops, is yield, i.e. metric tons produced per hectare of land under cultivation (tons/ha). At the aggregate level presented here, yields vary due to both the yields of specific crops and the mix of crops produced. For example, in 2014 (the latest year for which the FAO provides data), wheat yields in Africa ranged from 0.4 tons/ha in Somalia to 7.2 tons/ha in Zambia (continent average was approximately 2.6 tons/ha). Meanwhile, average yields across Africa for different crops range from under 0.25 tons/ha for oil crops to over 63 tons/ha for sugar cane.37

Keeping this in mind, Northern Africa has the highest aggregate crop yield of all African regions (Figure 5.3), due in large part to high production in Egypt. The data reflect both high yields for individual Egyptian crops and a large number of high-yield crops such as sugar cane and sugar beets. Egypt—a highly irrigated agricultural region—produces 24.6 tons of crops per hectare of land under cultivation, more than four times the global average and nearly eight times the African average.

In sharp contrast, average agricultural yield in Africa in 2011 was only 3.2 tons per hectare, just over 50% of the global average of 5.9 tons per hectare. Thus, there is the potential for increasing agricultural production through higher yields rather than through an expansion of cropland.

Figure 5.3: *Yields (tons per hectare) for African regions.*



Source: IFs version 7.19, using data from FAO. Increase in Central Africa in 2012 is from countries for which no historical data exists (Burundi, DRC, and Equatorial Guinea), but we still forecast yield. Interpolation used to fill some data holes. Five-year moving average.

Green Revolution

Scientific innovations in seeds, fertilizers, irrigation, and pesticides led to rapid increases in agricultural production in some developing countries in the 1960s and 1970s: the Green Revolution.

These high yield varieties (HYV) of seeds accounted for 90% of the increase in food production by the end of the 1960s, and 70% by the end of the 1970s (Bazuin, Azadi, & Witlox, 2011).

This increased production has reduced hunger, improved nutrition, and reduced the conversion of natural ecosystems to agriculture (Tilman, Cassman, Matson, Naylor, & Polasky, 2002). While the Green Revolution was successful in both Asia and Latin America in reducing hunger, it has struggled to take off in Sub-Saharan Africa (Bazuin et al., 2011). Complications for Africa include the diversity of food crops relative to heavy dependence elsewhere on cereals such as rice, wheat, and corn. Other challenges for increasing African yields include the diversity of local growing conditions, the abundance of land in Africa (which encourages extensive farming rather than intensification), high fertilizer cost and low output prices, underdeveloped transportation systems, and concerns about the effects of fertilizers and pesticides to human health and the environment (Bazuin et al., 2011).

It should also be noted that yield per hectare can be a misleading measure of agricultural productivity because it considers only the volume of crops produced, not their monetary value. Many countries that produce relatively expensive crops for export—such as coffee—will have lower yields in terms of volume but higher yields in terms of monetary returns. Differences in tonnage per hectare across countries and regions reflects only one measure of production.

High-yield crop varieties with heavy fertilization on irrigated land fueled the success of the Green Revolution in Asia and elsewhere (Ehui, Williams, & Meijer, 2002). Inefficient soil management practices, unsuitable fertilizer application, and the overexploitation of soil and water resources has led to poor soil quality in much of Sub-Saharan Africa (Ladha et al., 2003; Sarkar & Kar, 2011). To raise yields in Africa substantially, improved soil-management practices, appropriate fertilizer application, and the sustainable use of water resources must accompany high-yield crops.

Fertilizers

In East Asia, fertilizer use rose by 850% from 1965 to 1995 (Ehui et al., 2002, p. 31). In 2006, the African Union's Abuja Declaration called for fertilizer use in Sub-Saharan Africa to increase from today's average of 8 kg/ha — the world's lowest — to at least 50 kg/ha by 2015 (Glatzel, 2014).

Seeds

Some argue that after the hybrid seeds of the 1940s, a new version of the Green Revolution is emerging in the form of the Gene Revolution (Wu & Butz, 2004). This movement is geared toward creating plants resistant to diseases, water shortages and poor soil texture. This strategy comes with controversy (in Europe as much or more than in Africa) concerning effects to human health and the environment. South Africa, Burkina Faso, Egypt, Kenya, Uganda, and Nigeria are the six first adopter nations showing political support for GMO technology (Okeno, Wolt, Misra, & Rodriguez, 2013). These nations have pro-biotech legislations, public awareness strategies and GMOs approved for field-testing (Okeno et al., 2013).

Irrigation

With the exception of North African countries, African water resources are underutilized. Increased water resource usage can lead to productivity gains even in areas currently under irrigation. Only six percent of African cropland is under irrigation compared to 40% in Asia (NEPAD, 2013). Irrigation guards against the variability of rainfall patterns. It also enables year-round planting, which produces diversification of crops. An expansion of land under irrigation could significantly increase yields and complement initiatives aimed at increasing the use of fertilizer.

Implications for Yield Growth

Africa could derive yield gains from a combination of interventions. Improving soil quality through sustainable farming practices that reduce the loss of nutrients, improvements to local-specific seed varieties, increases in use of fertilizer, and expansions in irrigation could dramatically improve yields. A look at yield gains in East Asia is instructive: cereal production there rose 92%--using only an additional 4% of land—during the three decades from 1969/71 to 2000 (Ehui et al., 2002).

A reasonable target for yield increase is about 3.5 percent per year over the next nine years for countries with relatively high yields (Tran & Kajisa, 2006).38 This is the average annual growth rate of Viet Nam rice yields from 1980 to 2000 and just below the average growth rate of Rwanda from 1994 to 2003.39

For countries with relatively low yields, it is possible for yield to grow faster than 3.5 percent per year. From 1983 to 1992, Nigeria experienced a growth rate of 8 percent per year, though that was starting from a base of just 1.5 tons per hectare.40 The table below shows the specific possible targets by region that guide our No Hunger-High Security scenario.

Table 5.1 Yields in Base Case and No Hunger-High Security

REGION	Base Case Yield Tons per Hectare	(2016) Target yields in 2025
AFRICA AU	3.6	4.9
CENTRAL	3.1	4.3
EAST	2.8	3.8
NORTH	6.6	7.6
SOUTH	4.3	6.0
WEST	3.3	4.7

Source: IFs version 7.19.

5.2.2 Land

An increase in yield will increase overall agricultural production in Africa, but yield increases alone are not enough to solve Africa's hunger problems. Land is the other proximate driver of crop production. The FAO defines arable land as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned because of shifting cultivation is excluded.41

The IFs model divides land into 5 categories: cropland, grazing land, forestland, urban or built-up land, and other land. Investment in cropland development is the primary driver of changes in the area of cropland, though conservation policies and urbanization will also effect change.42

While 40% of the land in Africa is potentially arable (usable for crop cultivation), only nine percent is actually cultivated. An estimated 60% of the globe's available and unexploited cropland is located in Sub-Saharan Africa (KPMG, 2013). Sixty percent of the arable land in Africa is concentrated in seven countries: DRC, Angola, Republic of Congo, Zambia, Cameroon, Mozambique, and the Central African Republic (NEPAD, 2013).

Land management

While an expansion of land under cultivation could increase overall agricultural production, improved land management practices could increase production while ensuring the benefits go to those most in need. Current farming practices of low input within an extensive farming framework results in land deforestation, land degradation, loss of bio diversity and the release of carbon that has been sequestered in soils or trees. A move from extensive to intensive farming does not necessarily decrease the harmful environmental consequences of farming. Intensive farming systems harm water resources and human health, but technological applications have managed to militate against the effects of intensification of agriculture (Morris, 2009, p. 4).

An extension of 39MH of cropland in Africa by 2025 is possible, with the biggest extension occurring in Eastern Africa (see table 5.2). Unfortunately, an expansion of cropland could lead to increased levels of deforestation; in the IFs model, cultivating this 39MH will require deforestation of 20% of the total acreage.

Table 5.2 Cropland Increase in No Hunger-High Security

REGION	CHANGE IN LAND AREA in MH
AFRICA AU	38.8
AU CENTRAL	3.7
AU EAST	20
AU NORTH	0.1
AU SOUTH	5.1
AU WEST	10
Source: IFs version 7.19.	

Table created by Authors from IFs forecast. Discrepancy between sum of regions and Africa due to rounding errors.

5.2.3 Investment

In 2003, at the African Union (AU) summit in Maputo, African leaders pledged to allocate at least 10% of national budgets to agriculture and rural development within 5 years, and to increase agricultural growth to 6 percent per year. With these goals in mind, they created the Comprehensive Africa Agriculture Development Program (CAADP).[43]

Rwanda became the first country to sign the CAADP Compact in 2007, with the ministers of the country agreeing to increase expenditure on the agricultural sector from 4% to more than 10% within five years. In the 2011/2012 fiscal year, Rwanda met this target and spent 10.2% of the annual national budget on the agricultural sector (Bizimana, 2014).

As of May 2011, 26 countries had signed the CAADP Compact, though only eight have surpassed the 10% budgetary allotment target as of 2016.[46]

Since 2007, Rwanda has been an example of an East African success story in terms of both poverty reduction and agricultural intensification leading to hunger reduction. Through investments in infrastructure for irrigation and erosion control and the provision of quality inputs and capacity building, the government has been able to increase yields, reduce poverty, and since 2010, maintain a positive food balance sheet.44 Hunger in Rwanda decreased from 45 to 34 percent of the population from 2007 to 2013 or the equivalent 532,000 people who are no longer hungry.[45]

As of May 2011, 26 countries had signed the CAADP Compact, though only eight have surpassed the 10% budgetary allotment target as of 2016.[46]

5.2.4 Aquaculture

As of 2013, around half the fish consumed globally comes from farms rather than wild capture; this number is projected to increase to 62% by 2030 (FAO, 2014b). Fish farming is commonly referred to as aquaculture. The FAO first defined aquaculture in 1988 as

> ...the farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants.
>
> Farming implies some form of intervention in the rearing process to enhance production, such
>
> as regular stocking, feeding, protection from predators, etc. Farming also implies individual or
>
> corporate ownership of the stock being cultivated.[47]

Today, 80 percent of aquaculture production occurs in small to medium-sized operations, and communities with these types of operations have the most to gain from aquaculture in terms of food security. Aquaculture contributes to families' food security in terms of both increased income and increased supply of fish. Fish is also a good source of proteins and certain micronutrients, filling a gap in the diets of most low-income individuals (IFPRI, 2015).

The FAO's most recent State of World Fisheries and Aquaculture Report confirms that world aquaculture production is steadily growing, though at a slower rate in recent years. In 2012, total production broke previous records at 90.4 million tons total, including 66.6 million tons of food fish and 23.8 million tons of aquatic algae. Aquaculture development is not evenly distributed throughout the world, however; China alone accounted for 61.9% of world production, reporting 43.5 million tons of food fish and 12.5 million tons of aquatic algae in 2012. Southern and Eastern Asia are also major fish producers, with 26.23% of total production in the same year (FAO, 2014b).

Aquaculture has also emerged in Africa however. In 2012 North Africa reached 1.03 million tons of total production, and SSA 0.68 million (FAO, 2014b). The continent has plenty of room to grow in this area. The IFs Base Case projects that North Africa will experience growth in aquaculture, doubling production by 2025; other regions, however, are expected to stagnate or slowly decline.

Historically, we see very high growth rates in aquaculture among the top global producers, led by China. For several years in the 1980s, China achieved annual growth in inland aquaculture of over 20%; from 1980 to 1990, the growth was over 300%. Egypt and Uganda lead inland aquaculture in Africa and are among the top producers worldwide. Egypt increased its aquaculture 180% from 1993 to 2003, while Uganda achieved 52% growth from 1994 to 2004.

Given this history of rapid growth both on the continent and around the world, we chose in the No Hunger-High Security scenario to increase growth in Africa's aquaculture to 13% annually from 2016 to 2025, simulating a 95% overall increase for the nine-year period. The result is a 43% increase in forecast supply of fish in 2025, or an additional 3.8 million tons compared to 2016 levels. North Africa sees the greatest increase in fish supply, with an additional 9.3 million tons cumulative increase by 2025. The West African region follows at a cumulative 2.3 million ton increase. The East and Southern African regions experience total increases of 1.1 and 0.2 million tons respectively.

5.3 Loss

5.3.1 Scale of Losses

Most agricultural research and development focuses on increasing food production, but the anticipated outcomes of increased yields on food security and undernutrition can be offset by loss along the food supply chain (FSC) (Kader, 2005). The FAO defines food loss as "wholesome edible material intended for human consumption, arising at any point in the FSC that is instead discarded, lost, degraded or consumed by pests"(Parfitt, Barthel, & Macnaughton, 2010). There are alternative ways to measure food loss, but here we follow the FAO definition.

Food loss is generally divided into three categories: production loss, transformation loss, and consumption loss. Production loss includes crop losses before the point of harvest due to pests, rodents, and pathogens (Lundqvist, Fraiture, & Molden, 2008). Transformation loss includes product loss between the point of harvest and the point of sale and consumption. Finally, consumption loss, also called "food waste," includes retail and consumption food disposal, and is comprised largely of food disposal in wholesale locations (FAO- Food and Agriculture Organization of the United Nations, 2011).

Globally, about one third of food is lost along the FSC (Kader, 2005). Interestingly, while growth in food production increased by 100% globally from 1980 to 201348, rates of food loss have not changed since the 1970s (Kitinoja, 2010). This is despite an international target to reduce loss by 50% set by the FAO in 1970 (Parfitt et al., 2010). It follows that food loss reduction remains an area of intervention that could result in significant positive outcomes for food security and undernourishment, especially among smallholder farmers.[49]

The rate of food loss is surprisingly homogenous across countries. North America and Oceania, for example, lose an average 32% of food, while Sub-Saharan Africa (SSA) and East Asia lose around 31.5%.50 There is enormous variability, however, in the rate of loss between crop types, especially in the production and transformation phases, from as little 0% to as much as 80% (Kitinoja, 2010). More importantly for this report, there is also variability between the types of losses among world regions and particularly between developing and industrialized countries.

While the bulk of food loss in developed countries occurs at the consumption stage (40 %+), for developing countries loss is a greater concern during production and transformation, with most (40 %+) occurring during transformation. Transformation comprises the largest section of the FSC, and includes the post-harvest, processing, and distribution phases. Transformation loss is likewise the most pervasive form of food loss SSA.[51]

5.3.2 Addressing Transformation Loss

Below is a table outlining the major types of food loss affecting Africa, the causes of each type of loss, and possible solutions.

Transformation Loss: Sample of Types, Causes, and Solutions		
Type of loss	**Cause of loss**	**Solution**
Lost caloric and nutritional value of produce	Premature harvesting	Training in utilization of harvest indices
Water loss; wilting; bruising; decay; low prices at farm gate due to overloading at peak season and volume loss	Lack of facilities (storage & processing)	Cooling (e.g. evaporated forced air cooling; low-energy cool storage); investment in infrastructure; contract farming linkages (esp. with farming associations and cooperatives); methods to slow ripening (e.g. ethylene scrubbers)
	Inadequate infrastructure & marketing systems	Marketing cooperatives; investment in infrastructure (e.g. roads, market facilities); improved communication capacity along FSC; alternative distribution such as selling directly to consumer
	Lack of tools and equipment, including packaging	Allow for imports of farming technologies (e.g. plastic crates); develop adapted technologies with local materials; improved field packing methods during harvest; low-cost, low-technology food processing such as indirect solar drying
	Lack of information and training on best practices	Training for farmers and handlers; local communication technology provision and application

Table 5.3: Created by authors. Sources: (FAO- Food and Agriculture Organization of the United Nations, 2011; Kader, 2005; Kitinoja, 2010)

The limited data available estimate that in Africa there is about a 25% rate of post-harvest loss alone in grains, and up to 50% in horticulture (Lundqvist et al., 2008). Transformation loss also makes up the majority of total loss in cereals, roots and tubers, fruits and vegetables (though production loss of fruits and vegetables is also very high), and fish in both the Mahgreb region and SSA. Only meat and oil seeds see their highest loss at the production phase, and these are generally considered "luxury" items, though they are increasing in popularity, particularly in urban areas (Lundqvist et al., 2008).

Loss literature suggests that transformation loss is the logical starting point for overall loss mitigation in Africa. Currently transformation losses are estimated at 21% for African countries within IFs. We have chosen for the No Hunger-High Security scenario to make a fairly aggressive 25% reduction in transformation loss in Africa, taking it to 15.75%, by 2025. This is a rate just below Asia's average, but still nearly twice the average for industrialized countries 8.1%.52 Asia loses around 17% at the transformation stage, and Latin America 19% (Rosegrant, Cline, Li, Sulser, & Valmonte-Santos, 2005).

Cereals, fruits, and vegetables are products with the highest relative transformation loss compared to other regions in Asia53 and could be an effective area for intervention in Africa. Sri Lanka, Thailand,

and Vietnam for instance, have been able to attain horticulture losses as low as 16% and 17%, and 20% respectively, a rate significantly lower than the 40-50% average for Africa (Lundqvist et al., 2008; Rolle, 2006). States in Latin America have had even greater success in this area. Brazil, for instance, has an average of 16.6% fruit and vegetable losses in the transformation period (Kitinoja, 2010).

Cereal losses in Asia and Latin America are also lower on average than in Africa, albeit to a lesser extent. There are a number of African cases, though, that perform quite well in the area of cereal losses. In Zimbabwe, for instance, only 8.3% of maize weight is lost among small-scale farmers, compared to 17.4% in Uganda and 17% in Zambia (Rembold, Hodges, Bernard, Knipschild, & Leo, 2014). And as recently as 2003, wheat loss was as low as 5% across the continent, though the percentage has increased in subsequent years.54 There is also a large body of research on promising interventions for losses in Africa, a number of which are presented below.

The No Hunger-High Security scenario includes 18% reduction in transformation loss across the continent, which accounts for an additional cumulative 107 million metric tons of available food available by 2025. Loss reduction also has the important effect of decreasing imports without causing a significant increase in exports, leading to a reduction in import dependence and an increase in overall food security.

While losses increase food supply, a complementary increase in demand is still critical to insuring food access among the poorest. Loss reduction alone does little for calories per capita. There is also still room to improve production losses, the second-highest loss type following transformation loss. Spillover effects from transformation loss (e.g. cooperative membership) are likely to have a positive impact on consumption loss as well, but it may be difficult to quantify.

Distal Interventions: Physical and Market Infrastructure

Food-loss literature points to both distal and proximate interventions for mitigating transformation loss. Distal interventions cut across the FSC, and could have a longer-term and more sustained impact on food loss. One of the most widely cited distal drivers is physical infrastructure, including market infrastructure (Kader, 2005; Kitinoja, 2010; Lundqvist et al., 2008; Parfitt et al., 2010). Physical infrastructure, such as roads and irrigation, is key to helping farmers get food to market quickly and with minimal physical damage and water loss (i.e. wilting) (Kitinoja, 2010).

Likewise, appropriate marketing facilities—taking into account sanitation standards, storage facilities, areas to load and unload, etc.—can ensure food reaches consumers with minimal loss, reducing overall costs in the long run. Infrastructure is also important in the context of rapid urbanization. As more consumers move into urban areas, efficient supply chains are needed or the poorest may be priced out of the food market (NEPAD, 2013; Parfitt et al., 2010).

Proximate Interventions: Cooperatives, Information, and Technology

Two promising proximate drivers are production and marketing cooperatives and the provision of information and technology. Cooperatives can help farmers engage more effectively in the market by improving access to resources (namely credit and technology) and increasing potential for sales capacity (in the form of both wholesale contracts and direct access to consumers). They also allow farmers to pool resources along the transformation process for easier transportation, packaging, and processing (FAO- Food and Agriculture Organization of the United Nations, 2011; Kader, 2005). One report notes, however, that in some cases farmers organize in these ways only to find the market infrastructure unable to accommodate them.[55]

Information and Technology Access

Food-loss researchers have also identified a lack of access to information and technologies that could easily reduce losses at both on-farm and off-farm transformation stages. Technology as simple as plastic crates and packaging could significantly reduce losses, for instance, while training on best practices in harvesting, processing, and transportation is sorely needed (Kader, 2005; Kitinoja, 2010). Access to both information and technology is especially lacking among Africa's largest agricultural labor force: women (Kitinoja, 2010; NEPAD, 2013).

5.4 Summary of Interventions for Alternative Scenario Analysis

The International Futures (IFs) forecasting system has extensive representations of agricultural and broader development variables (see Appendix 2), but no model can incorporate all possible interventions for addressing hunger and food insecurity. Instead, our scenario analysis will frame the future of hunger in Africa in terms of macro-level interventions that draw upon the more micro- and meso-level discussion above.

With respect to the demand side and reducing hunger, as explained, GDP per capita, as a proxy for household income, is key.

Might Africa raise its GDP per capita to levels that would provide the income needed to create effective calorie demand sufficient to eliminate hunger?

On a global basis, countries eliminate hunger when average calories per capita rise above about 3000- 3100. Across countries, caloric intake is strongly correlated with GDP per capita at purchasing power parity; that target calorie level is typically reached with a GDP per capita of around $15,000 ($2011), about that of Azerbaijan, Iran, Mexico, and Uruguay. Subject, of course, to great variations within and across countries, Africa in 2015 had a GDP per capita (at PPP) of just over $4,600. In the IFs Base Case forecast, with average annual GDP growth rates of about 4.8% and an annual average GDP per capita growth rate of 1.2%, that number will climb to about $5,212 in 2025. It would take a GDP per capita annual compounded growth rate of about 12.5 percent for the continent on average to reach $15,000. Moreover, even if average GDP per capita rose to $15,000, many countries would fall below that level.

Rise in GDP per capita, then, will not be adequate in any scenario to generate the needed effective demand of the continent. Box 4.1 noted that it would theoretically be possible to eliminate undernourishment with a much smaller increase in caloric intake for the continent if the effort were targeted precisely at raising levels only for the hungry and only up to the level needed to eliminate that condition. Such a perfect targeting of food subsidy (or income redistribution plan) is, of course, effectively also impossible. Yet the range of increase needed for effective demand is bracketed by the general raising of effective demand across entire populations and the precise targeting of the undernourished.

This chapter has noted that programs to eliminate poverty have an important role to play in eliminating hunger. In fact, extreme poverty levels (now at $1.90 per person per day) were originally closely tied to income levels sufficient to eliminate hunger. It would be possible, therefore, for us to develop a scenario around poverty eradication, but that endeavor-- like a scenario to eliminate hunger itself--would require a complex and multi-pronged effort.

The following section (6) outlines a No Hunger-High Security scenario that raises the average caloric intake level of each African county to the level needed to reduce undernourishment to 5 percent or below.56 This scenario also includes a governmental income transfer from skilled to unskilled households (section 5.1.1) which improves access to food, but the overall distribution of calories remains constant.

Section 4 concluded by noting that across Africa the scenario requires 14 percent higher levels of average caloric intake in 2025 than the level anticipated in the Base Case. Some countries require considerably higher percentage increases: Madagascar (39), Zambia (36), Ethiopia (33), and Chad (31). Regionally the values are North Africa (0.2), West Africa (5), Southern Africa (15), Central Africa (18), and East Africa (27). No Hunger-High Security is a conservative (high) estimate of calorie intake needs, but it can help to explore the potential for eliminating hunger.

The supply-side question for the scenario then becomes: *Were the governments of Africa able to eliminate hunger through increased caloric intake, whether through targeted programs or overall increases in average caloric consumption, could agricultural production increase enough to meet the needs for those calories and simultaneously reduce net imports to zero?*

Turning to the supply side, agricultural production level is directly driven by land under cultivation and average yield per hectare of land. The discussion in this section identified a wide range of more micro-level drivers of both these variables, from land tenure and irrigation programs to focuses on seed quality, fertilizer use, infrastructure support, and investment levels. The No Hunger-High Security scenario has scaled assumptions about land expansion and yield increases across African regions and selected important countries within them. The scenario constitutes an aggressive but potentially reasonable scenario should a great many such interventions be undertaken simultaneously.

Box 5.1. Summary of Assumptions in the No Hunger-High Security Scenario to Compare with Base Case

Increases in government transfers to households (generally, pension payments and welfare-oriented disbursements to unskilled households) to provide income support for food consumption: Transfers reach a level of 11.6% of GDP in 2025, compared to 9% in the Base Case.

Average calorie consumption by country rises to levels sufficient to reduce undernourishment to five percent or below (taking into account some reduction in need due to government transfers).

Efficiency gains reduce agricultural transformation losses by 6 percentage points relative to the Base Case to 9% of production in 2025. This reduces the volume of food needed to meet the calorie demand.

Agricultural yields rise at a compound growth rate of about 3.4% annually, with some variation across regions (see Table 5.1).

Land under crop cultivation rises a total of 39 million hectares by 2025, with variations again by region (see Table 5.2).

Aquaculture production rises by a compound annual growth rate of 13% annually.

Box 5.1 provides a summary of the assumptions in the scenario discussed here as an alternative to the Base Case. This scenario is very aggressive with respect to food access and availability. There are, of course, a great many possible constraints on its accomplishment.

Not least, the successful implementation of all of the proposed interventions in Box 5.1 will require effective governments and low levels of conflict.

Section 6 considers the ability of the No Hunger-High Security Scenario to meet the goals of the African Union.

SCENARIO ANALYSIS: NO HUNGER AND HIGH SECURITY

Can Africa provide food access to all and therefore eliminate hunger by 2025 and, if so, what will it require? Can Africa produce enough food to become able, continent-wide (if not for each country or even each region), to meet the needs of a fully nourished population and not be dependent on net agricultural imports? If so, what will that require?

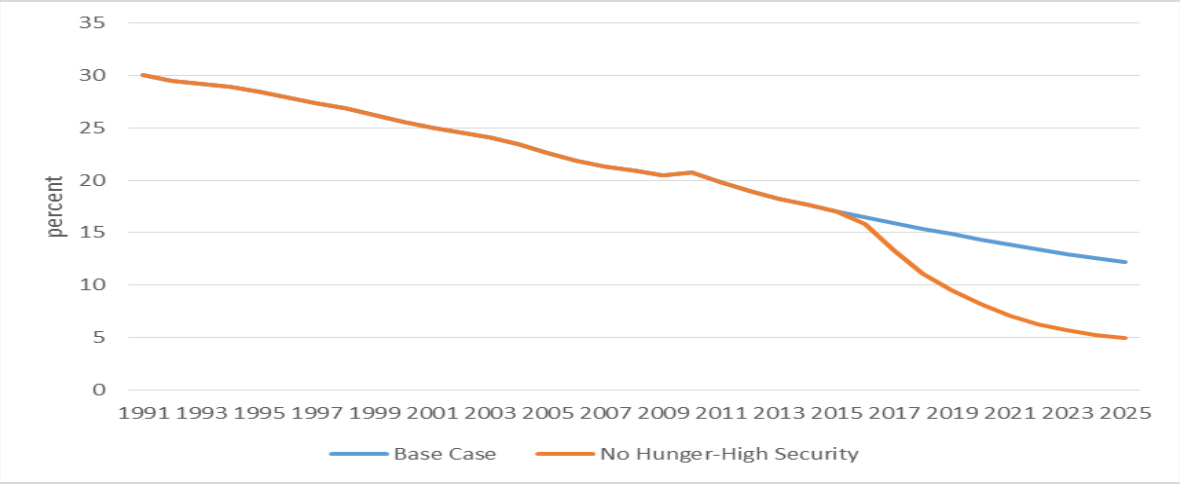
Section 4 of this report provided information on the path Africa has been on with respect to improving food access and security. Although much progress has been made, we have seen that continuation on that path will not meet the goals. Section 5 reviewed the various interventions that could be undertaken and summarized the macro-level changes in demand and supply that might be possible in the current path.

This section builds on those foundations to examine a No Hunger-High Security Scenario. We first look at what the scenario would require in terms of additional caloric intake levels and total food demand. We then turn to the supply side and explore whether high production elements of the scenario could not only support the elimination of hunger but also reduce continental import dependence. Finally, we consider regional differences with respect to the requirements and potential of the scenario.

6.1 African Food Access and Hunger

Reducing the prevalence of undernourishment to five percent or less of the African population requires a major bending of the historical path of decline. Figure 6.1 shows that path relative to the Base Case scenario.

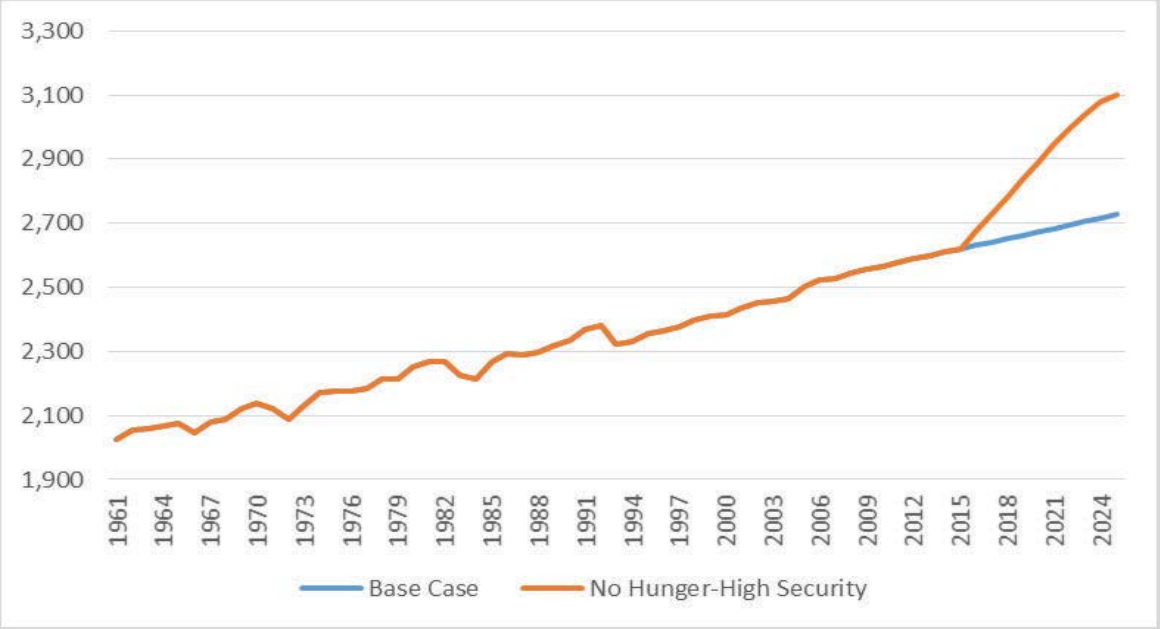
Figure 6.1: *The malnourished portion of African population, Base Case and No Hunger-High Security scenarios*



Source: IFs version 7.19, using FAO data. Interpolation used to fill some data holes.

Earlier text explained that such a reduction of hunger could be achieved with a variety of interventions, including: overcoming constraints on subsistence farming; providing transfers to low- income populations; increasing yield through seeds, fertilizer, irrigation, and soil management practices; improving land-tenure regulations; increasing overall investment in agriculture; and increasing aquaculture production. If an approach were taken that involved some income transfers but otherwise assumed the same calorie distribution, Figure 6.2 shows the calories that would be needed continent-wide. Such an increase is, of course, highly improbable if not outright impossible. The more production goes to Africans who actually need it, the more feasible a zero-hunger future will be.

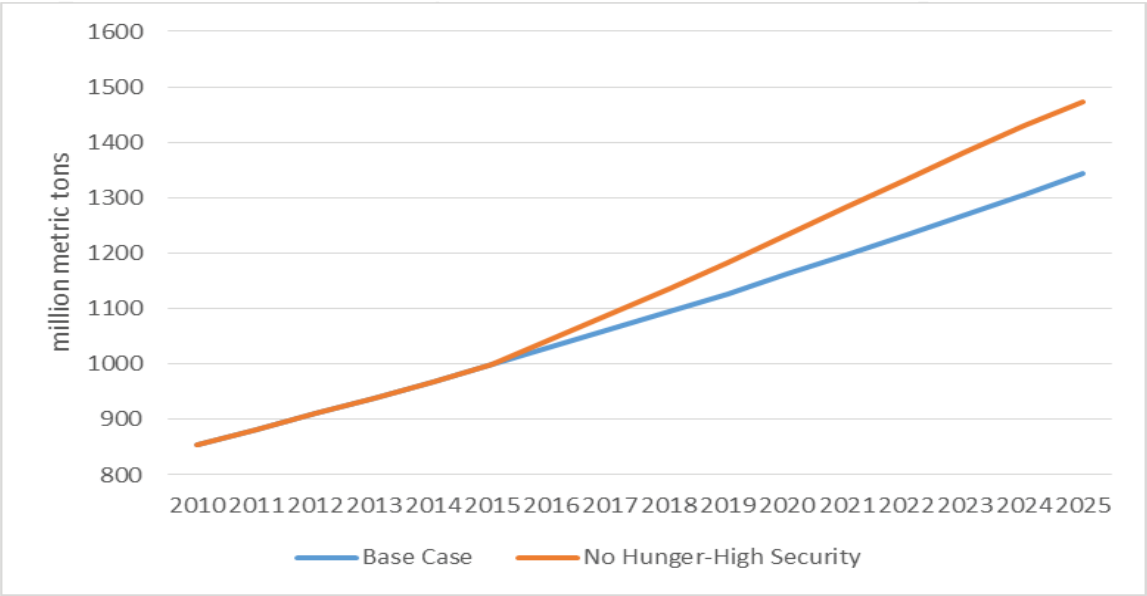
Figure 6.2: Calories per capita of the African population, Base Case and No Hunger-High Security scenarios



Source: IFs version 7.19, using FAO data. Interpolation used to fill some data holes.

Fortunately, raising calorie consumption of all constitutes an extreme upper limit. Societies would almost certainly be able to target some needy populations with direct food subsidies, for example through conditional transfers. Likewise, interventions aimed at subsistence farmers have the compound benefits of increasing food production, ensuring that it is consumed by the hungry, and alleviating poverty. Yet, especially if food losses can be reduced, even the calorie needs shown in Figure 6.2 might not require as large as expected an increase in total effective food demand/consumption. Figure 6.3 shows the increase relative to the Base Case. For Africa as a whole, it is 10% more than the Base Case in 2025 (although we shall see that East Africa would need an increase of 25%, making it a nearly impossible option).

Figure 6.3: Agricultural demand (volume) of Africa, Base Case and No Hunger-High Security scenarios

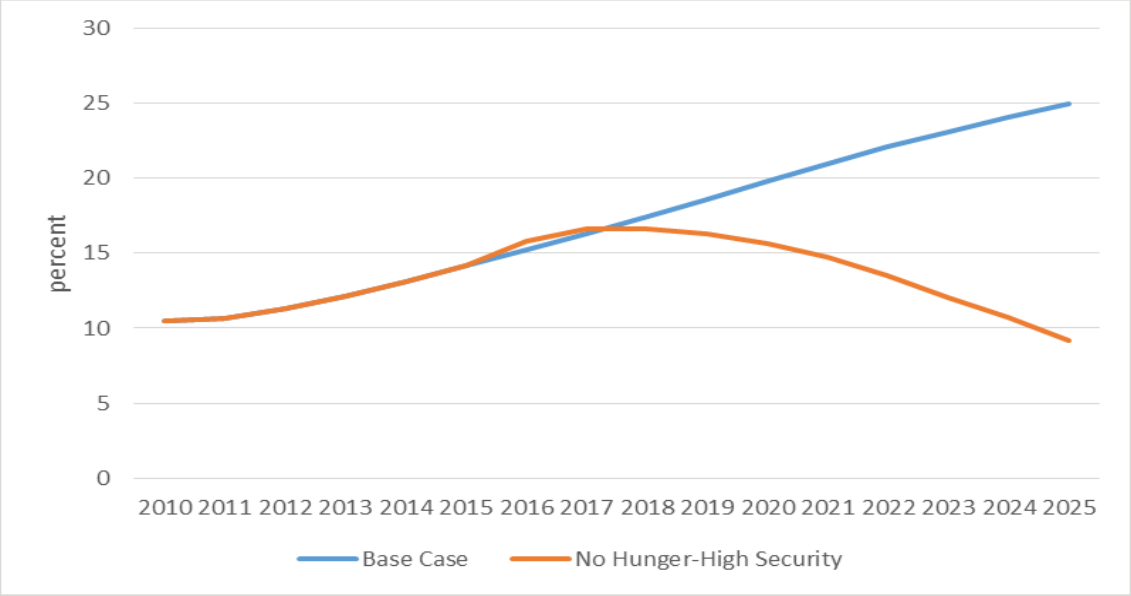


Source: IFs version 7.19.

6.2 African Food Security (Independence)

Turning to the food security side, Figure 6.4 shows again the degree to which insecurity appears on track to rise in the Base Case: net imports climb to 25% of demand. In contrast, however, in the No Hunger-High Security scenario, even in the face of a conservatively high-calorie demand level for the elimination of hunger, net imports decline very nearly to zero.

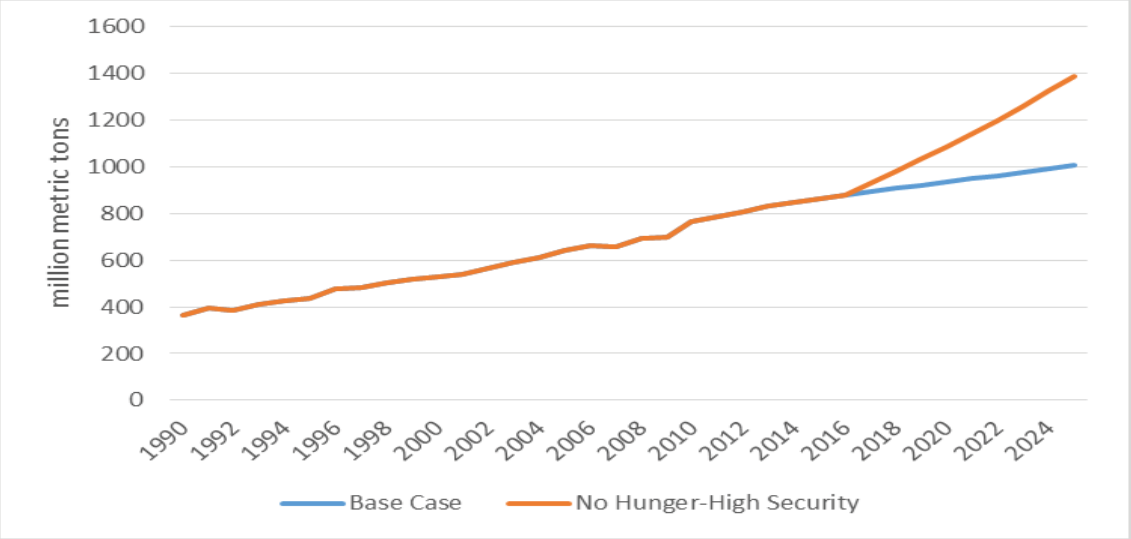
Figure 6.4: *Net Agricultural imports of Africa as percentage of demand (import dependence), Base Case and No Hunger-High Security scenarios*



Source: IFs version 7.19.

To accomplish the progression to food security, the No Hunger-High Security scenario shifts the path of production noticeably upward (Figure 6.5). Specifically, the compound average annual growth rate of production from 2016 through 2025 is 5.2%.

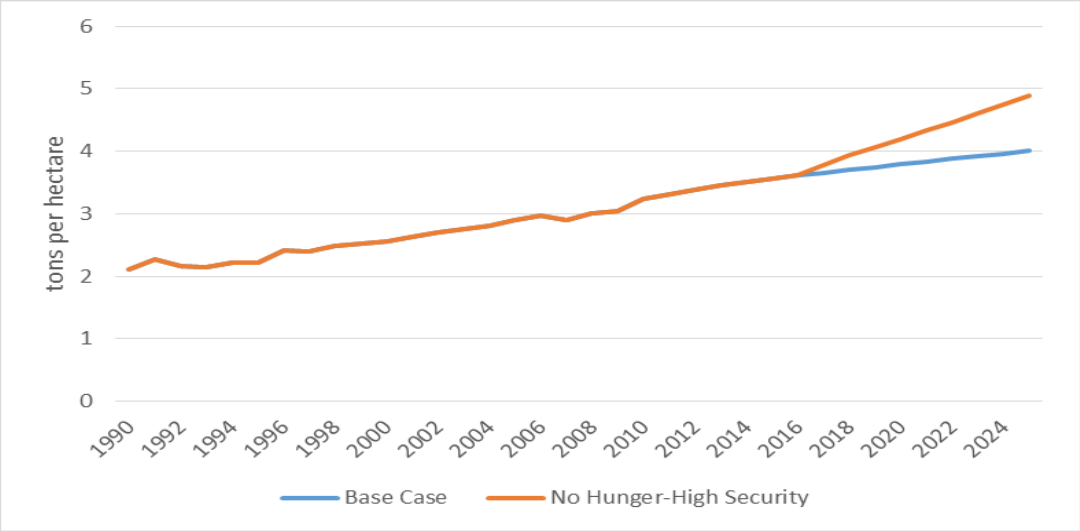
Figure 6.5: *Agricultural production of Africa, Base Case and No Hunger-High Security scenarios*



Source: IFs version 7.19, using data from FAO. Interpolation used to fill holes.

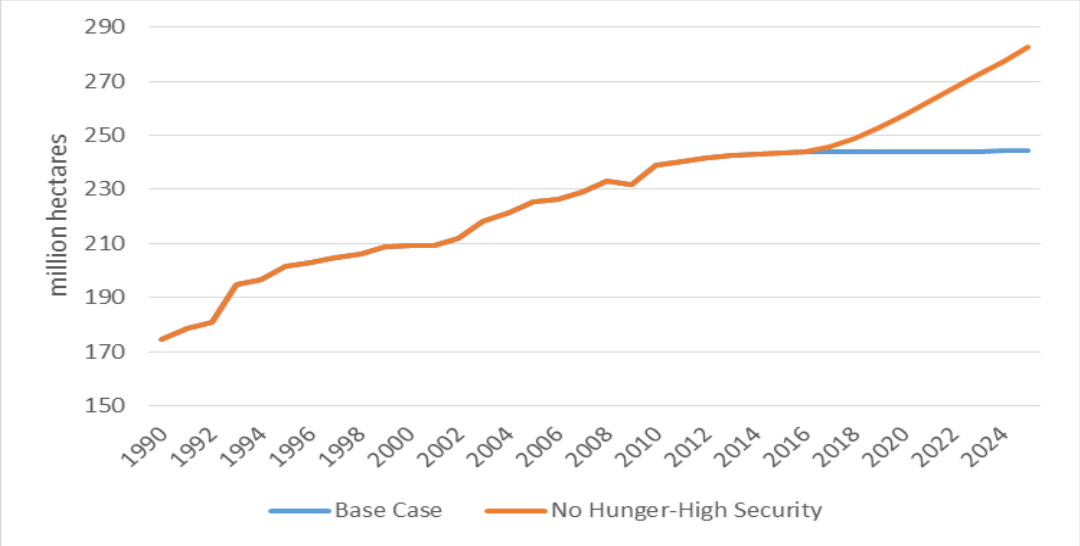
This increased production would be the result of a combination of higher yields and more land under cultivation. Figures 6.6 and 6.7 show the patterns in the two scenarios.

Figure 6.6: Agricultural yield of Africa, Base Case and No Hunger-High Security scenarios



Source: IFs version 7.19, using FAO data. Interpolation used to fill some data holes.

Figure 6.7: *Cultivated Crop Land in Africa, Base Case and No Hunger-High Security scenarios*



Source: IFs version 7.19, using FAO data. Interpolation used to fill some data holes.

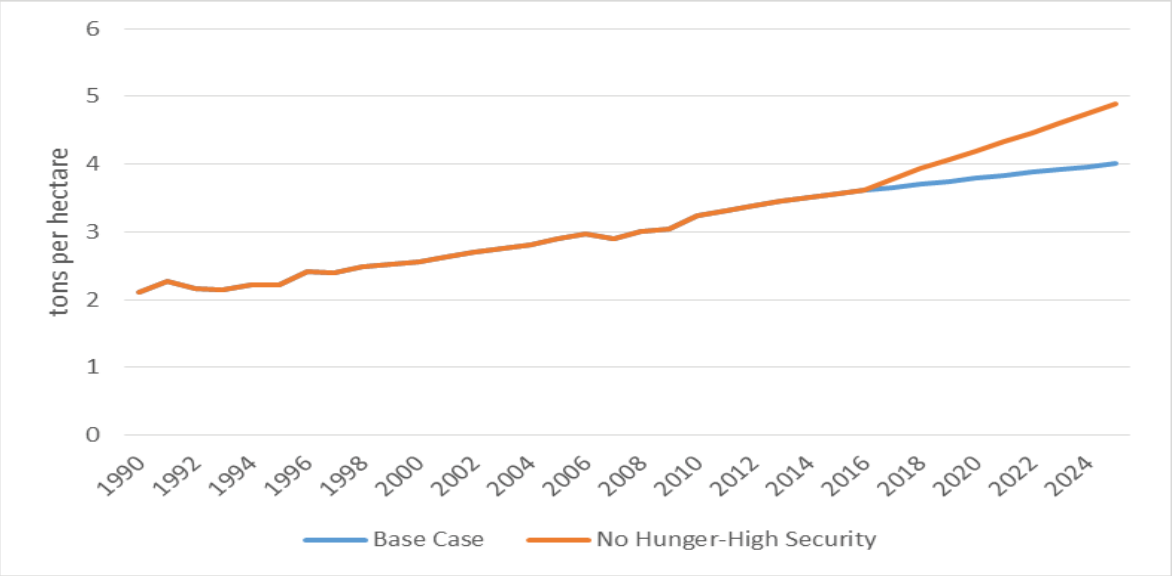
While these increases in yield and land under cultivation are aggressive, they are not impossible. The success of the Green Revolution, notably in Asia, is proof that agricultural production can increase dramatically through investment and intensification of crop production. The more difficult aspect of alleviating hunger and achieving food security is increasing food access. Eliminating hunger is about more than just increasing production; it requires that the food go to the hungry, who are also often poor. How realistic is it to increase the calorie demand required to eliminate hunger?

6.3 Regional Variation: Food Access and Hunger

Eliminating hunger in Africa will require a considerable continent-wide boost in average daily calorie consumption (Figure 6.2) if there were no change in distributional patterns. Figure 6.8 shows the incremental requirements for each region relative to the levels of the Base Case. Although none would be needed in North Africa and a relatively manageable increase would work in Western Africa,

Southern Africa will require a 15% increase, Central Africa will require an 18% increase and East Africa will require a 27% increase in calories per capita, which are already increasing in the Base Case.

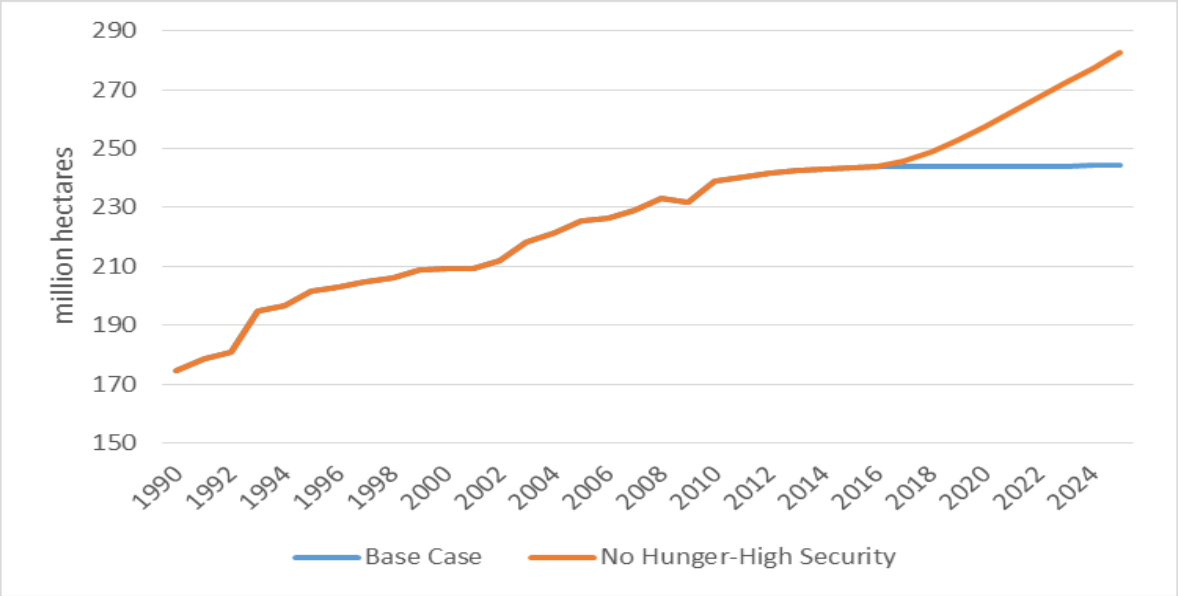
Figure 6.8: Calorie consumption in African regions, No Hunger-High Security scenario relative to Base Case



Source: IFs version 7.19.

Because the No Hunger-High Security scenario posits reductions in agricultural loss during transformation processes, the post-loss agricultural demand would not need to increase by volume as much as would the calorie consumption (Figure 6.9). Even then, of course, the needed increments on top of a rising Base Case would be daunting.

Figure 6.9: Agricultural demand in African regions, No Hunger-High Security scenario relative to Base Case

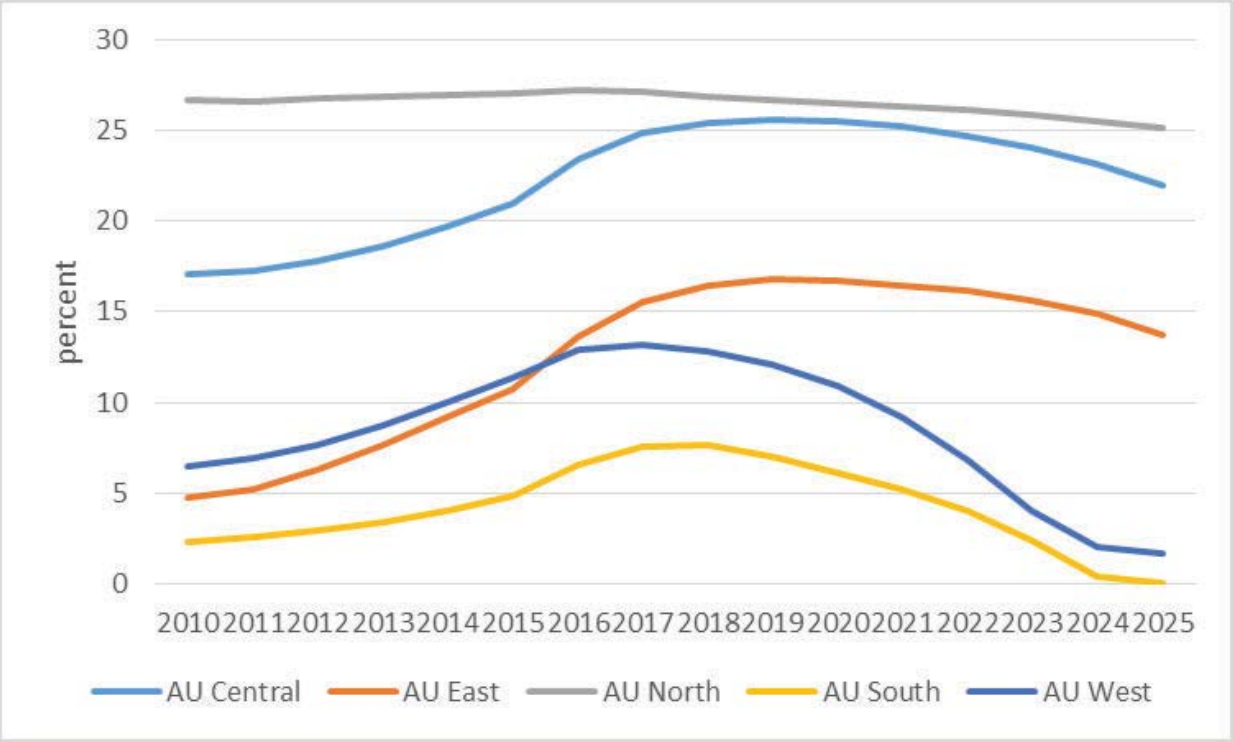


Source: IFs version 7.19.

6.4 Regional Variation: Food Production and Security

Figure 6.4 showed that the assumptions of the No Hunger-High Security scenario could allow Africa as a whole to reduce net agricultural imports by 2025. Figure 6.10 shows, however, the great variation in that reduction by region. Whereas Southern Africa might become net food independent, Northern Africa is likely to remain relatively unchanged in its high level of net import dependence, even in the No Hunger-High Security scenario. In between those extremes, Western Africa could become near net independent by 2025, while Eastern and Central Africa remain net food importers.

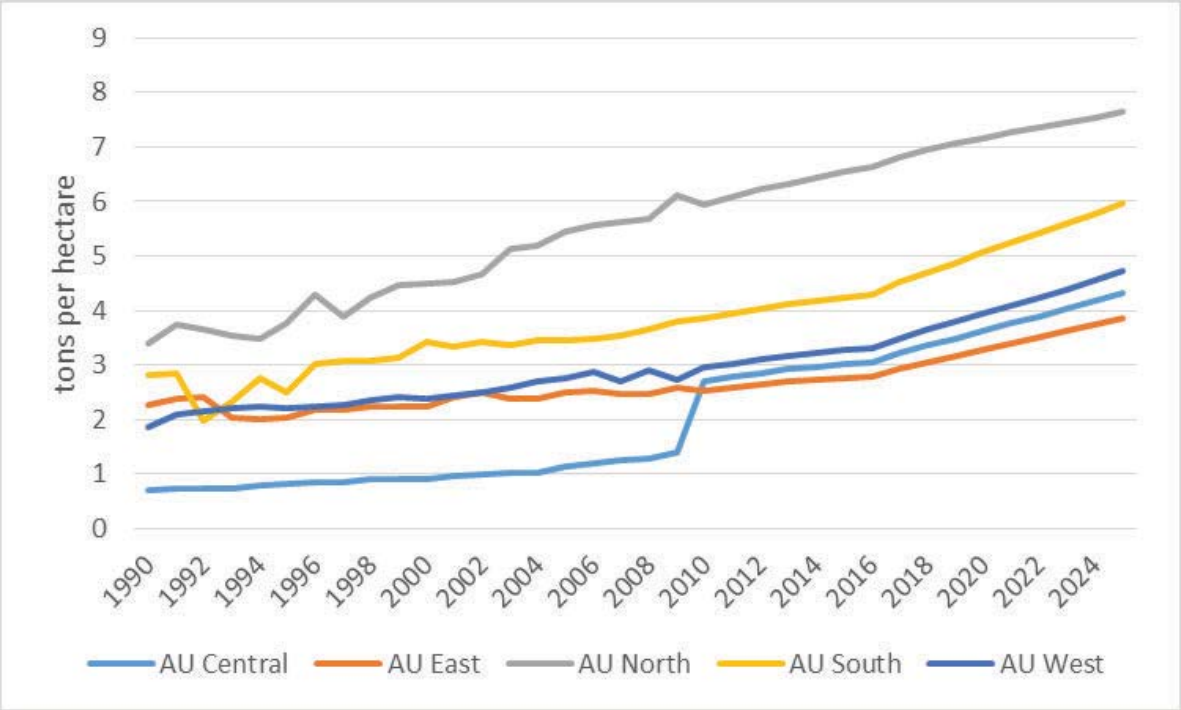
Figure 6.10: Agricultural imports of African regions as percentage of demand (import dependence), No Hunger-High Security scenario



Source: IFs version 7.19.

The movements toward import dependence depend on increasing calories per capita, but also on the ability to increase land under cultivation and especially to boost average yields. Figure 6.11 shows the yields of the No Hunger-High Security scenario. All regions increase yields rapidly compared to historical trends (see section 5.2.1 for the exact figures). Similarly, the scenario assumes increases in land under cultivation relative to the Base Case, based on the discussion of potential in Section 5. Relative to the Base Case, values for 2025 in Eastern Africa are 24% higher; those in Central Africa increase by 15%; those in Southern Africa by 14%, and those in Western Africa by 11% (see section 5.2.2 for exact figures).

Figure 6.11: Yield per hectare of African regions, No Hunger-High Security scenario



Source: IFs version 7.19. Values for Central Africa not shown before 2010 because of missing data for DRC. Other missing data estimated by interpolation.

This section has shown there are assumptions—consistent with global best practice and most- successful experience in recent decades—to support a scenario that eliminates African hunger and achieves food security for the continent. The assumptions are by no means conservative. They are very aggressive, but they are also possible.

CONCLUSION

Africa has been making progress toward eliminating hunger and reducing food insecurity, progress that has dramatically improved the lives of tens of millions of people. Northern Africa has reached the goal of reducing hunger to less than 5 percent of the population, and Western Africa has made especially great progress in reducing undernourishment since 1990.

Unfortunately, over 200 million Africans still suffer from hunger and over 30 million African children are underweight. Dependence of the continent on imports of food is on a path that could well increase. Overall, the current trajectory as forecast in the Base Case scenario of the International Futures (IFs) system, while very promising with respect to reducing rates of hunger, will not allow the continent to reach the goals of Agenda 2063 and the Malabo Declaration. Additional interventions will be required to achieve the targets.

This report has explored the potential for such interventions on both the demand and supply side of African food access and availability (and security). It did so by reviewing literature and by considering a large volume of data since 1960 from countries around the world. Based upon that exploration, our work shaped an alternative food and agriculture scenario for Africa: No Hunger-High Security.

The scenario is very aggressive, but also potentially achievable. It points to the need to increase caloric consumption by between 15 percent in Southern Africa and 27 percent in East Africa. It also shows that Africa could both satisfy increased demand and reduce net continental imports with growth in yield and land cultivation that is very aggressive, but not beyond the experience of countries around the world.

For example, China and Vietnam made enormous progress in reducing hunger and food insecurity in the 1990s and 2000s. China reduced the prevalence of undernourishment by nearly 7 percentage points from 1992 to 2001 (from 23.9 to 16.1 percent), and Vietnam saw a reduction of over 16 percentage points between 1998 and 2007 (from 34.1 to 18 percent). At the same time, however, GDP per capita was growing rapidly. From 1992 to 2001, China's GDP per capita more than doubled and Vietnam's GDP per capita increased by 64 percent.

Reaching the goals of eliminating hunger and food insecurity appears possible if Africa can increase its food supply and the accessibility of this supply to hungry segments of the population. Increasing supply is a formidable challenge; it involves many interventions, including technical ones such as improved seeds, fertilizers and irrigation.

Increasing access, however, will involve an even more complex and context-specific set of policies that can sustainably improve the purchasing power of the Africa's most vulnerable populations. Both conditional and unconditional cash transfers and direct food transfers are, of course, possible parts of the solution. Interventions aimed at producers can also help to reduce the price of food and thus increase access.

This report has provided foundational analysis at a generally macro level that clearly shows the scope of the challenges and the magnitude of the responses required. Drawing upon historical data from around the world, it has scaled the responses needed and created the No Hunger-Food Security scenario to demonstrate the potential feasibility of them. Although the report has also surveyed available literature to understand intervention points and to further support the scaling of scenario

interventions, it is CAADP, NEPAD more generally, and other African institutions and actors that have the expertise to determine what most needs to be done and how to do it.

Given the current path, reaching of the goals of eliminating hunger and food insecurity appears unlikely. A significant shifting of trajectory toward the goals is, however, very possible and very important. We have seen in the analysis underlying this foundational study the basis for much hope, and the need for much effort.

Appendix 1: FAO's Suite of Food Security Indicators57

AVAILABILITY
• Average dietary energy supply adequacy
• Average value of food production
• Share of dietary energy supply derived from cereals, roots and tubers
• Average protein supply
• Average supply of protein of animal origin
ACCESS
• Percentage of paved roads over total roads
• Road density
• Rail lines density
• Gross domestic product (in purchasing power parity)
• Domestic food price index
• Prevalence of undernourishment
• Share of food expenditure of the poor
• Depth of the food deficit
• Prevalence of food inadequacy
STABILITY
• Cereal import dependency ratio
• Percent of arable land equipped for irrigation
• Value of food imports over total merchandise exports
• Political stability and absence of violence/terrorism
• Domestic food price volatility
• Per capita food production variability
• Per capita food supply variability
UTILIZATION
• Access to improved water sources
• Access to improved sanitation facilities
• Percentage of children under 5 years of age affected by wasting
• Percentage of children under 5 years of age who are stunted
• Percentage of children under 5 years of age who are underweight
• Percentage of adults who are underweight
• Prevalence of anaemia among pregnant women
• Prevalence of anaemia among children under 5 years of age
• Prevalence of vitamin A deficiency in the population
• Prevalence of iodine deficiency in the population

APPENDIX 2: THE INTERNATIONAL FUTURES (IFS) FORECASTING SYSTEM

IFs comprises both a large database and an integrated assessment model that represents demographic, economic, energy, education, health, agriculture, infrastructure, socio-political and environment sub-models for 186 countries. IFs quantitatively formalizes the relationships within and across these subsystems, allowing us to analyze historical trends and to forecast alternative scenarios as far out as the year 2100. In this way, IFs can frame multiple uncertainties around decisions faced by policy makers. The model is housed at the Frederick S. Pardee Center for International Futures at the Josef Korbel School of International Studies, University of Denver, and it is freely available to download or use online at www.pardee.du.edu/ifs. We used Version 7.19 of IFs for this report.

The IFs database contains historical data from a wide range of large international databases provided by the FAO, the World Bank, and other organizations. Table A2 summarizes some of the key data series highlighted in this report.

TABLE A2: Key Data Series for this This Report	
DESCRIPTION	SOURCE
Prevalence of Undernourishment	FAOSTAT
Percentage of Children Underweight	FAOSTAT
Agricultural production, trade, and use	FAOSTAT and FishStatJ
GDP per Capita	World Bank
Access to Water and Sanitation	WHO-UNICEF Joint Monitoring Programme

With regards to agricultural forecasting, IFs tracks the supply and demand, including imports, exports, stocks, and prices, of three agricultural commodity groupings: crops, meat, and fish. Each of the groupings can be used directly for human consumption, used as feed or seed, processed into more refined food products, or used for industrial purposes (e.g. to produce biofuels). IFs also accounts for on-farm losses, losses between the farm gate and the final consumer, and consumer waste. At present, the only resources explicitly considered in food production are capital, land, and labor, although we have made initial efforts to include other resources including water and fertilizers. Land for crop and meat production competes with land for forests, urban areas, and other uses. Capital investment and technological trends, along with price effects, influence crop yields and, to a lesser extent, meat production.

On the consumer side, IFs estimates total per-capita calorie demand, both in total and separately for crops, meat, and fish as a function of average income and prices, with some adjustment for country- specific historical patterns. Prevalence of undernourishment is determined by actual calorie availability, which is affected by both demand and supply. For percentage of underweight children, we also consider access to improved water and sanitation, recognizing their importance for food utilization.58 The levels of access to improved water and sanitation are determined in the IFs infrastructure sub-model.

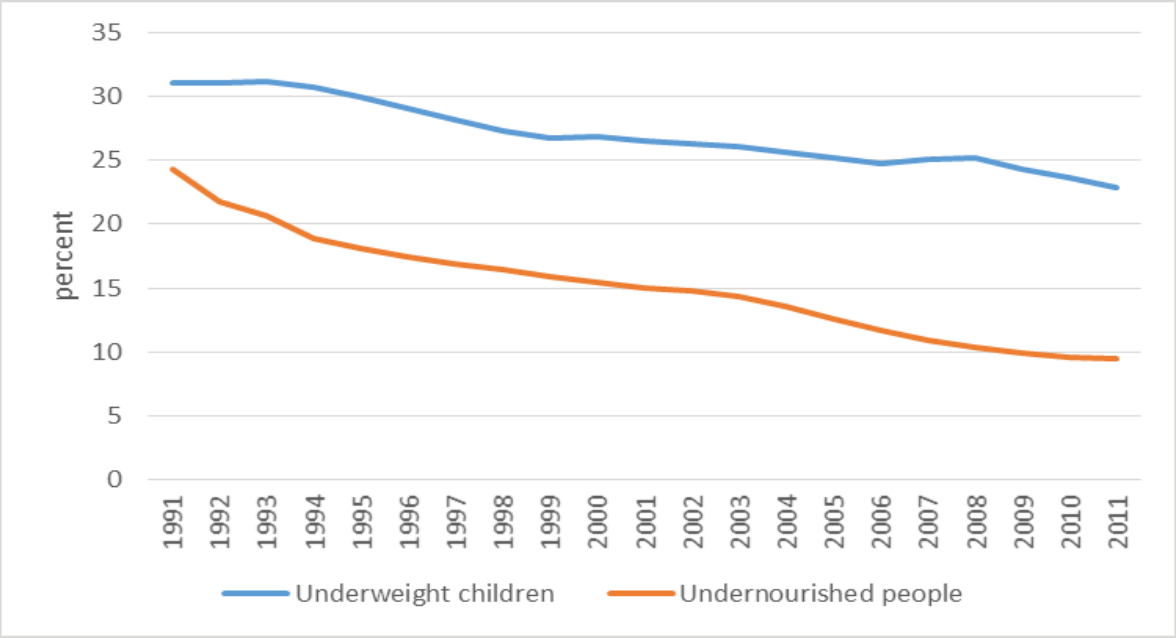
This report has made use of a previous Pardee Center research paper, "Cultivating the Future: Exploring the Potential and Impact of a Green Revolution in Africa," (Moyer & Firnhaber, 2012).

Appendix 3: Underweight Children

The rate of underweight children can be either higher or lower than that of the total population (see again Figure 4.4). The drivers of pediatric malnutrition are not identical to those that shape adult nutritional levels. Child malnutrition can be caused by undernourishment (hunger) or by the poor absorption and/or biological use of nutrients because of repeated infectious disease. Furthermore, communicable diseases can reduce the ability of the population, especially children, to absorb these calories. Addressing the prevalence of underweight children therefore can require not just increases in calories per capita but also investments in water and sanitation to reduce the spread of communicable diseases.

An illustrative demonstration of the distinction between undernourishment and undernutrition is the comparison of recent trends in hunger in Western Africa and Southern Africa. While Western Africa has made laudable progress in reducing undernourishment through agricultural production, the portion of children that are underweight for their age has not declined comparably (see Figure A3.1). In fact, Western Africa has one of the highest rates of underweight children of all African regions, despite having the second-lowest prevalence of undernourishment.

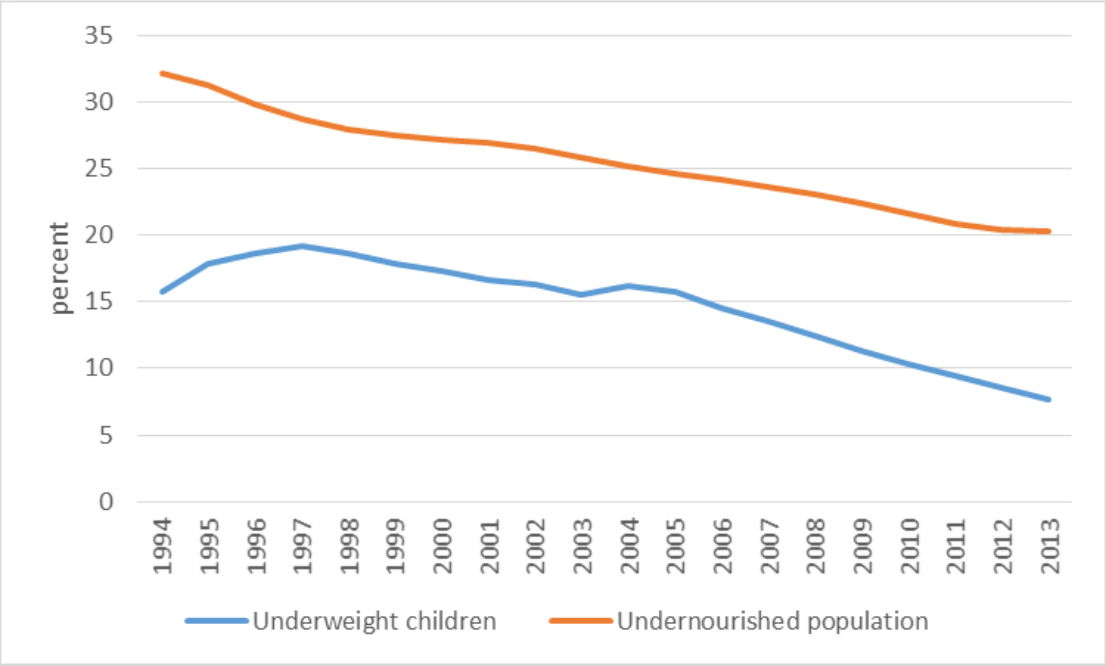
Figure A3.1: Portion of children underweight for their age and portion of the population undernourished in Western Africa.



Source: Ifs using FAO food balance sheets.

Conversely, Southern Africa has been able to reduce the prevalence of underweight children faster than the rate of undernourishment (Figure A3.2).

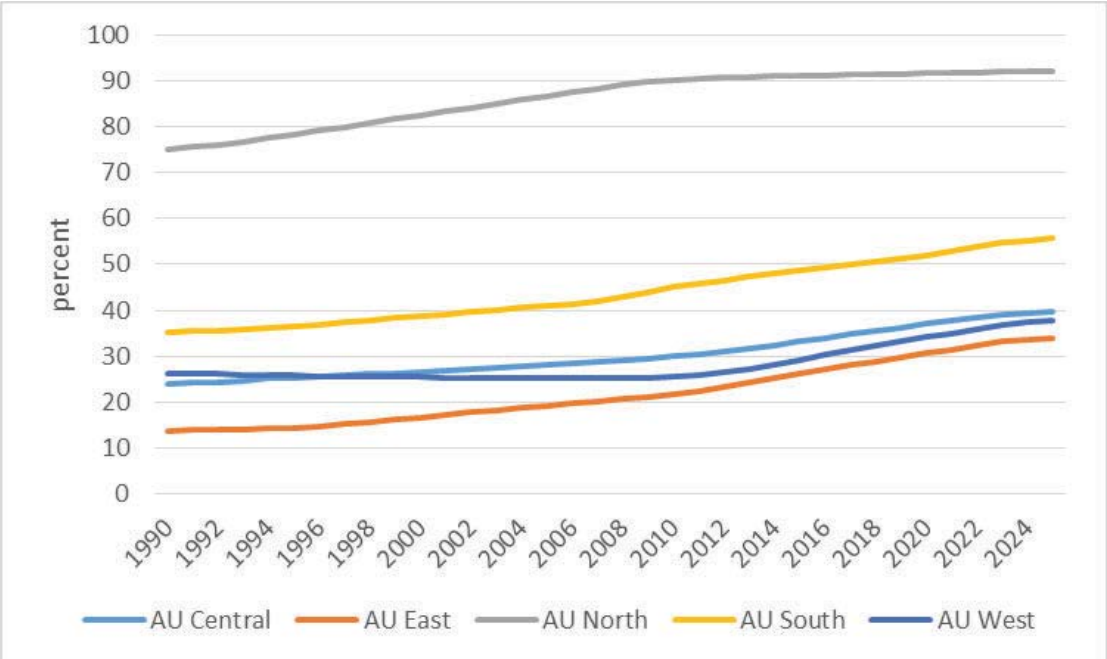
Figure A3.2 Portion of children underweight for their age and the portion of the population undernourished in Southern Africa.



Source: IFs version 7.19, using FAO data.

The more rapid decrease in undernourishment compared to underweight children in Western Africa is an indication of more room for improvement in diet, hygiene, and access to improved water and sanitation. Only 40% of people in SSA have access to improved sanitation facilities, the lowest level of all world regions. Moreover, the share of those with improved facilities has barely increased since 1990, largely due to population growth (Figure A3.3) (WHO/UNICEF, 2015).

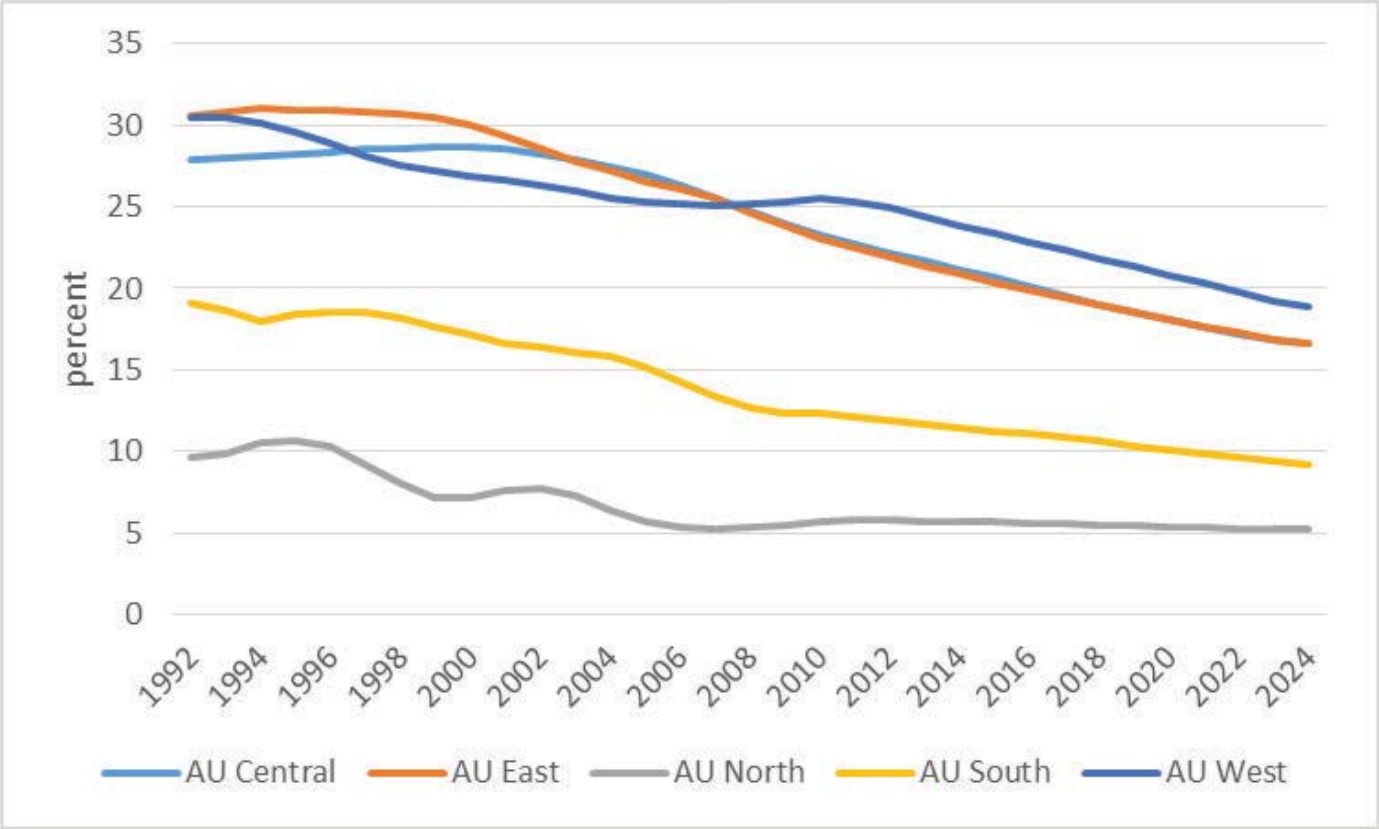
Figure A3.3: Percent of African population with access to improved sanitation facilities, history and forecast.



Source: IFs version 7.19, using data from WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. Interpolation used to fill some data holes. Five-year moving average.

The forecast for underweight children (Figure A3.4) looks quite different from the forecast for hunger (see Section 4 of this report). Northern Africa nearly reduces the prevalence of underweight children to below five percent, but Western Africa is forecast to have the highest prevalence within Africa by 2025. The AU Southern Africa region is able to reduce underweight children to below nine percent by 2025, but only reduces the prevalence of hunger to 14%.

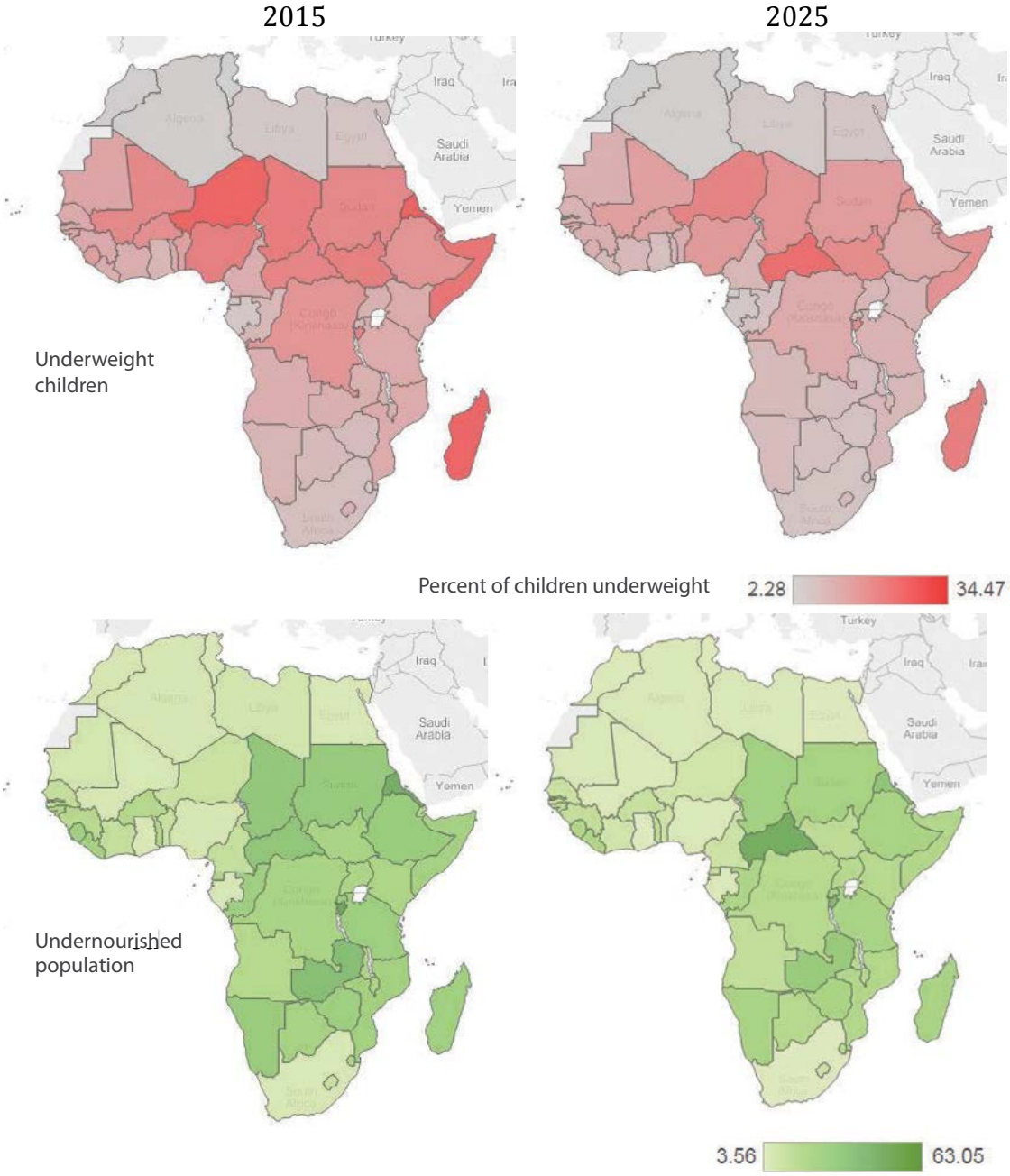
A3.4: Prevalence of underweight children, data and forecast.



Source: Data from FAO, forecast from IFs version 7.19. Interpolation used to fill some data holes. Five-year moving average.

Only six countries in Africa are on track to eliminate the prevalence of underweight children by 2025 and only two countries in the African Union are on track to eliminate both undernourishment and the prevalence of underweight children by 2025: Algeria and Tunisia.

Figure A3.5: *Prevalence of underweight children in 2015 and 2025 and prevalence of undernourished people in 2015 and 2025.*



Source: Data from FAO, forecast from IFs v7.18.

One reason Southern Africa has such a relatively low prevalence of underweight children is the relatively high level of access to improved water and sanitation facilities. The IFs model forecasts that 79% of the Southern African population will have access to improved water facilities by 2025, the highest of any African region other than Northern Africa. The model also forecasts that nearly 57% of people living in Southern Africa will have access to improved sanitation facilities by 2025 (see Figure A3.4). Western, Eastern, and Central Africa, on the other hand, are not expected to substantially increase access to improved sanitation facilities, which constrains their ability to decrease the prevalence of communicable disease and underweight children

Appendix 4: Fertility Rate Sensitivity Analysis

A number of unknowns could affect the analysis of this report. If fertility rates decline faster than expected, less food will be required to eliminate hunger. Below we explore the effects of an alternative to one of the patterns of the Base Case scenario.

In the Base Case, the African population will increase by 25% over the next 10 years, to nearly 1.4 billion people. In 2025, 17% of the world will be African. As shown in section 4 (Figure 4.5), Eastern and Western Africa are expected to grow particularly fast, partly due to high fertility rates. East, West, and Central Africa all have fertility rates above five, meaning the average woman will have 5 to 6 children in her lifetime. Compare this to the global average of 2.5. In the Base Case of IFs, fertility rates in Eastern, Western, and Central Africa are 4.2, 4.8 and 4.8 respectively in 2025.

How would a lower fertility rate affect hunger and the volume of food required to eliminate hunger?

We have created a scenario where fertility rates in Eastern, Western and Central Africa decrease to 3.5, 3.7, and 3.8 by 2025. In this scenario, the African population decreases by 27 million people by 2025, from 1.39 to 1.36 billion. This means that effective demand will need to increase by 401 million metric tons (mmt) to eliminate hunger. This is equivalent to increasing agricultural demand 8% above the 2025 value in the Base Case. In the No Hunger-High Security scenario, effective demand needed to increase by 473 mmt, or 10% higher than the 2025 value in the Base Case.

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1 Special attention is paid to the prevalence of underweight children in Africa in appendix 3.

57 FAO, IFAD and WFP. 2015. The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, FAO. Page 48.

58 The Pardee Center is currently extending the capabilities of the IFs model to forecast Severe Acute Malnutrition (SAM).

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