Agriculture and Food Policies for Better Nutrition Outcomes in Africa

Senior Policy Seminar XXII

Bringing Rigour and Evidence to Economic Policy Making in Africa

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Agriculture and Food Policies for Better Nutrition Outcomes in Africa

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About African Economic Research Consortium (AERC)

African Economic Research Consortium, established in 1988, is a premier capacity building institution in the advancement of research and training to inform economic policies in sub-Saharan Africa. It is one of the most active Research and Capacity Building Institutions (RCBIs) in the world, with a focus on Africa. AERC's mission rests on two premises: First, that development is more likely to occur where there is sustained sound management of the economy. Second, that such management is more likely to happen where there is an active, well-informed cadre of locally based professional economists to conduct policy-relevant research. AERC builds that cadre through a programme that has three primary components: research, training, and policy outreach. The organization has now emerged as a premier capacity building network institution integrating high quality economic policy research, postgraduate training, and policy outreach within a vast network of researchers, universities, and policy makers across Africa and beyond. AERC has increasingly received global acclaim for its quality products and services and is ranked highly among global development think tanks.

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Abbreviations

AERC	African Economic Research Consortium
AfDB	African Development Bank
AFPON	Agricultural, Food and Nutrition Policies on Nutrition Outcomes in Africa
AIDs	Acquired Immune Deficiency Syndrome
BMGF	Bill and Melinda Gates Foundation
BMI	Body Mass Index
CAPOD	Policy Analyst, Centre d'Analyse des Politiques de Développement'
CBN	Central Bank of Nigeria
CCI	Crop Commercialization Index
CoNA	Cost of Nutrient Adequacy
CSO	Central Statistical Office
DHS	Demographic and Health Surveys
ESR	Endogenous Switching Regression
FAO	Food and Agricultural Organization of the United Nations'
FBS	Food Balance Sheet
FCS	Food Consumption Score
FISP	Fertilizer Input Support Programme
FTLRP	Fast Track Land Reform Program
GDP	Gross Domestic Product
GHIIC	Gradient Health Improvement Incidence Curve
GIC	Growth Incidence Curves
GIMPA	Ghana Institute of Management and Public Administration
GMOs	Genetically Modified Organisms
GNI	Gross National Income
GoU	Government of Uganda
HAZ	Height-for-Age
HDD	Higher Household Dietary Diversity
HDDS	Household Diet Diversity Score
HIV	Human Immunodeficiency Virus
IAPRI	Indaba Agricultural Policy Research Institute
IHS	Integrated Household Survey
ILO	International Labour Organization
ILOSTAT	International Labour Organization Databases
ISFM	Integrated Soil Fertility Management
IWSE	Work & Iron Status Evaluation
LMICs	Low Income and Middle-Income Countries
LSMS-ISA	Living Standard Measurement Surveys – Integrated Surveys on Agriculture
MDD-W	Minimum Dietary Diversity for Women
MICS	Multiple Indicator Cluster Survey
NAADS	National Agriculture Advisory Services
NCDs	Non-Communicable Diseases

NGO	Non-Governmental Organization
PFJ	Planting for Food and Jobs
PPP	Public Private Partnership
PREPOSAM	Politiques de Sécurité Alimentaire au Mali
RALS	Rural Agricultural Livelihoods Survey
RALS	Rural Agricultural Livelihoods Survey
SMEs	Small and Medium Scale Enterprises
SPS	Senior Policy Seminar
SSA	Sub-Saharan Africa
SWC	Soil and Water Conservation
TBM	Triple Burden Malnutrition
UNDP	United Nations Development Programme
UNHS	Uganda National Household Survey
UNICEF	United Nations Children's Fund
USA	United States of America
WAZ	Weight-for-Age
WDDS	Women's Dietary Diversity Score
WDI	World Development Indicators
WHO	World Health Organization
WHZ	Weight-for-Height
WISE	Work and Iron Status Evaluation
WRA	Women of Reproductive Age
ZimVAC	Zimbabwe Vulnerability Assessment Committee

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Preface

The African Economic Research Consortium (AERC), with support from the Bill and Melinda Gates Foundation, has implemented several activities under the "Analysis of the Impact of Agricultural, Food and Nutrition Policies on Nutrition Outcomes in Africa" (AFPON) programme since 2016. The AFPON project seeks to contribute to the recent interest in leveraging agricultural development for improving nutrition by exploring the link between agricultural policies and nutrition outcomes in Africa. This research sought to link agricultural policies to these nutrition outcomes such as stunting, wasting, anemia, child mortality, micronutrient deficiencies, obesity, and malnutrition, among others. We sought to understand, among other things, how gender access to productive agricultural resources, such as land, affects the nutrition of individuals and households in sub-Saharan Africa (SSA) countries, how agricultural productivity, agricultural extension, and advisory services affect nutrition outcomes, and establishing the policies and practices that would best improve food security and nutritional status.

To help inform policy making in the continent, AERC disseminated the findings from these studies to senior African policy makers through its flagship dissemination vehicle, the "Senior Policy Seminar" (SPS). These senior policy seminars are annual forums convened by AERC that provide high level African policy makers the opportunity to come together to learn about the results of AERC research, exchange policy experiences with each other and interact with AERC researchers in an atmosphere of peers. Each seminar features the presentation and discussion of four papers related to a chosen policy theme.

AERC is hugely indebted to the Government of Nigeria for welcoming us to the country for the Senior Policy Seminar (XXII). The event was hosted in partnership with the Central Bank of Nigeria (CBN) and Hon. Alh. Sani Nanono, Minister for Agriculture and Rural Development, Nigeria was the Chief Guest. He also chaired the opening session. Gov. Godwin Emefiele, Governor, Central Bank of Nigeria was represented by Mr. Isaac Okorafor, Director, Corporate Communications, Central Bank of Nigeria, who also read his opening remarks. Hon. Otunba Adeniyi Adebayo, Minister for Industry, Trade and Investment, Nigeria gave brief remarks during the official opening session. The welcoming remarks at the beginning of the Plenary was by Prof. Njuguna Ndung'u, AERC Executive Director.

A total of 117 participants from 37 countries across Africa, including high level policy makers in the rank of ministers, permanent secretaries, members of parliament, executive directors, former ministers, governors of central banks, members of parliament, managing directors of research institutions among other dignitaries participated. The conference featured four presentations by thought leaders about Agriculture and Food Policies for Better Nutrition Outcomes in Africa. Session One on Agricultural Growth Patterns, Transformation, Health and Nutrition Outcomes in Africa was chaired by Hon. Issa-Toure Salahaddine, Deputy Speaker, National Assembly of Togo. The paper presenter

was Prof. Germano Mwabu, University of Nairobi, Kenya. This paper was discussed by Prof. Wisdom Akpalu, Ghana Institute of Management and Public Administration (GIMPA). Session Two was on Nutrition Transition and the Triple Burden of Malnutrition in Africa: Status, Determination and Economic Welfare Costs. The session chair was Prof. Akpan Hogan Ekpo, Former Director General West African Institute for Financial and Economic Management (WAIFEM). The presenter was Dr. Esi Colecraft, University Ghana. This paper was discussed by Dr. Cyrille Honagbode, Policy Analyst, Centre d'Analyse des Politiques de Développement' (CAPOD), Benin. The Third Session was on Combating Africa's Malnutrition through Food, Agriculture and Targeted Policies. This session was chaired by Hon. Onyoti Adigo Nyikwac, Minister for Agriculture and Food Security, South Sudan. The paper was presented virtually by Dr. Mekbib Haile, World Bank, USA. The discussant for this paper was Dr. Victor Ajieroh, Senior Programme Officer, Nutrition, Bill and Melinda Gates Foundation (BMGF). The presenters produced high-quality papers, and the participants were very active, thus enabling us to produce the seminar's policy recommendations that were shared with other African policy makers who did not find time to take part in this event.

We are grateful to all those who made the seminar a success. Dr. Innocent Matshe, Director of Training, who made valuable input into the preparation and implementation of the seminar. In equal measure, AERC appreciates the hard work of Sandra Coyle, Chief Communications Officer, Dr. Charles Owino, Publications Manager, Juffali Kenzi, ICT Manager, and Edith Mutui, Communications and Publications Assistant in organizing the event. AERC also acknowledges with thanks Dr. Wilson Wasike, Collaborative Research Manager and Dr. Mark Korir for their role as rapporteur as well as Pamela Kilwake, Joel Mathia, Susan Miyengi, Margaret Mwangi and Jackson Nganga who assisted with logistics. To these, and the many others who were involved, AERC extends its heartfelt appreciation.

Prof. Njuguna Ndung'u
Executive Director
African Economic Research Consortium (AERC)

Agricultural Growth Patterns, Transformation, Health And Nutrition Outcomes In Africa

David E. Sahn

and

Germano Mwabu

Introduction

A strong connection exists between the process of structural transformation in an economy and the nutritional status of the population. In the case of the food and agricultural sector, structural transformation involves technological change and innovations that lead to increased efficiency and productivity. The structural transformation in the agricultural sector does not only affect food output and markets but is also a crucial driver of the growth in other sectors of the economy, such as the manufacturing and services sectors, and thus, all aspects of the modern economy. Simply stated, structural transformation in agriculture is needed to ensure the availability of plentiful and low-cost wage goods, particularly food, which enable the process of urbanization and industrialization, there by achieving the goals of income growth and poverty alleviation. Although economic growth and poverty alleviation are certainly the main motivations of economic policy that promote structural transformation in the agricultural and food sector, this paper takes a slightly narrower perspective and instead examines the role of structural transformation in agriculture in terms of its relationship to improving nutritional status.

Five central, desirable characteristics of structural transformation of an economy are:

- A declining share of agriculture in the gross domestic product (GDP), which reduces the importance of land relative to capital in GDP growth, but not the importance of agriculture in the economy;
- increased capital intensity in urban areas, which encourages population movements from rural areas to towns, as agriculture sheds low productivity jobs, and as the industrialization process takes root;
- the growth of employment and output outside agriculture, particularly in the service sector, but more importantly, in manufacturing;
- a general improvement in population quality due to better health and nutrition; and
- a decline in early mortality and, subsequently, birth rates, which are key to demographic transition and to reaping the “demographic dividend”, i.e., growth due to an increase in the working-age population, ceteris paribus.

There are many important caveats and qualifications to these features of structural transformation; perhaps it is most important that agriculture’s decline in terms of GDP is not to be confused with the notion that agriculture does not continue to play a leading role in economic growth both during the transitional phase, and in a fully modernized phase of the economy. To the contrary, the success of the transformation process is predicated on productivity increases in agriculture, such that the sector is increasingly in competition with non-agricultural enterprises.

The importance of the evolution of the agricultural sector and overall food system goes beyond the general equilibrium effects that ripple across the economy as the transformation occurs or afterwards. Of particular interest here is the concern over its impacts on nutrition as patterns of production and systems of food processing and marketing evolve. This is the central concern of this paper and is particularly relevant during the transitional process from more traditional, low productivity labour-intensive agriculture dominated by smallholders and weak market linkages, to a more capital-intensive, technologically advanced farming phase. Inevitably, there are winners and losers because of the process, both in the short- and long-term, as measured in terms of nutritional risk. Understanding who these nutritionally vulnerable groups are requires an appreciation of the agricultural and food system as a source of income and employment, as well as its effects on food availability and food prices. Further, this paper is concerned with the critical role of policy in terms of guiding the structural transformation in agriculture to help realize multiple development goals, including the affordability and availability of a diverse low-priced food supply, a safe diet of high quality, and rural income growth and time savings of a highly constrained population, especially vulnerable groups like women and children. Superimposed on this analysis is the imperative of minimizing the stress on fragile ecosystems in Africa and fostering the goal of environmental sustainability and resilience.

Using agriculture share in GDP as evidence of transformation, African economies have entered a transitional phase, albeit at a slower pace than has been observed in other regions of the world. Commensurate with more disciplined fiscal and monetary policy and progress in terms of reducing hyperinflation and accompanying overvalued exchange rates and parallel markets, foreign investment is increasing, and many African countries are among the most rapidly growing economies in the world. Although GDP growth has accelerated, as predicted, agriculture's share is on the decline. Specifically, the share of agriculture, forestry, and fishing, as a share of GDP, has been between 16 and 17 percent in the 2010s, in contrast to being between 20 and 25 percent in the last decade of the previous millennium. Also, the share of the labour force in agriculture is on the decline, as economies throughout the continent are diversifying and labour is rapidly moving to cities and towns. Employment in agriculture as a percentage of the total is around 26 percent, down from around 44 percent in 1990. The urbanization rate is currently around 40 percent, up from around 20 percent in 1980, and this rate is expected to reach 70 percent by 2050. Although agricultural growth in Africa lags many other regions of the world, it has been more robust since the turn of the millennium, markedly exceeding rates of the previous decades (World Bank, 2017). In fact, between 2005 and 2010, agricultural growth averaged around 4 percent per year. Consequences of the improved economic performance, especially agricultural GDP, are that poverty rates are falling and other non-monetary measures of well-being, such as levels of education, are increasing rapidly, despite quality concerns. Likewise, infant and child mortality rates are witnessing dramatic declines. For example, infant mortality fell by more than

half, from 108 in 1990 to 51 in 2017, per 1,000 births. The rate of improvement in health indicators accelerated over this period. For example, the rate of decline in under-five mortality more than doubled between the last decade of the 20th century and the first decade of the current millennium.

There is also evidence that fertility rates are beginning to fall, in keeping with expectations that economic development contributes to the demographic transition accompanying structural transformation. The fertility rate fell from 6.8 in 1980 to 4.9 in 2015 (UNDP, 2017). This gives rise to the potential for a large demographic dividend, like what has been previously observed in Asia. However, this potential is predicated on enlightened policy, including food production, marketing and trade policies that foster the availability of moderately priced wage goods, particularly, in terms of a diversified food supply. Additionally, while fertility rates are declining globally, Africa's population continues to grow rapidly and will likely do so for decades. In 1980 there were 376 million Africans and over 1 billion in 2015. Projections are that Africa's population will be nearly 2.5 billion people by 2050. This clearly represents a formidable challenge in terms of feeding the rapidly expanding population and has important implications for both the level of investment and technological progress, as well as related trade and economic policies that will be required to forestall large food shortages.

Another important consideration is that the cautious optimism concerning the process of transformation of Africa is tempered by the fact that statistics about the continent overall mask the poor performance of many individual countries on the continent, most prominent of which are those that have been mired in conflict and adversely affected by failed governance and acute economic distortions. The heterogeneity in performance is to be expected, given the size and diversity of the continent and its large number of nation states. In fact, that heterogeneity exists not only between countries but within countries, where the process of structural transformation is characterized often by large differences between regions and communities. Innate geographic and natural resource endowments are partially the explanation for within-country inequalities in the pace of structural transformation; there is still an important role of policy to address these regional inequalities.

It is with this broad perspective in mind that the remainder of this paper aims to provide a better understanding of and guidance on addressing the challenges associated with structural transformation in agriculture in Africa, with a focus on the effect of this transformation on nutrition outcomes. The intent is to inform the channels through which agriculture and related food systems policies impact nutritional outcomes in Africa, and to provide both guidance and context for the research in this field.

Structural transformation and under-nutrition: The evidence

We first turn to a discussion of the evidence from Africa on the extent of progress in terms of reducing malnutrition and, second, on the relationships between GDP per capita, agricultural growth, poverty alleviation and nutritional outcomes. Of particular interest are issues such as whether the evidence suggests that economic transformation and, more specifically, the agricultural and food system has and will contribute to improvements in the nutritional status of the population.

A quick perusal of the most recent statistics suggests that stunting among children under the age of five in Africa is on the decline, from 38.3% to 30.3% prevalence between 2000 and 2017 (Table 1), but the number of stunted children is on the rise. While progress in the proportion of stunted children is noted in all regions of Africa, it is slowest in southern Africa and most rapid in eastern Africa. More noteworthy is that improvements in nutritional status in Africa has been substantially slower than in Asia, particularly, but by no means in only Eastern Asia, where levels of stunting fell from 19.2% to 5.3% in 2017.

Table 1: Stunting – regional numbers of children affected and respective shares in total

	2000		2017	
Region	**millions**	**Share of total**	**millions**	**Share**
Africa	50.6	38.3	58.7	30.3
Eastern Africa	21.5	45.7	23.9	35.6
Middle Africa	7.1	40.2	9.3	32.1
Northern Africa	4.9	23.8	5.0	17.3
Southern Africa	2.0	33.1	2.0	29.1
Western Africa	15.1	36.9	18.6	29.9
Asia	134.6	38.1	83.6	23.2
Latin American and the Caribbean	9.7	16.9	5.1	9.6
Oceania	0.4	36.8	0.5	38.1
Australia and New Zealand	0.0	--	--	--
Europe	--	--	--	--
North America	0.7	3.0	0.5	2.3

Source: UNICEF, WHO and World Bank (2018: 12)

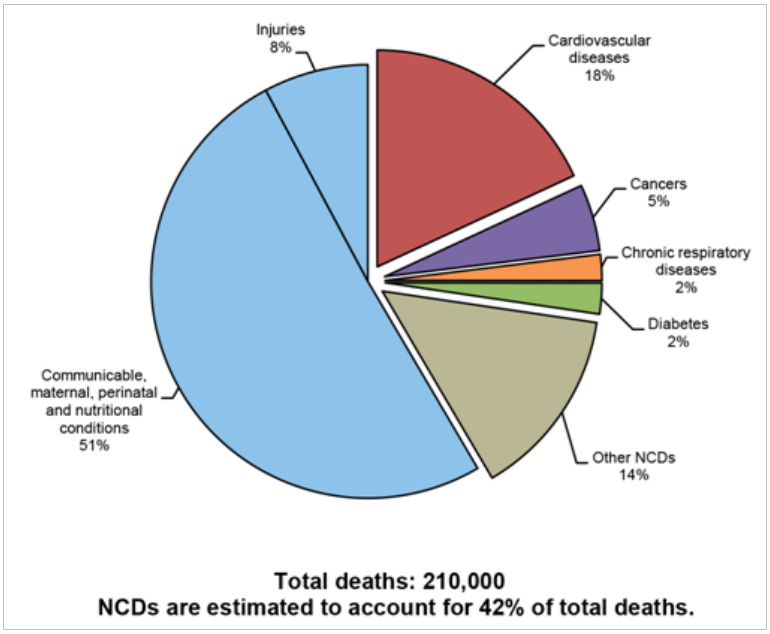
The qualitative story in terms of magnitudes and changes is similar for other nutritional indicators, such as the prevalence of underweight and wasting (low weight-for-height). As observed throughout the world, wasting prevalence, a measure of acute episodes of malnutrition, among children under five years of age is much lower, afflicting approximately one quarter as many children as stunting or chronic malnutrition. Similarly, there are some differences in the regional dimensions of the problem, most notably that wasting prevalence is half the magnitude in southern Africa as in West Africa, while prevalence rates are very similar for stunting. As we will discuss further, this is expected given the differences in the nutrition production functions and diversity of policies for addressing different types of malnutrition.

There are, however, a myriad other types and indicators of malnutrition that go beyond what are regarded as the best indicators of overall health, as particularly captured by stunting. Of particular concern are micronutrient deficiencies, which have profound functional implications and other potentially devastating health impacts. Much of the early attention to micronutrients was focused on European populations; as various policies and interventions reduced the severity of these micronutrient deficiencies in higher income countries, the sense of urgency about their global dimensions receded. Thus, although much has been learned regarding the relationship between micronutrient deficiencies and disease and disability as far back as the 19th century, a renewed sense of urgency has emerged during the past couple of decades when advocates, concerned with the health of low-income populations, have branded widespread micronutrient deficiencies, especially of vitamin A, iodine, and iron, as "hidden hunger." We find this label an odd one insofar as the physical manifestation of several of these deficiencies, especially when more acute, such as goitre from iodine deficiency and blindness or Bitot's spots[1] from Vitamin A deficiency, are often quite manifest. Of course, the overt signs of these deficiencies are not always present; this can also be said of stunting and other forms of chronic malnutrition. Thus, any discussion of the relationship between the transformation of the agricultural and related food system and its impact must accord attention to the devastating toll of common afflictions, such as iron deficiency, which affects more than one and a half billion people worldwide (WHO, 2008). Hardest hit are preschool-aged children, for whom prevalence rates are estimated at 47 percent. Forty-two percent of women worldwide are also iron deficient. Regional estimates indicate an even worse picture in Africa where two-thirds of pre-schoolers suffer from anaemia. The prevalence rate of anaemia among pregnant women is 57%. Vitamin A deficiency similarly affects 250 million preschool-aged children, resulting in blindness estimates of between 250,000 and 500,000 children, and among them, half die within a year of losing their vision (WHO, 2016). Iodine deficiency disorders, which contribute to cognitive impairment among children, afflict nearly 30 percent of children, or around 240 million children worldwide. Among these children, around 5 percent have intakes that are severely deficient (Andersson and Zimmermann, 2012).

1 Bitot's spots are the build-up of keratin located superficially in the conjunctiva of human eyes.

While the persistence of various types of undernutrition continue to challenge policymakers in Africa, one of the consequences of prosperity and a globalized food system that accompanies structural transformation is the marked change in the availability and prices of, as well as preferences for, food. This, in turn, has contributed to the global epidemic of overweight and obesity. Over 2 billion people over the age of 18 are estimated to be obese or overweight; this problem, in sheer numbers, afflicts more than two times the number of people suffering from insufficient calorie intake. The number of obese and overweight individuals has more than doubled between 1980 and 2014.Although this problem is still largely concentrated in middle- and upper-income countries, low-income countries and the poor are not immune to this affliction, which is strongly associated with the growing epidemic of noncommunicable diseases (NCDs), such as cardiovascular disease, diabetes, and cancers. Similarly, although the problem of overweight and resulting deaths is concentrated in adults, the problem cuts across all demographics, including children under the age of five. In Africa, the number of overweight and obese children increased from 5.4 to 10.6 million between 1990 and 2014 (WHO, 2017). Globally, one in four obese children live in Africa. Certain countries have been particularly hard hit by this growing epidemic. For example, in southern Africa there has been a 33%increase in the share of overweight children, from 10.3% to 13.7% between 2000 and 2017, respectively (UNICEF, WHO and World Bank, 2018). Consequently, throughout the continent, NCDs, much of which is related to malnutrition, is increasingly the cause of mortality. Figure 1 for Ghana illustrates this well – in 2014, 42% of deaths were a result of NCDs.

Figure 1: Causes of mortality, Ghana, 2014



Source: Sahn (2015)

For policymakers, the challenge of addressing overweight and obesity is complicated. Perhaps most important is that overweight and undernutrition are linked in complex ways. For example, there is compelling evidence that early childhood undernutrition contributes to later life obesity, as explained by the expression of the thrifty phenotype hypothesis (Barker1992, 1998a, 2008b). This has been widely discussed in the literature and provides the biological explanation for how the same (i.e., under-nutrition) in utero and early childhood stress may lead to the stunting of an individual as a child and to an increase in the risk of overweight and obesity in that individual as an adult. Thus, there are strong links between undernutrition and overnutrition, providing evidence on the role of early childhood experiences in adult health and their deleterious impacts across the life course. As such, all the dimensions of malnutrition discussed in this paper are part of a complex aetiology, often with competing agents, interest groups and constituencies, as well as conflicting goals and policy prescriptions. And, more specifically, this complexity sets up difficult challenges in how the underlying process of structural transformation, as related to the agricultural and food sectors, can be better understood, and made to contribute to improvements in the nutritional status of the population.

The role of economic growth

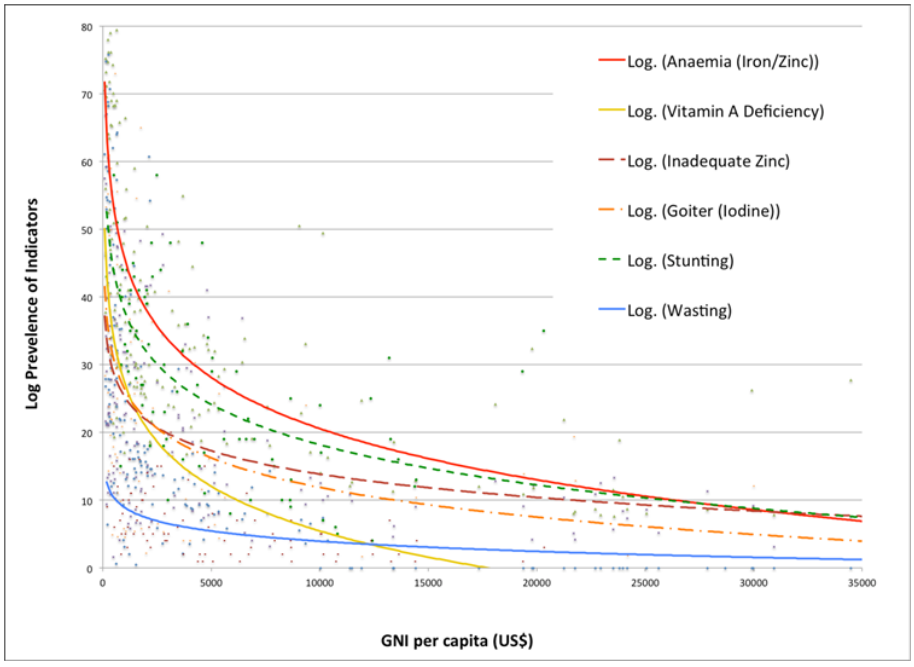
Two fundamental questions underlie concerns with the role of agriculture in improving nutritional outcomes. The first is about understanding the relationship between economic growth and nutritional outcomes. The second is whether there is anything distinguishing the impact of growth and structural transformation in the agricultural sector from that of growth in general. That is, does the source of growth, at least in terms of agriculture versus non-agriculture, matter for nutrition?

To address these questions, we can begin with some stylized facts from cross-country evidence. Figure 2 shows a strong relationship between gross national income (GNI) per capita and levels of malnutrition.

As can be readily seen for countries in Africa, this negative relationship is strong and consistent for stunting, wasting and a range of micronutrient deficiencies. Similar studies that incorporate data from other regions of the world show the same pattern.

The association in Figure 2, however, may not be interpreted causally. It is possible that the same factors that promote GDP growth also co-determine nutritional outcomes. If economic growth and nutrition are jointly determined by other exogenous variables, then it is not increasing income that is causally determining these improvements in nutritional status. Additionally, there is the prospect that causality runs from better nutrition to economic growth. This would be consistent with the large literature, discussed later in this paper, about the productivity-enhancing power of improving nutritional status. That is, there are a range of pathways through which better nutrition can impact economic growth, most important of which are mechanisms related to improved cognitive outcomes and physical stamina and strength.

Figure 2: Associations among income and malnutrition indicators



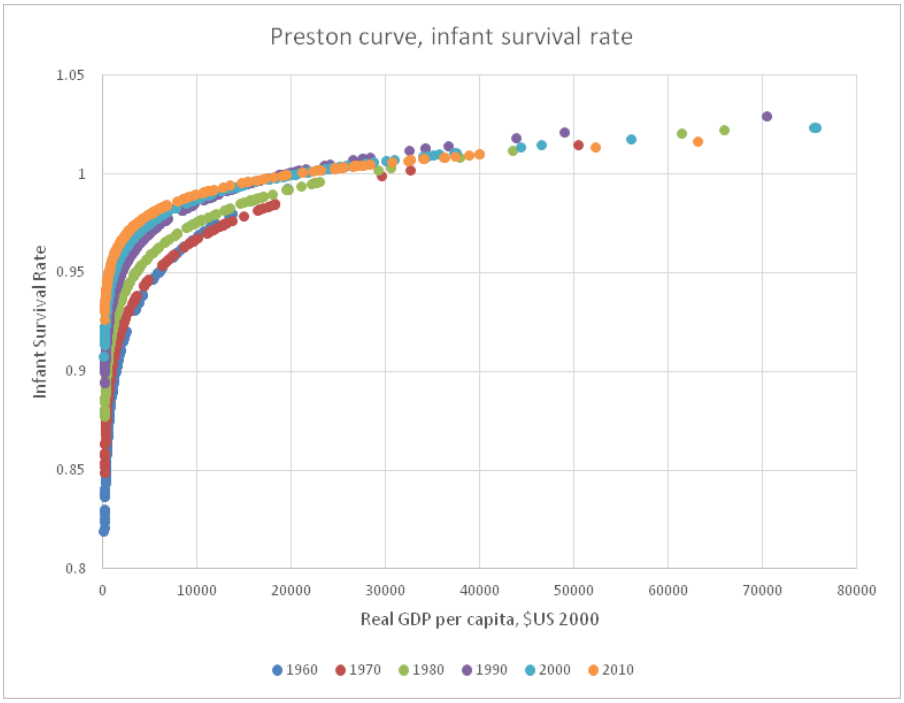
Source: Barrett and Bevis (2015: 63)
Data sources: GNI data from World Bank (2014); anaemia, vitamin A and zinc indicators from United Call to Action (2009); goitre data from World Health Organization's Iodine Status Worldwide 2004 (WHO, 2004); stunting and wasting data from UNICEF (2013)

Several studies have endeavoured to explore the extent to which increases in incomes are causally related to nutrition, over what time horizon and through which mediating variables. The findings of this research paint a conflicting picture. Some studies, such as Haddad, Masset, and Smith (2015); Ruel et al. (2013); and Headey (2013), suggest that growth will contribute greatly to the reduction in malnutrition over the long-term. For example, Haddad, Masset, and Smith (2015) reported the long-term elasticity of stunting with respect to growth in GDP per capita to be -0.63. This high elasticity may in fact be explained if, over the long-term, structural transformation and the resultant increase in GDP improve education, infrastructure, government revenue, spending on social services, and so forth, which in turn contribute to better nutritional outcomes. In fact, the curve shown nearly captures this long-term picture, but it says little about nutritional impacts of short-term improvements in material levels of living.

One way to illustrate the complexity of these possible outcomes is with a similar graph, but in this case, we show the curves estimated by decade. Figure 3 illustrates a secular improvement in infant survival for any given level of real GDP per capita. That is, the relationship between real GDP per capita and the level of stunting is not

constant, meaning other factors not captured by GDP affect infant survival, and these factors have contributed to improvements over a constant level of real income. These improvements may be explained by a range of factors, including health technology, access to and quality of health services, the impact of better education, cognitive skills, and knowledge, and even the distribution of income and related services provided by the state and non-state actors.

Figure 3: Preston curve of infant survival rate vs. real GDP per capita



Source: Sahn (2019), computation based on World Bank Indicators data set

Figure 3 raises the question as to what the short-term elasticities of health improvements are with respect to increases in economic growth. Clearly, it is difficult to infer the impact of short-term economic growth on nutrition from long-term elasticities. Therefore, several recent studies have set out to determine shorter-term impacts. Here, the evidence is much more modest in terms of the benefit of economic growth. A recent paper by Smith and Haddad (2015) estimated a short-term elasticity of -0.17, which is quite close to the work of Alderman et al. (2013) that reported a doubling of GDP per capita would reduce stunting by 14.8 percentage points and reduce the share of children who are underweight by only 11.4 percentage points, implying an elasticity of only -0.11. Alderman et al. (2013: 52) concluded: “The overall

takeaway finding from this analysis is that growth has in and of itself little impact on reducing chronic malnutrition," which is consistent with the report of Subramanyam et al. (2011), who found that state-level rates of malnutrition are only weakly related to economic growth.[2]

The above finding can be explained partially by the absence of inclusive, or pro-poor, growth, now well documented in the literature (AfDB, 2012; Ravallion, 2004). Quite simply, the benefits of economic growth have often left behind those at the lower end of the welfare distribution.

Another potentially related explanation for the sobering estimates of how growth will impact nutrition has to do with the pattern of growth; specifically, the question is whether economic growth in certain sectors, particularly agriculture, is more likely to lead to reductions in malnutrition. Indications here are at best ambiguous, as discussed by Headey (2012), who pointed out that many factors will affect the strength of the relationship between agricultural growth and malnutrition. These include the extent to which food insecurity is a problem, and the fact that agricultural growth does increase food availability. If such circumstances exist, there is a likelihood that growth in the agricultural sector will reduce malnutrition more than in the case of non-agricultural growth. This makes sense to the extent that low-income households have deficits in calorie consumption and that the malnourished live in households that are disproportionately reliant on domestically produced food. The countervailing possibility is that, as Headey (2012) pointed out, non-agricultural growth may have a larger impact on dietary diversity through, for example, the increasing reliance on food markets with a greater range of products than in markets with primarily locally grown foods.

There is also reason to expect that the underlying economic conditions, such as the extent of income or land inequality, are important in terms of determining how sector-specific growth patterns affect nutritional outcomes. Similarly, Fan and Brzeska (2012) pointed to the fact that it is not whether growth is in the agricultural sector per se; it is a specific farm sector that matters. For example, growth in staple crops will have a different impact on nutrition than the growth of the livestock subsector. And depending on the nature of the nutrition problems that are prioritized, it may be that subsectors like fruits and vegetables, that supply micronutrients such as vitamin A, may be of greater importance that more calorie-rich crops, which may be more important when stunting and underweight are the main nutritional problems.

Another consideration in terms of nutritional impact of the subsector is whether growth is concentrated in export crops versus those grown primarily for domestic consumption. Also, the impact of growth on nutrition may differ, depending on

2 Neeliah and Shankar (2008) came to the same conclusion and argue for the importance of targeted interventions.

whether it is poor or rich farmers, or the disadvantaged regions of the country, that enjoy the direct benefits of agricultural productivity growth. Even if there is a focus on crops commonly produced and consumed domestically by the poor, there are other considerations that impact the extent to which agricultural growth will improve nutritional outcomes. These include the nutritional value of the food, the nature of food processing, and safety along the entire value chain. These considerations highlight the importance of policies designed to guide the process of agricultural transformation just beyond the narrow objectives of raising productivity, but also to agricultural research that prioritizes nutritious staple crops, fosters consumers' abilities to make informed choices about healthy foods, and even a study of related issues, such as the impact of technology on water resources, including diseases such as hookworm, and the more general issue of environmental sustainability.

These types of differences in agricultural growth are also strongly correlated with gender-specific roles in agriculture. The literature suggests that the gender-specific analysis of benefits from different types of growth is lacking in most instances. As we will expand upon below, there has been a serious neglect of attention to issues such as control of income by male and females, and time use by gender, including constraints presented by income, all of which are powerful determinants of nutritional status of young children and vulnerable groups. Of course, compounding this complexity is that, as noted above, malnutrition itself is multidimensional and will be differentially affected by different sectors and sub-sectoral patterns of growth.

The finding that there is a weak link in the short run between economic or income growth, and nutritional outcomes can be viewed in two lights. One is rather sobering and implies that, despite Africa's economic progress and increases in agricultural GDP, problems of malnutrition are going to persist soon. The other is that despite the absence of economic progress, policymakers need to explore more fully the short-term scope for reducing malnutrition – even in the absence of robust economic growth, including in agriculture.

Much of the literature on improving living standards, of which health and nutrition are clearly priorities, has been focussed on one paramount goal: poverty reduction through improving material resources of the poor. This quest has increasingly focussed the attention of policymakers on looking beyond economic growth and addressing instead the issue of the extent to which the economic growth is inclusive or pro-poor growth. Research suggests that despite the variation across countries, there is appreciable evidence that growth does lead to commensurate reductions in poverty (Ravallion, 2001; Dollar and Kraay, 2002; Ravallion, 2013; Dollar, Kleineberg and Kraay 2015). As Amartya Sen (1979, 1985, 1987) articulated in his seminal writings nearly four decades ago, poverty must be understood as deprivations in multiple dimensions of well-

being, which has given rise to a wide-ranging literature on the multiple dimensions of poverty (Duclos, Sahn and Younger, 2006a, 2006b; Alkire and Foster,2011a, 2011b). Although income growth is instrumentally important, and pro-poor growth even more so, broad measures of improvements in living standards must consider welfare in multiple dimensions, such as nutritional status, which are intrinsic to the human condition. This raises the question of whether there is a similar pattern in terms of how economic growth translates into nutritional improvements, as it does for a reduction in poverty and related measures of deprivation. That is, will structural transformation lead to a similar reduction in malnutrition? This would be expected if there is a strong and static correlation between income and nutrition. Even if there is a strong positive correlation between income and nutrition, it does not necessarily say much about whether there is a similar correlation between the distribution of improvements in income and nutrition across the population. That is, improvement in measures of mean nutrition (due to the growth in income from any sector), does not imply better nutrition for most of the population.

Sahn and Younger (2017) addressed this question in the African context using a technique originally proposed by Ravallion and Chen (2003) to examine the extent to which economic growth is pro-poor – the growth incidence curve. Klasen (2008) later adapted this tool to non-income measures of well-being. Sahn and Younger (2017) went one step further to investigate whether height gains are larger for children in poorer or richer households. That is, where in the income distribution are heights improving, and by how much? Sahn and Younger answered that question with a "gradient health improvement incidence curve" of the form:

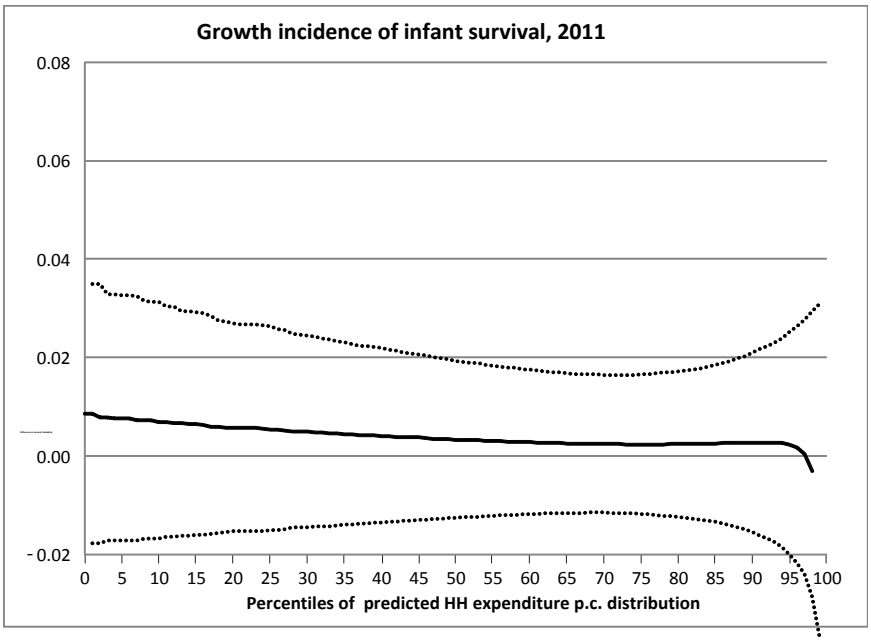
$$dgh_t(p) = h_t(y_t(p)) - h_{t-1}\big(y_{t-1}(p)\big) \tag{1}$$

where $h_t(y_t(p))$ is the height associated with the p^{th} quantile of the income distribution rather than the height distribution. As the estimation of $h_t(y_t(p))$ requires a regression, Sahn and Younger (2017) obtain the estimates non-parametrically, using local linear regression. As height is a measure of nutrition as well, the "gradient health improvement incidence curve" (GHIIC) is also a "gradient nutrition improvement incidence curve" (GNIIC); see Sahn (2019).

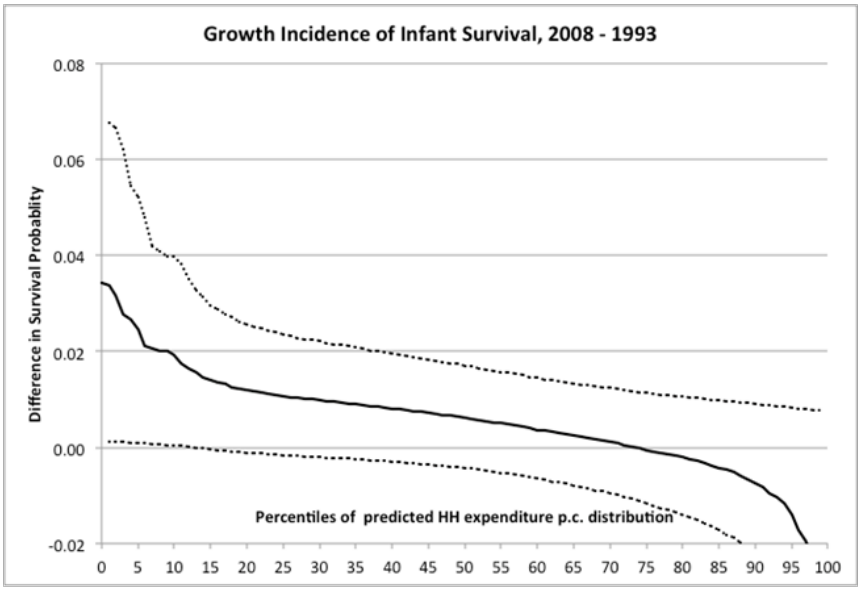
Four examples of GHIICs are shown in Figure 4.

Figure 4: Gradient health improvement incidence curves (GHIIC): Cameroon, Ghana, Malawi, Uganda

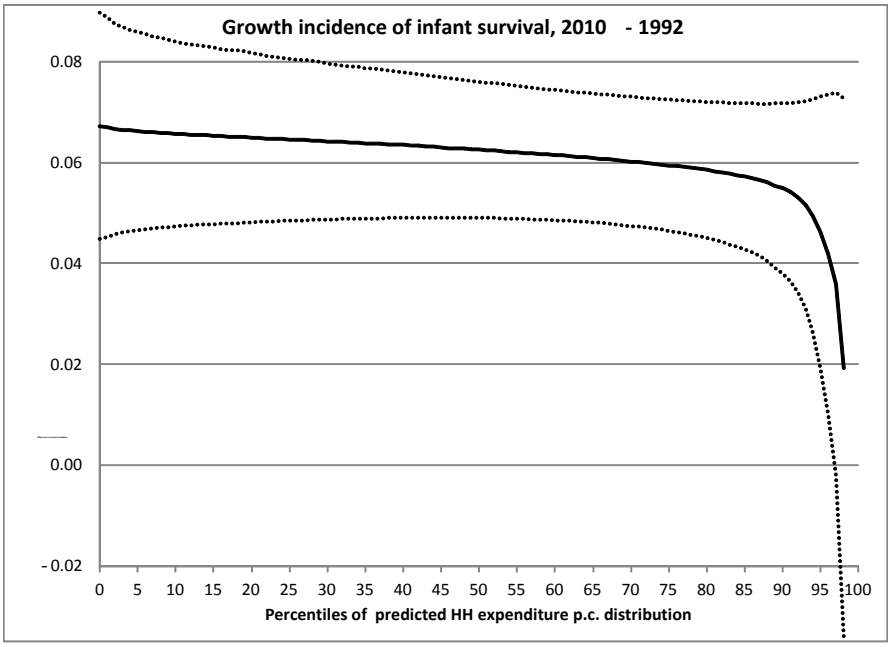
Cameroon:



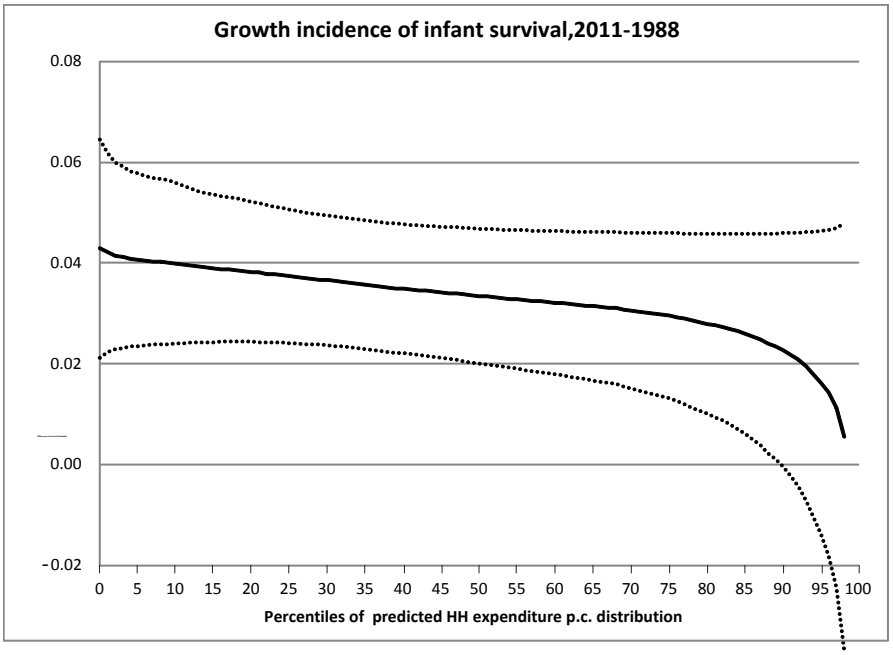
Ghana:



Malawi:



Uganda:



Source: Sahn and Younger (2017, Fig. 5: 315–16)

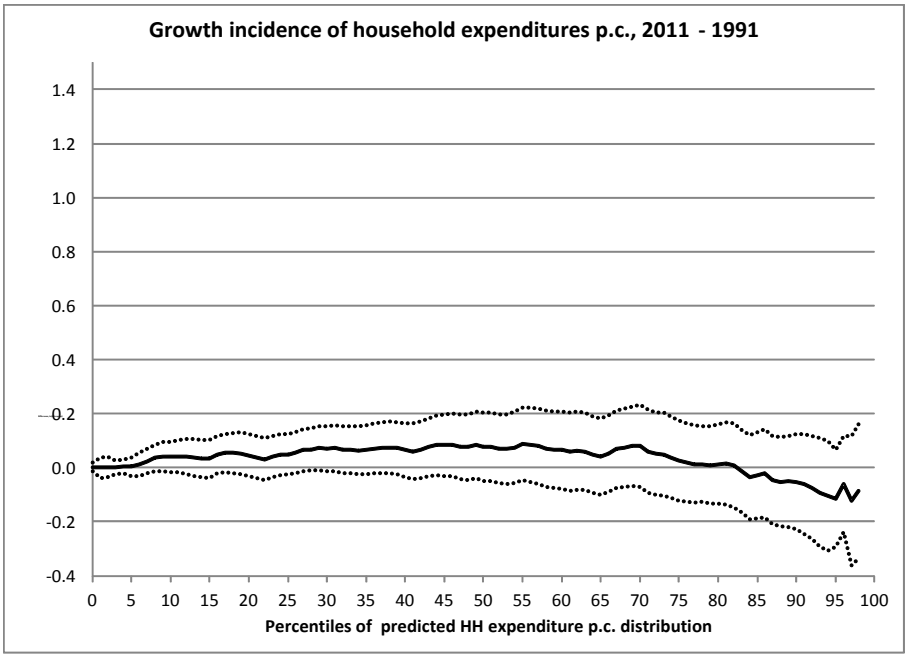
For Cameroon, there is a clear upward slope in this curve, implying that the health improvements are concentrated in the upper end of the health distribution, while for Malawi and Uganda the curve is flat. What is of equal interest, however, is how these curves compare with the more widely estimated and understood growth incidence curves (GICs) of the type estimated by Ravallion and Chen (2003), based on income improvements, where for a cumulative distribution of incomes F(y), let p be the quantile associated with a given income, so that $p = F(y)$. Then, p ranges from *0* (the poorest quantile) to 1 (the richest). Inverting this gives a quantile function, $y(p) = F^{-1}(p)$. The GIC is:

$$g_t(p) = \frac{y_t(p)}{y_{t-1}(p)} - 1 \qquad (2)$$

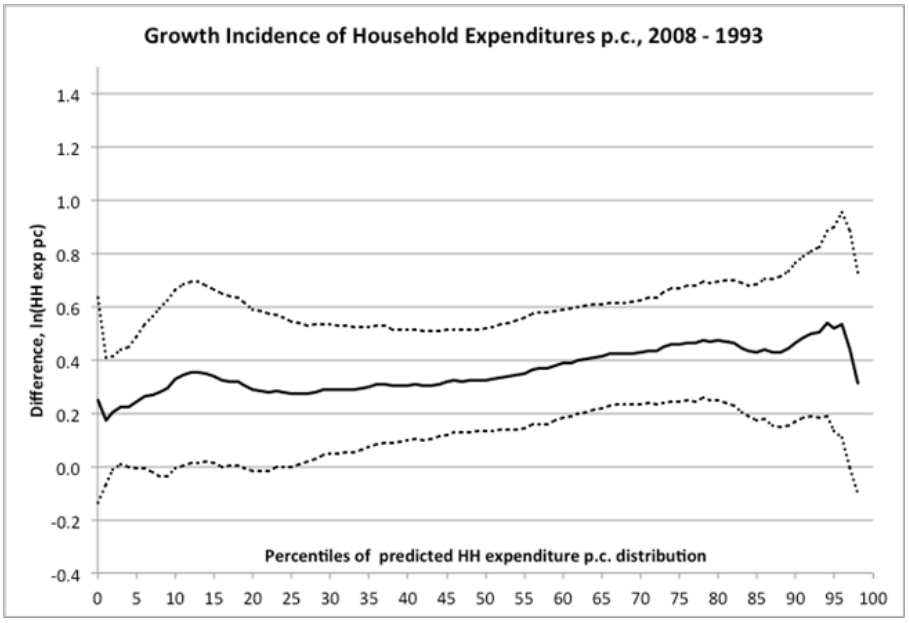
This curve shows how much income at the p^{th} quantile has grown at time t, graphing it for all values of p.

Figure 5: Growth incidence curves (GIC): Cameroon, Ghana, Malawi, Uganda

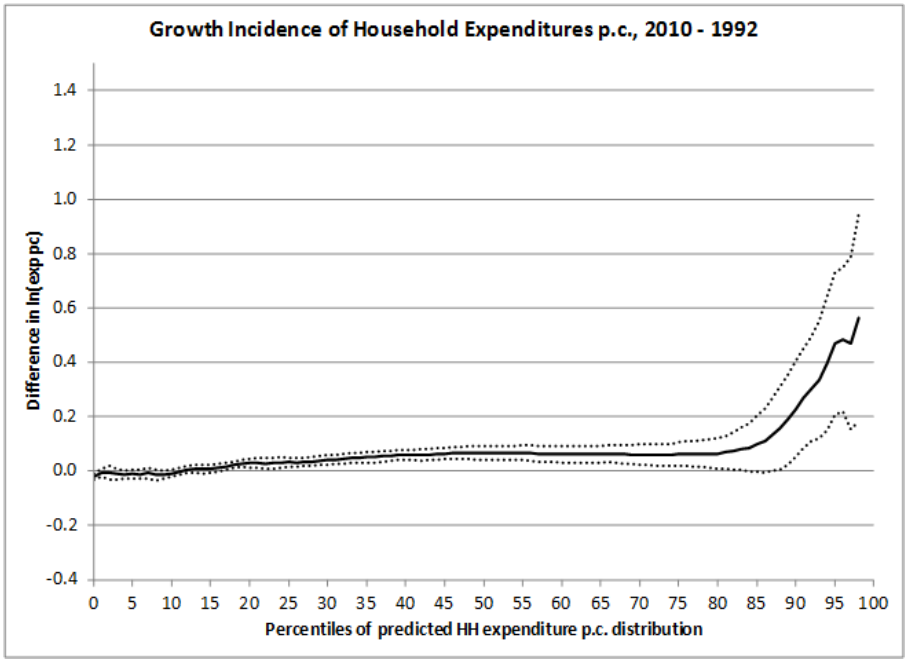
Cameroon:



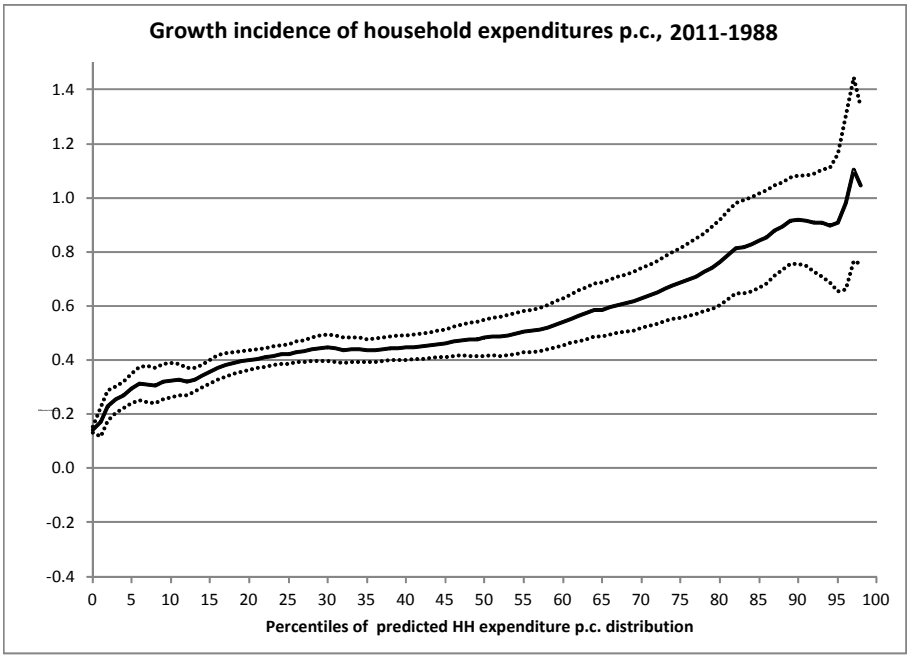
Ghana:



Malawi:



Uganda:



Source: Sahn and Younger (2017, Fig. 4: 314)

These curves for the same four African countries are shown in Figure 5, and we compare them with the gradient health improvement incidence curves. The highest level of growth in per capita expenditure distribution across the two periods was in Uganda. Incomes improved among those at the lower end of the expenditure distribution, and thus there was what may be referred to as weakly pro-poor growth, where there is growth in absolute terms. It is not pro-poor, however, in a "strong absolute" definition, which requires that income increases in currency value for the poor be greater than those for the rich. The economic growth in Uganda is additionally not pro-poor in a relative sense, where we define relative pro-poor growth as the case that the growth rate of the poor's income is greater than that of the non-poor. Growth is much slower in the other three countries, and in all these countries it is not pro-poor in relative terms.

In Cameroon and Malawi, there is no pro-poor growth in weakly absolute terms. In the cases of Malawi, the limited growth that occurred is concentrated in the upper end of the per capita expenditure distribution. In Malawi, for example, there is virtually no growth in per capita expenditures across 80 per cent of the expenditure distribution; then, there is a sharp upward slope of the curve, indicating that there was measurable growth in expenditures among the wealthiest quantiles of the population.

Comparing the GICs and GHIICs suggests, first, that improvements in stunting in a population have a different distribution than income/expenditure growth, and that distribution is usually more hopeful in the sense that it is more likely to be strongly pro-poor than the distribution of income growth. Thus, it is not sufficient to look at poverty and income growth, which, of course, is a more meaningful metric of well-being than economic growth. Second, we have yet to see clear patterns in terms of the within-country relationship between the distribution of improvements in income over time in growing economies and improvements in nutrition. This suggests that the economic development process that contributes to pro-poor growth is not the same as the process that defines the inclusiveness of improvements in nutrition. It is therefore not possible to assess the impact of structural transformation only in terms of the benefits measured by material measures of well-being; we must also think about income alone – the distributional benefits of income growth differ from those for health gains. Although Ravallion and Chen (2003) found that even when economic growth is not pro-poor, the opposite is true for stunting. This only reinforces the observed weak relationship between the process of structural transformation, including in the agricultural sector, and nutrition outcomes, raising the question as to why this is and what this implies for policy.

In addressing this question, we are inevitably directed to considering the role of direct agricultural policies, such as promoting investments in research on nutrient-rich staple crops and outreach policy initiatives that are targeted to poor areas or producers. The range of policy initiatives spans a wide spectrum, however, from those concerned with promoting environmental resilience, nutrition-informed fiscal and monetary policies, and those promoting nutrition-sensitive infrastructure development. So, although there is a strong case to push for structural transformation in agriculture and robust economic growth, such developments will not be sufficient to realize quick or acceptable rates of improvement in nutrition. Instead, agricultural transformation is not a panacea in terms of improving nutrition, especially in the absence of other investments, such as investments in health, education, and physical infrastructure. Their importance is highlighted in the next section that provides an analytical framework for focussing on the most salient programmes and policies to achieve nutritional goals.

Nutrition production function

While broad policy prescriptions focus attention on the myriad channels that link agriculture and nutrition, understanding the relationship between the process of the agricultural and food sectors and nutrition can be facilitated through consideration of the underlying nutrition production function, which links nutrition outcomes to various inputs, including those that are related to the structure and functioning of the agricultural sector. The underlying nutrition production function provides insight into the role of inputs in determining nutritional outcomes. More specific to the concerns of this paper, the nutrition production function represents a conceptual framework for how structural transformation in agriculture and, specifically, short- and medium-term improvements in food production and agricultural productivity contribute to reductions

in malnutrition. The intent is also to provide a framework for further consideration of the types of investments and policies that help realize the goal of reducing undernutrition without waiting decades for GDP growth to do so, while at the same time providing insights into how to mitigate the deleterious effects of structural transformation in terms of the growth of noncommunicable diseases.

As a point of departure, consider the simple nutrition production function that builds upon Grossman (1972). Abstracting from specific mathematical forms, we work with the following general functional form:

$$N_{it} = f(N_{it-1}, X_{it}, Y_{it}, Z^{f}_{it}, S_{it}, H_{it}, B_{it}, P_{it}, G_{it}) \quad (3)$$

Where N_{it}, is current nutritional status of individual i at time t; N_{it-1} is the status of the prior period; X_{it} is a series of inputs, notably the vector of nutrients consumed from food; Y_{it} is a vector of nutrients from other sources such as supplements; Z^{f}_{it} is a vector of different types of food (f) consumed; S_{it} is vector of time inputs in the form of self-care or care of the mother/father or other provider, which can include breastfeeding and weaning practices for young children; H_{it} is the general health environment, including housing conditions, the availability and quality of water and waste facilities such as latrines; B_{it} is a set of health behaviours such as smoking, alcohol consumption and engaging in risky sex practices; P_{it} is use and consumption of preventative and curative health services; and G_{it} comprises genetics and other unobservable factors, which affect the initial health endowment and mediate the impact of measured inputs on nutritional outcomes.

There are several important factors to consider in considering the above nutrition production function and how it informs the relationship between agriculture and nutrition. The first is that the relative importance of the parameters in this production function are likely to differ dramatically, based on the type of malnutrition dimension we are concerned with. For example, supplements are clearly going to be paramount in determining micronutrient nutrition, while having little impact on obesity. It is also the case that other inputs, such as water and latrines, may have an important impact on certain micronutrient deficiencies, such as iron status, as mediated through hookworm infection, but not on others, such as iodine deficiency. Similarly, certain nutrients will be important in determining the level of stunting (e.g., consumption of calories), but not micronutrient status (where dietary diversity and consumption of green leafy vegetables or iron-rich foods may matter more). And, of course, in the case of overweight and underweight, the sign on the coefficient of a nutrient input is expected to have an opposite effect on those outcomes, as the aim here is to reduce weight.

While the different role of inputs in the production of the different types of nutrition is intuitive, the challenges of empirically understanding these relationships is far from straightforward. More vexing is that, even if the parameters in the production function

are fully understood, the appropriate policy response to addressing the problems of malnutrition are complicated and involve formidable trade-offs in terms of which type of malnutrition to prioritize. Quite simply, both the characteristics of the population most vulnerable to different forms of malnutrition and the policies to address those needs of different populations groups (e.g., pregnant women and children under the age of two in the case of stunting and water, and adults in the case of obesity) are potentially contradictory, or at least would imply a different ordering in terms of importance and relevance.

Following from this realization is that the role of agriculture and food policies may have complex, and often more important indirect, pathways which impact nutritional outcomes. Take, for example, the paramount concern with malnutrition early in the life course, particularly for the period in utero to 24 months. A consensus has emerged over the past decade that this is the most critical period for intervention in terms of stunting and wasting, and that nutritional deficits during this period are unlikely to be compensated for, in terms of their functional implications, later in life. Damage is permanent in terms of growth, higher risk of mortality and morbidity, and related deleterious outcomes, such as reduced cognitive and physical abilities. So, it is during these critical 1,000 days, from conception to a child's second birthday, that irreversible damage can occur from nutritional deprivation. This point is perhaps easiest understood by looking at the simple figure showing the association between age and growth faltering. It is in the early months of life that this slowing of growth occurs, and there is little evidence of catch up. In this sense, the problems of stunting and wasting (and the composite indicator of low weight-for-age) mirrors the disturbing evidence for certain micronutrient deficiencies, such as folate and iodine, that have serious consequences if they occur during pregnancy, resulting in irreversible damage to the new-born child. A similar story applies to deficiencies of vitamins A and D, as well as iodine, where long-term irreversible consequences are particularly devastating early in life.

Although this high-risk window is now widely accepted in policy circles, the question arises as to the policy measures in response to this reality. The nutrition production function represents an important construct to consider policy options in response to these deficits. First and foremost, the production function highlights the importance of the temporal dimension, as indicated by the subscripts in the functional relationships. As a result, there is considerable discussion in the literature of time-sensitive interventions. This is relatively straightforward in terms of targeting programmes, such as prenatal folate supplementation. In that case, the issue of timing is more challenging, because by the time a woman is aware that she is pregnant and/or seeks out prenatal care, it can be too late in terms of damage done from folate deficiency. This is in contrast, for example, to iron deficiency, where the time-sensitive period is later in pregnancy, and the consequences for foetal development less urgent. Thus, in the case of folate, the target population is all women of childbearing age, unlike iron supplementation.

However, this illustration is for nutrition-specific interventions, in contrast to the focus of this paper on broader agricultural policies. The challenge is that policies are often more complicated to formulate in terms of addressing nutritional goals, as the lags and the mediating mechanisms between policy changes and their impact on vulnerable groups are inherently less direct and often involve unanticipated delays.

Another issue that the production function highlights is that there are many inputs that affect nutrition. Noteworthy, however, is that nutrient intake is only one of the many inputs that matter, and of course intake is a far step away from issues of production. Mediating factors include the supply chain, and related issues of price and income that affect food demand. Likewise, when consumption is measured at the level of the household, it obfuscates the issue of intrahousehold dynamics, which is a critical issue in terms of who consumes what nutrients, which is what we want to capture in the production function.

In the case of children under the age of two years, the nutrient requirements are of course modest, at least in terms of their quantity. For the first six of the 24 months, these are ideally supplied exclusively through breastfeeding. Even with the introduction of weaning, breastmilk is still a crucial source of nutrients and, likewise, the food-based diet provided to the infant and young child involves the provision of modest amounts of calories, proteins, and other vital nutrients. Thus, nutrient consumption from food, Z_{it}^{f}, is only a small part of the equation that will affect nutritional status, and given that, the likely direct role that food prices and availability play is less important than several other parameters in the production function. These include those that affect the likelihood of infection and disease, as well as the types of preventative and curative health services accessible by the mother and child. Thus, it would be a great simplification to conflate the issue of food consumption, availability, and prices, let alone agricultural output and production, with nutritional outcomes, especially among young children. It is likely that agriculture and food systems play a crucial role in the availability, quality and diversity of the diet, which is an important complement to other inputs in the nutrition production function.

It is also the indirect role of the agriculture and food system, in terms of affecting other inputs in the nutrition production function, that should be the focus of policymakers. There are many mechanisms by which agricultural policy affects nutritional outcomes indirectly. The first is as a source of employment and livelihoods for rural households. The second is that agricultural transformation has important implications for time availability and related constraints faced by what is often scarce, seasonal labour. This is especially an acute issue for women who often have conflicting time demands in terms of food production and marketing, on the one hand, and their role as mothers and care providers of young children on the other. The time demands of these productive and reproductive roles are altered through the process of structural transformation. Labour-saving technologies reduce labour demand and, also, the demand for more children among households falls as rural incomes rise and infant and child mortality rates drop.

These changes are expected to allow women more time to care for their children and to reduce the health risks and stress on them directly, contributing to their improved health and nutrition.

Further, of paramount importance is the contribution of the process of agricultural transformation to robust rural economies, which can be a source of schools, clinics, and other public infrastructure vital to nutritional well-being. As depicted in the nutrition production function, these elements of social infrastructure are important inputs, and the paucity of such services has been an important constraint to reducing levels of malnutrition.

Another important but indirect impact of structural and agricultural transformation that will affect nutritional outcomes is mediated through the challenges associated with the environment and natural resource management – promoting environment resilience and lessening climate change, soil degradation, water pollution, shortages, and related concerns of sustainability. Although environmental concerns are of greater importance to households living in rural areas, they are also relevant to urban households. For example, access to clean and plentiful water is a prerequisite to prevent infection and disease that can contribute to malnutrition. Related concerns, such as the generation of hydroelectric power instrumental to the structural transformation of more energy-intensive agricultural practices and, of course, a robust urban economy, is one of many examples of how environmental concerns can affect key inputs in nutrition production.

In terms of the relationship between agricultural transformation and nutritional outcomes in urban areas, again, the production function makes clear that there are a wide range of mechanisms through which this process will affect nutritional outcomes. To highlight a few, the most basic is that the agricultural sector and related food system is the essential provider of a plentiful, diverse, and safe food supply in urban areas that enables the large population movements to urban areas that is occurring throughout Africa. Of course, it is in this environment that the demand for agricultural products changes, as tastes and lifestyles evolve and, likewise, the role and nature of the food processing and market systems become increasingly prominent. As the supply chain creates more distance between producer and consumer, including an increasing role for imported goods, the issue of the challenges associated with noncommunicable diseases from obesity gains prominence. Note that in the context of the nutrition production function, the inputs that contribute to the various types of malnutrition in urban areas, from severe cases of wasting to the rise in obesity, are often very different and operate through opposite signs on the parameters in this model. This represents a formidable challenge to policymakers trying to formulate agricultural and food policies to address the diversity of nutrition problems.

Labour markets and employment linkages with food and nutrition policy

Employment and labour market-related linkages between agriculture, the food system and nutrition are complex and bidirectional. The agricultural and related food processing and marketing sectors are not only the main food producer, but also the largest employer and source of economic output. Thus, the agricultural sector is instrumental to both providing employment, and thus, economic growth, and a source of wage goods necessary to lift rural but, more importantly, urban households out of poverty. Quite simply, even in the context of an open economy, without the surpluses from domestic farms, non-farm households will not have access to and equate, diverse, and reasonably priced food supply, an essential input into good nutrition. And, in turn, good nutritional status is an important input into a productive agricultural sector and food system, reflecting the role that health plays in human capital development and productive work.

Employment and wages

Structural transformation will inevitably reduce the share and the number of workers employed in the agricultural sector. This process has long been recognized, and in fact, was written about as far back as the 1930s and 1940s by Fisher (1939), and elaborated on in many seminal articles, including papers by Clark (1957), Chenery (1960) and Johnston (1970).

This transformation has historically been driven largely by advances in agricultural technology, which affects numbers of workers engaged in agriculture, but also by the nature of skills required for successful farming and related food processing and marketing. The reduction in agricultural employment is not only being driven by technological change in agriculture that lowers demand for workers per unit of land and other inputs, but structural transformation also increases the demand and opportunities for non-farm work, particularly in urban areas, as well as in rural areas.

In Africa, this process of transformation has begun, albeit at a slow pace. Although the decline in the share of workers in Africa corresponds to expectations based on experiences in other regions of the world, agriculture still employs well more than half of Africa's labour force. So, the process of transformation of the labour force is quite clearly in its early stages. However, some important warning signs are emerging.

The movement of workers out of agriculture has been accompanied, as expected, by a declining share of agricultural value added as a share of GDP. This process is in keeping with the movement of labour away from low productive agricultural work. The low productivity of farmers in Africa has been highlighted by Gollin, Lagakos and Waugh (2014) who pointed to the fact that the productivity of African farmers lags those in other sectors. By implication, the movement of labour out of agriculture is, on balance, a positive step in the modernization of African economies in keeping with the process of

structural transformation. The alternative would be continued lagging productivity in the agricultural sector, as workers struggle to grow enough food to feed themselves and their families and as land becomes increasingly scarce and degraded through over-exploitation of natural resources. Yet, the issue of how to enhance productivity in agriculture during and after the transformation remains the key policy challenge.

There are several important distinguishing characteristics of this shift away from low productivity agricultural activities to high yielding activities in non-farm sectors. One is that there is emerging evidence that instead of labour moving into productive manufacturing activities, it is largely destined for services-based activities, mostly in urban areas. Around one-third of workers are employed in the service sector and just over 10 percent are industrial workers. The failure of African economies to follow the East Asian model of manufacturing-led structural transformation is a source of concern that has been discussed, for example, by Page (2018) and Bhorat, Steenkamp and Rooney (2016). There is a need to note that the effect of structural transformation on the relative size of agriculture's contribution to GDP depends on the extent to which labour moves out of agriculture and on the productivity of labour that remains in agriculture.

Although much has been written on the subject, there are some important considerations over how agricultural transformation has related to the nutritional status of rural as well as urban populations. In particular, nearly 30 years into this process of structural transformation, a large share of Africa's workers is still engaged in agriculture, despite agriculture having declined, and the share of agricultural value added still remains high in most countries, decreasing from 20 percent in the 1990s to around 15 percent currently (World Bank, 2015).More importantly, the concern over nutrition is that poverty remains concentrated in households primarily engaged in agriculture (Shimeles, 2014), contributing to malnutrition being higher in rural than urban areas (WHO, 2002). This reflects, in part, the low capital intensity of African agriculture. By implication, the process that can raise earnings of those engaged in agriculture, increasing capital intensity and productivity will, however, lead to the sector shedding jobs. These two realities of the transformation in agriculture – to higher productivity with a reduced demand for labour – need to be managed appropriately, to not contribute to transitional loss of livelihood, food shortages, and other negative outcomes such as instability in food prices, all of which imperil nutritional status.

There are many perils to nutritional status that are potentially associated with the structural transformation, which leads to labour shedding in the agricultural sector. The first that is of considerable concern in the African context is that those who are displaced in the agricultural sector labour market end up migrating to cities and towns only to be unemployed or engaged in low productivity, informal sector work. These newly urbanized workers are at heightened risk of not only poverty, but often lack the type of social safety nets, social networks, and community-based mutual assistance arrangements that they left behind when leaving their places of origin.

The process of agricultural transformation also poses risks, if not properly managed, for workers who remain employed in the modernizing agricultural sector on which they rely for their livelihoods. In this regard, there are two paradoxes that confront policymakers. First, technological innovation is essential to a long-term strategy to feed the poor and ensure improved nutritional outcomes, both through its direct impact on food availability and indirect impact in terms of raising wages and time savings, especially for women. However, the process of technical change is enabled in part by higher and more stable food prices. Higher prices can be a risk to the nutrition of low-income net food consuming households, but price stability is good for consumers and producers. Simply, if prices fall, farmers have lower incentive to produce more. And if prices rise, and if wages also rise in the non-farm sector, this will impede structural transformation, as demand for industrial labour is curtailed.

The appropriate response to this food policy dilemma is to design short-term policies that provide low-income households access to food and to below market prices in this transitional phase toward a more productive and modern agricultural sector, which offers workers higher returns and raises the living standards of farmers. So, efforts to create safety nets for the poor and promote food price stability cannot become an excuse for subverting markets and their role in price formation. The transitional process that characterizes structural transformation can put considerable pressure on policymakers, especially if employment falls, wages are stagnant, and the process is considered a threat to food security and nutrition. This may encourage ill-advised policies, ranging from agricultural protection to input subsidies, that only serve to promote rent-seeking and retard the rate of transformation. Concerns over nutritional impact during this transition are certainly warranted and merit a serious policy response, but this must be done in a way that does not create more market failures and impede market efficiency.

The second and related paradox is that, as the agriculture sector's contribution to employment and GDP falls, it is necessary to increase investment to raise worker productivity and increases wages, especially relative to the non-agricultural sector. This imperative is often not a policy priority, and agriculture is neglected, especially as governments look toward cheap imports as an alternative to domestic agriculture for a source of low-cost wage goods for the growing urban population. These low food prices in turn serve to enable policymakers to neglect investments that, over the longer term, are essential to technological change, higher rural wages, and a reliable supply of food products to fuel the growth and productivity of the urban labour market. Especially important in this regard is avoiding the food price instability that has plagued Africa, representing considerable nutritional risk for lower income households. Instead of investing in agriculture to raise productivity and wages, and adopting related policies that stabilize food markets, the response of governments has been to neglect agriculture.

Women, production and reproduction

African women play a unique role in African agriculture. Thus, improving their employment prospects and productivity is perhaps the single highest priority of policymakers who are

focused on nutrition-sensitive policies. This importance reflects women's dominant role in food production and markets and their special vulnerabilities related to reproductive health, as well as unique responsibilities in the home, particularly in terms of childcare. Although the role of being a productive worker can conflict with demands of biological reproduction, particularly in terms of binding time constraints, there is ample scope for policymaking to bridge this divide in the quest to improve nutritional outcomes of women and children. In fact, there are several areas of investment that both bolster the productivity of women in the labour market and enhance their roles as mothers and caregivers. The most obvious is raising educational opportunities. Women in Africa are catching up in terms of school attainment, but still lag behind men in many countries, particularly in West African francophone countries. Additionally, improving access to maternal and child health services, as well as providing for modern contraception and even childcare alternatives, are all critical to improving the employment opportunities of women. These policy measures work through improving women's health status and raising productivity, an issue we address further later in this paper, as well as by altering time allocation. Healthier children mean more opportunities for women to work. Likewise, the availability of day care facilities and other similar options for caring for young children are important. Likewise, access to modern contraception reduces unwanted pregnancies and enables women to engage in productive work more fully (Almanza and Sahn, 2018).

Structural transformation also brings greater capital intensity to farming, reducing some burdensome tasks associated with many activities, from gathering water to harvesting and milling grains. In combination, labour-saving technologies, fewer children, more education, and better health directly enter the production function to improve nutritional outcomes of women and their children. Rural women – who are overwhelmingly dependent on agriculture for employment, income, and food – need to be the focal point in terms of examining the link between agriculture and nutrition. Rarely, however, are agricultural interventions defined or driven by nutritional goals, particularly, with a focus on rural women and children. Agriculture is a key sector of employment and opportunity for women, providing improved gender dynamics. As women have traditionally had limited access to technology, inputs, extension and output markets, as structural transformation occurs, it will alter investment in basic rural infrastructure and labour-saving technologies. In this section, will examine the extent to which such investments impact women's special vulnerabilities and opportunities. For example, since women are the primary food producers in sub-Saharan Africa, identifying opportunities for reducing the labour burden in pre-harvest and postharvest operations would contribute significantly to their health. Given the continued importance and the large share of staple crops in the diets of the poor, identifying mechanisms for enhancing the micronutrient density of grains through biofortification can potentially be a high return strategy. Policymakers need to consider the importance of the gender dimension of research and investment in agriculture and related food systems in pursuing food security and dietary diversity (both production and consumption diversity) at the household level.

Nutrition and productivity

While the role of structural transformation in promoting increased efficiency and productivity in agriculture is essential, there is an equally important relationship that recognizes the importance of improved nutrition of workers as an input into raising output in the agricultural sector. The literature on the impact of nutrition on productivity is vast[3] and falls into two broad categories: the macroeconomic literature showing that nutrition and health have contributed in an important way to increases in productivity and economic growth, and the microeconomic literature that involves individual-level studies that show the impact of better nutrition on outcomes, such as schooling, cognition, and the ability to do physical work.

In regard to the macro literature, some of this work is from economic historians such as Robert Fogel, who estimated that 50% of Britain's growth since 1800 was attributable to the increases in dietary energy available for work, and to the improvements in the efficiency in the transformation of nutrients, particularly calories, into work (Fogel, 2004).[4] These estimates are in line with other studies such as the World Health Organization report showing that 30% of the per capita growth between 1780 and the middle of the 20th century can be directly explained by improvements in nutritional status (WHO, 2002).

Various macro-econometric cross-country models, which have similarly examined how economic performance has been affected by the health and nutrition of the population, include the work by Barro (1997); Bloom and Sachs (1998); Arora (2001); Gallup, Sachs, and Mellinger (1999); Gallup and Sachs (2001); and Bloom, Canning and Sevilla (2004). They all show large health-induced increases in productivity. It is also the case that this literature has been criticized for not showing definite causation, as identification of the models is challenging, and for problems with the reliability of data, especially from Africa (Weil, 2007). Other macro-simulation techniques have also been employed to evaluate the impact of health on economic growth, including the research of Weil (2007); Young (2007); and Ashraf, Fink and Weil (2010). This literature reports far more modest effects than cross-country regressions.

The challenges of identification and causal inference in all these techniques focusses attention on the micro literature, which is more compelling, and where a combination of experimental and non-experimental evidence shows a large impact of nutrition on productivity, particularly in the agricultural sector. The fact that malnutrition prevalence is higher in rural areas and that work on farms is labour intensive, requiring strength and stamina, makes the sector particularly vulnerable to any functional consequences of malnutrition. One strain of the literature on the productivity effects

3 See Strauss and Thomas (1998) for an excellent review.

4 Fogel (2004) argued that nutrient intake was so constrained that 20% of the labour force was unable to engage in productive work, and it was increases in agricultural productivity in the 19thcentury that improved the health and productivity of workers, leading to more rapid economic growth.

of better nutrition shows that taller workers in agriculture have higher earnings (Deolalikar, 1988; Haddad and Bouis, 1991; Glick and Sahn, 1997; Schultz and Tansel, 1997; Thomas and Strauss, 1997). This result is presumed to capture the mechanisms that taller and better nourished adults are more able to conduct physical work, but it is certainly possible that causation is running through other intermediating factors such as better nourished children growing up to be taller adults, with higher cognitive skills. Recent papers have addressed this possibility. LaFave and Thomas (2016) use data from the Philippines and reported a 1%increase in height as related to a 1.9%increase in hourly earnings, when controlling for both cognition and education. Similar findings were reported by Bossavie et al. (2017), who conducted a study with workers in Pakistan that included both Raven's scores as well as an index of non-cognitive skills. Vogl's (2014) findings showed that earnings among those working in a "brawn"-intensive occupation were increased by 0.63 percentage points for each additional centimetre of height, although, the effect declined by more than half when other covariates and a Raven's score was added to the regression. Kaila, Sahn and Sunder (2018) also show an independence of height on productivity, even after controlling for cognitive ability.

There is also research that shows how low body mass index (BMI) contributes to lower productivity in poor countries (Glick and Sahn, 1997; Schultz and Tansel, 1997). Additionally, productivity has been shown to be affected by nutrient intake: Strauss (1986) estimated a farm production function for Sierra Leone and found that calorie intake had a significant positive effect on the marginal product of agricultural labour; Sahn (1988) instrumented per capita household calories using prices, and the results from Sri Lanka indicated that there was a positive effect on market wages for rural men but not women. Behrman and Deolalikar (1989) found calories impact productivity in the peak agricultural season for men. The positive effect of intake on productivity is not a universal finding, as shown in studies by Haddad and Bouis (1991) and Deolalikar (1988).Much of this research focusses on the role of iron status in affecting aerobic capacity(Haas and Brownlie, 2001).Noteworthy among these studies is the causal effects of iron supplementation on the output of rubber workers in Indonesia (Basta et al., 1979), cotton mill workers in China (Li et al., 1994), and tea plantation workers in Sri Lanka (Edgerton, et al. 1979). Additionally, several studies have demonstrated how the cognitive development of children was impaired by iron deficiency (Pollitt, 2001). Another interesting field experiment was the "Work and Iron Status Evaluation" (WISE) study that provided iron supplements to adults in Central Java, Indonesia, and demonstrated that iron deficiency had a causal impact on time allocation and economic productivity (Thomas et al., 2006).

Randomized food supplementation of sugarcane cutters in Guatemala indicated that those living in treatment villages were not more productive than workers in control villages (Imminck and Viteri, 1981); and another study in Kenya found a limited impact of food supplementation on the productivity of road workers (Wolgemuth et al., 1982).

In addition to this evidence on the importance of nutrition for labour productivity of adults, there is equally important evidence that nutrition affects schooling and enhances cognitive skills through both the timing and amount of schooling, as well as the learning per year of schooling (Glewwe and Jacoby, 1995; Alderman, Hoddinott and Kinsey,2006; Yamauchi, 2008). Going one step further, Alderman and Behrman (2006) used the association of low birthweight and cognitive capacity in childhood to estimate the impact on wages. Alderman, Hoddinott and Kinsey (2006) and Hoddinott et al. (2013a, 2013b) showed the impact of nutritional supplementation in childhood on later life productivity.

In a recent African Economic Research Consortium paper, Mwabu and Wambugu (2019) argue that the household is the main channel through which agricultural transformation and innovation affect nutrition outcomes of individuals. Using data from several household surveys in Kenya, they show that farm policies that improve land productivity have favourable indirect effects on nutrition. The effects are indirect because they arise only when the households use agriculture-induced incomes to improve nutrition of their members. The nutrition production function presented in this paper suggests that agricultural incomes have little or no effect on nutrition if the incomes accrue mainly to the rich, highlighting the need for targeted interventions. Consistent with the findings of this paper, Mwabu and Wambugu (2019) show that the agricultural policies with the greatest potential to improve nutrition in Africa include adoption of high yielding farm inputs, intensification of extension services and subsidization of farm inputs.

Nutrition, the demographic transition, and the rise of obesity

From the end of the 18thcentury to the middle of the 20thcentury, the concerns of demographers and related social scientists were with population growth, focussed on the apocalyptic fears of food shortages and famine. As Malthus articulated in “An Essay on the Principle of Population” (Malthus, 1798), famine was inevitable on a massive scale, a sentiment echoed over the next two centuries, including by Ehrlich (1968), following a drought in North India in 1965 and 1966. Indeed, Malthus failed to foresee the remarkable increase in agricultural productivity resulting from technological change and embodied in the Green Revolution and, more recently, the development of biotechnology.[5]

While famine continues to plague small areas of the world, particularly in failed states where civil conflict and egregious policy failures are prominent, the primary demographic discussion is about the broader process known as the demographic transition. This process whereby fertility rates fall in response to declines in infant and child mortality, which result from investments in health and social services and improved nutrition, is early in its development in sub-Saharan Africa, as contrasted with other regions, such as Latin America, (Lam, 2011). A corollary of this process is the movement of populations from urban to rural areas, especially among the youth. This does not mean that rural

5 In addition, Malthus failed to anticipate the reductions in marketing and related transactions costs due to progress in transportation and communication that allowed for intercontinental trade in grain, as well as relatively rapid relief efforts on a global scale.

populations will decline quickly or dramatically in Africa, as the overall rate of population growth will continue for decades, but it does present several challenges in terms of the nutritional implications of these demographic trends, especially as the share of the population on farms decline. Therefore, increased output per worker and per unit of land, the key characteristics of structural transformation in agriculture, will be a corollary of success in managing this demographic change.

Another equally apparent aspect of this transition that invariably accompanies population movements off farms to cities and towns, is an increase in obesity and overweight, contributing to a rapid increase in the burden of chronic disease. This is a result of changing patterns of food consumption and lifestyles, including the nature of work. To date, the increase in overweight and obesity in Africa has been modest, compared to other regions of the world, but the wide intra-continent variation in obesity is worth noting. Likewise, in comparison to other regions of the world where structural transformation is further advanced, especially in Latin America, the Middle East, North Africa and parts of Asia, the prevalence of overweight and obesity is relatively low in Africa. This is expected since the demographic and related nutrition transition is in the early stages in Africa. There is little doubt that as GDP per capita increases and the structural transformation of the economy and agriculture accelerate the disease burden in Africa will shift along with nutrition transformation.

Understanding the factors underlying the changing patterns of consumption and activity in the nutrition transition can assist policymakers trying to dampen the inevitable trend toward the shifting burden of disease that accompanies urbanization. At the core of the factors that contribute to an increasing prevalence of obesity is the movement toward foods being marketed and purchased through a commercialized food sector that offers different products than consumed on farms and in rural areas. More specifically, there has been a widespread shift toward consumption of high-fat, high-sugar, high-salt, and highly refined and processed foods and beverages, at the expense of fruits, coarse grains, legumes, vegetables, and other plant-based products. This reflects both changes in the supply chain and food markets commensurate with structural transformation in agriculture. The availability of less healthy food choices, however, is not just a consequence of food producers, processors and marketing institutions conspiring to increase their earnings at the expense of unwitting consumers, who are being manipulated through advertising and coercion. Indeed, these considerations, especially given the effectiveness of advertising and ineffectiveness of nutrition education efforts, may be an important part of the explanation for turning to less healthy consumption choices. So, too, are changes in consumer preferences, as time constraints and lifestyles interfere with more traditional forms of food processing and preparation.

Another dilemma for policymakers is that the growing tide of overweight is not replacing undernutrition, but instead, is co-existing in the same countries, communities and even households. This so-called double burden of malnutrition may seem contradictory but is not surprising after consideration of the nutrition production function previously discussed.

For example, infectious diseases, which are especially debilitating for vulnerable groups such as women and children, will continue to contribute to the downward spiral of disease and malnutrition. These diseases may be especially problematic in more densely populated urban areas where clean water is scarce, sanitation facilities absent, and maternal and child health facilities strained, unable to meet the expanding needs of the burgeoning population. These problems are exacerbated by the simultaneous demand from the better-off households, who demand access to secondary and tertiary curative care, and the political economy that enables elite capture of government budgets.

Obesity and overweight, however, result not only from adverse consumption behaviours, but additionally, from the increasingly sedentary lifestyles of urban dwellers. Simultaneous with increasing consumption of energy-dense, sugar and fat-laden foods, people living in cities take up more sedentary work, rely on new modes of transportation, and are less physically active than their rural counterparts. Thus, both sides of the energy balance equation are contributing to overweight and obesity. Having identified the more proximate causes of obesity only provides limited policy guidance, particularly in terms of how agricultural and related food policies can tackle this issue. Indeed, while observations that the "supermarketization" of Africa, as a source of processed and unhealthy food, is at the core of the problem, an inextricable march into the modern supply chain that links agriculture with consumers defies easy solutions. Several policy prescriptions have been widely discussed. These include:

(1) Using tax and related fiscal policy to reduce sugar in food and, particularly, consumption of sugar-sweetened beverages, as well as alcohol.

(2) Introducing incentives to manufacturers and retailers to develop and distribute products with lower sugar and fat content.

(3) Requiring consumer food labelling, both in supermarkets and eating establishments.

(4) Instituting food standards for meals and beverages that are provided and sold in institutions, particularly schools and day-care facilities.

(5) Increasing availability and use of sports and recreational facilities in communities, especially in schools, to increase physical activity.

(6) Limiting marketing practices, by legislation, such as advertising directed at children for sugar-filled food and beverages.

(7) Promoting nutrition education and literacy that focusses on healthy eating behaviours, body size and levels of physical activity through a variety of avenues, ranging from public service announcements to school curriculums and other healthcare-related facilities.

(8) Providing more direct guidance to women, especially in antenatal settings, for infant nutritional needs, and to women who are pregnant and lactating regarding the relationship between food choices and pregnancy risks, such as hyperglycaemia and gestational hypertension.

(9) Encouraging breastfeeding, including through maternity leave, and making the workplace compatible with breastfeeding.

(10) Creating initiatives to increase availability of and access to healthy food choices in poor and disadvantaged communities.

It is worth noting that most of these policy prescriptions, which will certainly affect agriculture through, for example, affecting consumer demand, are not agricultural policies per se. Instead, agriculture will certainly be impacted by changes in the regulatory environment, trade policies, fiscal policies and effective nutrition education and behavioural change initiatives. Thus, farmers are expected to respond to market signals to the extent that the direct measures listed here affect demand, but they are not the focus of policy initiatives to reduce obesity and overweight. Nonetheless, there is no question that agriculture and the broader food system is integral to any effort to reduce overweight and obesity. Coordinating with other sectors, ranging from commerce and industry, health, education, transport, to finance and trade, will be essential. This process will only prove successful, however, if coordination takes place at various levels, from communities to transnational corporations. Although government clearly occupies a central role in the effort to slow the rapid increase in noncommunicable disease related to obesity and overweight, private industry, nongovernmental organizations, and other non-state actors must work together to ensure success. Quite simply, government's paramount role in policymaking and setting the incentive and regulatory framework will only prove as successful as their ability to bring along the private sector and civil society in pursuit of this agenda. This is particularly the case for the agriculture sector. Prices will be impacted, whether from trade policies or direct subsidies or tax policy on certain foods, and private sector producers will be expected to respond. There is a complementary role, however, that the public sector needs to play. Whether in terms of agricultural research, extension programmes to promote the production of a new or more diverse set of food options, or investments in infrastructure to facilitate the marketing of healthier products, government will have a continued and important role to play in transmitting those incentives into profitable production increases on the farm.

Complementary nutrition-sensitive and nutrition-specific interventions

Structural transformation that brings about changes in agricultural and food systems has its limits in terms of expectations for contributing to declines in malnutrition. Therefore, in this section of the paper, we discuss interventions or programmes that address the underlying determinants of foetal and child nutrition – food security; adequate care-giving resources at the maternal, household and community levels; access to health services; and a safe and hygienic environment that incorporates specific nutrition goals and actions. These interventions include programmes in sectors such as agriculture, water, and sanitation, as well as social protection. In addition, these programmes are generally intrinsically targeted to the poor and often contain design features that can empower women. Still, the nutrition-sensitive sector that has the most potential to

address constraints to nutrition is agriculture and related food policy. This should include generalized food subsidies to increase food security, conditionally or unconditionally targeted cash transfers, biofortification and food supplementation, home gardens and, more generally, preventative, and primary healthcare interventions.

Although these programmes hold considerable potential, to date, they have been largely implemented outside of Africa. And many, such as generalized food subsidies to increase food security, while once widespread (Pinstrup-Andersen, 1988) are less common, given their expense and the comparatively low share of total expenditures accruing to the malnourished. Similarly, food rations and in-kind distribution of quotas have become less common, in part due to the tendency for leakage (Alderman, 1988; Mehta and Jha, 2014). Conversely, targeted cash transfers, either conditional or unconditional, have become a widespread means of increasing access to food. While such cash transfers have long been recognized as less distortive than subsidies, the current focus builds upon the evidence from PROGRESA, a well-documented, large-scale pilot in Mexico, as well as improved technology for delivering and tracking cash. Nevertheless, nearly two decades after the introduction of PROGRESA, large in-kind food distribution programmes remain active in diverse settings, mainly from outside of Africa, as in India, Egypt, and Indonesia.

Biofortification is another nutrition-sensitive agricultural intervention. It involves breeding staple crops to increase the availability of micronutrients and essential amino acids to improve the quality of protein. While breeding may prove successful, adoption by farmers is often more problematic (Saltzman et al., 2013). Likewise, there have been major challenges in terms of acceptance by consumers. The most well-documented example of biofortification is orange-fleshed sweet potatoes (Hotz et al., 2012). One of the most successful stories from Africa is that of sweet potatoes and iron-rich beans released in Rwanda. Over 500,000 households adopted these crops by 2014, and there is evidence that these crops have begun to spread to neighbouring countries with little outreach. Biofortification can also be achieved through other channels, such as applications of fertilizers that increase zinc and selenium concentrations in crops and soils. Iodine has similarly been added to water systems used for agriculture.

Many challenges remain with these types of interventions, most prominent of which is enlarging the scale of such efforts. In the absence of doing so, the potential for highly targeted programmes, such as home gardens, is inevitably quite limited (Pinstrup-Andersen, 2013).

Conclusions

The nutrition impact of structural transformation in agriculture is part of a larger nexus of development challenges and opportunities. Africa is at the early changes of this transformative process, and evidence-based policy will be crucial to exploiting the opportunities and limiting the potentially deleterious effects of the complex of changes in the economy and agricultural and food system that are taking place simultaneously. In this paper, we have discussed the broad contours of structural transformation,

including the acceleration of economic growth, the declining share of agriculture in GDP, the increase in productivity in the agricultural sector, and the movement of labour off the farm to urban areas and smaller towns and into services and manufacturing. These processes are well underway in many, but not all African economies. The continued success of this transformation is predicated on enlightened policymaking, including reducing economic distortions, responsible fiscal and monetary policies, and fostering an economic climate that is attractive to foreign investment, including trade policies that encourage an outward looking, exported-oriented economy. Meanwhile, there is an emerging consensus that Africa is facing a debt crisis that could derail much of the economic progress that has been made in the past decade.

Even with enlightened domestic macroeconomic policy, this will not be sufficient to promote the continued structural transformation of African economies. Other factors, many of which are out of the direct control of policymakers, present challenges. These range from instability and adverse conditions in world commodity prices, as well as the threats posed by increased trade tensions and barriers being imposed by developed countries. Additionally, the implications of climate change and related environmental challenges will prove perilous, especially for Africa where agriculture remains the leading sector of economic activity. Thus, any discussion of structural transformation needs to be cognizant of the alarming process of resource degradation due to overexploitation of resources, global warming, and climate instability.

While these transformative processes in the economy are essential to economic development and raising living standards, the closely related demographic and nutrition transitions have important implications for the role of agricultural policy. These transitions are occurring simultaneously with changes in the supply chain and food markets, as well as food choices and preferences. Stunting, wasting, and micronutrient deficiencies are beginning to decline during this transitional process but will not quickly disappear. And at the same time, these forms of malnutrition are increasingly accompanied by a rapid increase in overweight and obesity. Conflicts inevitably arise in terms of priority setting. These are particularly salient in terms of how to invest public resources efficiently, simultaneously incorporating nutritional considerations into those decisions, but there are also difficult choices in terms of policymaking itself. This includes a range of policy dilemmas such as: price policy that is inherently conflicted in terms of supplying low-cost wage goods to a growing urban population and remunerative prices to farmers; increased reliance on modern agricultural technologies that may come at the cost of sustainability and resilience in the agricultural sector and food system; food and other related transfers that, while designed to assist the poor, may in fact exacerbate the growing problem of obesity and overweight; agricultural policies that focus on productivity-increasing and labour-saving technologies that will displace small farmers and small-scale producers who are unable to find good jobs in the nascent manufacturing sector and low-productivity service sector; increasing the efficiency of the supply chain and availability of a reliable, safe and diverse food supply that could lead to dominance of large-scale retailers and

the related risks to nutrition associated with the "supermarketization" of the food supply; and trade policy that promotes engagement in world markets, at the risk of externally induced market failures that lead to food price shocks and represent a serious risk to better nutrition.

Dealing with these policy dilemmas requires strong government institutions and cooperation among a range of stakeholders, from international organizations, commercial interests, and local organizations, including women's groups and farmers' organizations. Perhaps, the biggest challenge is strengthening and fostering joint engagement among these stakeholders. This can only occur if there is a common priority accorded to nutrition when designing a broad range of policies. Consensus on such a priority, however, has proven elusive in Africa, not unlike other regions of the world, including Western and wealthy countries that have left many nutritional challenges unmet, as narrow interests are advanced at the expense of social welfare.

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Nutrition Transition and the Triple Burden of Malnutrition in Sub-Saharan Africa: Status, Determinants and Economic Welfare Costs

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Introduction

The concept of "nutrition transition" has been used to describe the shift in dietary intakes and energy expenditure that coincides with economic, demographic, and epidemiological transitions. Demographic transition suggests that with improvements in health, mortality rates start to drop faster than fertility rates resulting in an increase in family size. The change from high birth and death rates to low birth and death rates will lead to an increase in population. Epidemiological transition refers to the fact that with rapid economic development and a decline in fertility rates, there has been a shift in the disease profile of countries from predominately infectious diseases and nutritional deficiencies to overweight/obesity and diet-related noncommunicable diseases (NCDs). Sub-Saharan Africa (SSA) is currently undergoing wide demographic, epidemiologic, and economic transitions contributing to a change in the prevalence of infectious to noncommunicable diseases [1-3].

Malnutrition is defined as a spectrum of nutritional disorders that range from mild to severe and result from an imbalance of energy and nutrient intake. The imbalance can be related to the intake of macronutrients, which are the sources of dietary energy in the or the imbalance can be related to micronutrients. On the one hand, there is overnutrition (which includes overweight, obesity, and diet-related noncommunicable diseases) and, on the other hand there, is undernutrition (underweight, childhood stunting and wasting); this, along with micronutrient deficiencies (usually assessed by anaemia prevalence), is referred to as the triple burden of malnutrition (TBM). Current global estimates show that almost 2 billion adults and children are overweight or obese, while 462 million adults are underweight, over 155 million children under 5 years of age are stunted and 264 million women of reproductive age (WRA) are affected by iron-deficiency anaemia [4-6].

A country is considered burdened by this when its national prevalence exceeds the threshold of 20% for stunting among children under 5 years of age; 20% for anaemia among WRA (15 to 49 years old); and 20%, 30% and 40% for mild, moderate and severe overnutrition, respectively, for both adults and children [7]. These three malnutrition indicators are disproportionately distributed worldwide, manifesting singly or in combination at country, household, and individual levels. Unfortunately, low-income and middle-income countries (LMICs) are most severely affected, especially countries in SSA [7].

Interest in triple-burden malnutrition remains unabated due to the major health challenges it poses for populations of developing countries, as well as the potential economic implications. Disease and lifestyle patterns have been changing rapidly worldwide, including in Africa, due to recent changes in economic growth and urbanization. However, research related to the effects of these changes on nutrition status in Africa is limited. Little is also known empirically about the economic welfare implications of the burden on malnutrition in SSA. The goal of this paper is to provide

an overview of the current malnutrition landscape with respect to the triple burden of malnutrition in SSA and its research, programmatic and policy implications. The objectives of the paper are to:

i. describe the status and shifts in malnutrition in SSA within the context of the triple burden of malnutrition, and exploring associated factors; and

ii. explore consequences of SSA's malnutrition burden for infant mortality, education outcomes, the health system and labour productivity.

Findings will inform recommendations for policymakers and future research work.

Theoretical frameworks

Two conceptual frameworks guided this work: one showing the causal pathways to malnutrition and the other exploring pathways from malnutrition to social welfare and economic costs. Figure 1 depicts an adaptation of the United Nations Children's Fund (UNICEF) framework typically associated with undernutrition, to include overnutrition (UNICEF, 2013a; [8]). Both overnutrition and undernutrition lead to short and long-term morbidity and mortality outcomes with intergenerational consequences. These intergenerational consequences constitute an intergenerational cycle of undernutrition (related to low energy intake and micronutrient deficiencies) and an intergenerational cycle of overnutrition (related to high energy intake and associated co-morbidities such as diabetes) [9]. These vicious cycles of prenatal, perinatal, and postnatal exposure to nutritional inadequacies or excesses predispose children to undernutrition (especially stunting) or excess adiposity (obesity) in early life. Interaction between early life nutritional status and environmental exposure (especially the food environment) in later life influences adult nutritional status, whether optimal or suboptimal (undernutrition, overnutrition or both). Whether in early childhood or later in adulthood, the intergenerational effects leading to undernutrition or overnutrition represent another causal pathway to all forms of malnutrition in addition to well-recognized immediate, underlying, and basic causal pathways. Inadequate dietary intake is an immediate cause of both forms of malnutrition, in addition to physical inactivity for overnutrition and disease for undernutrition. Inadequate dietary intake is a consequence of insufficient access to healthy foods (an underlying cause) which is partly a consequence of food environments (a basic cause) that limit availability and access to a variety of fresh foods. The primary drivers of all forms of malnutrition are early life nutrition, diet quality, food environment and socioeconomic factors [10].

Figure 1: Conceptual framework of causal links to all forms of malnutrition

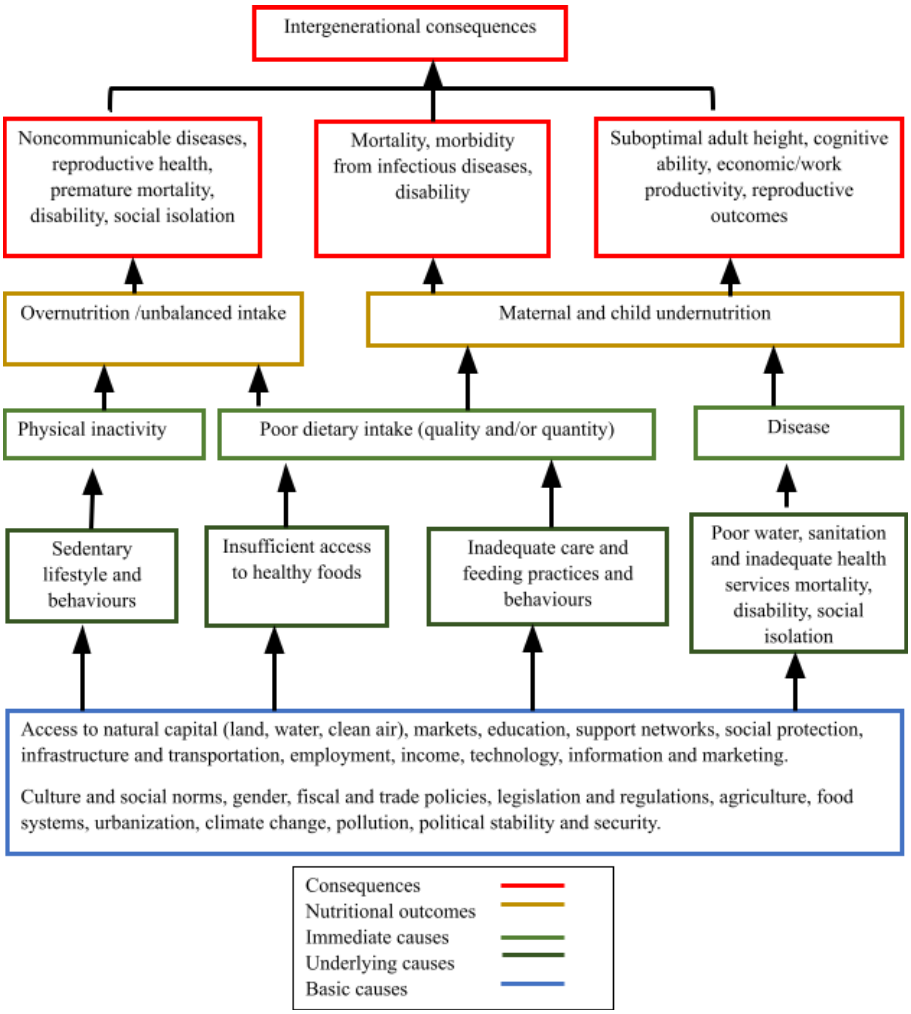
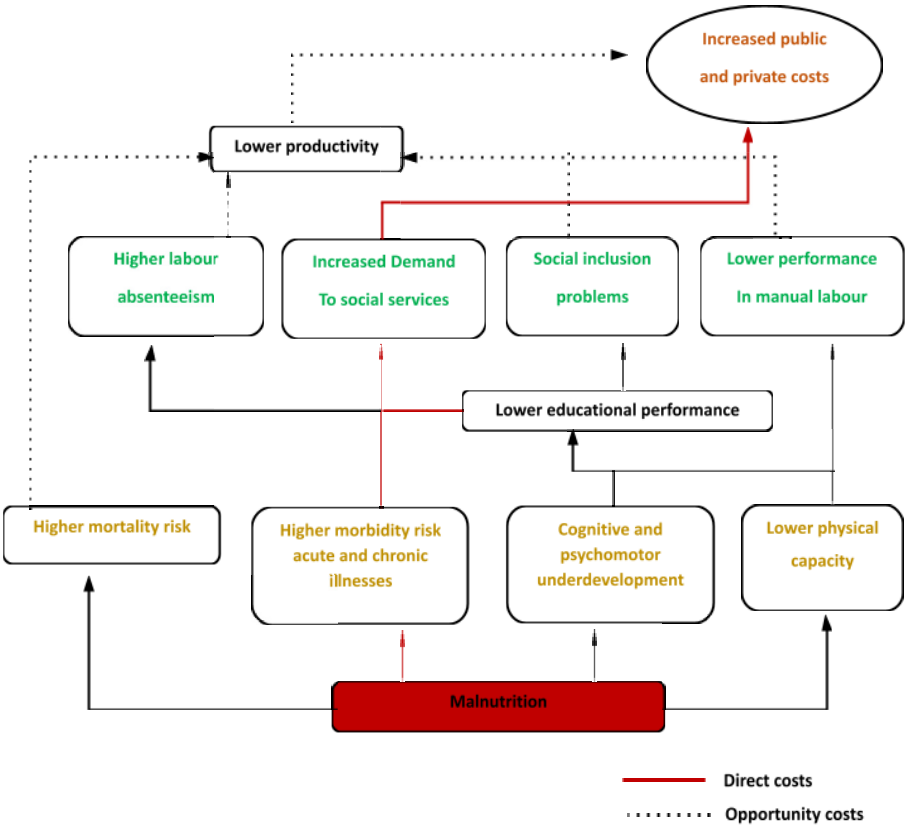


Figure 2 shows the pathways through which malnutrition negatively impacts economic and social outcomes, particularly mortality, health, education, and larger societal output. Malnutrition and child mortality are very strongly positively correlated [11-14] with malnutrition accounting for up to 28% of all child mortality in Africa, and from between a third [15] to a staggering 45% [11] of all preventable child deaths globally.

Figure 2: Pathways though which malnutrition impacts economic outcomes.



Source: Adapted from COHA report, UNECA 2014

Malnourished children are also likely to have a low quality of life due to compromised immune systems that lead to higher morbidities, like anaemia, diarrhoea, fever and respiratory infection [16], which also increase both health care costs to households as well as the wider society [17-19]. With regard to education and cognition, malnourished children are less likely to be productive adults due to impaired cognitive development that directly impacts their ability to acquire human capital skills leading to underperformance in school [20]. Undernourished children are more likely to do poorly in [21, 22] and drop out of school [23, 24]. Interventions that reduce stunting in children have been found to increase educational attainment [25, 26] and, ultimately, earnings [24, 26]. Malnutrition also has negative implications for individual and societal economic variables and, ultimately, on economic growth. At the individual level, losses are measured via lost earnings due to malnutrition, primarily stunting [27]. Height has been found to be a good measure for malnutrition status which, as noted earlier,

impacts cognition, health status and individual productivity and hence earnings [20, 28]. Shorter adults generally earn less than their contemporaries [28, 29]. Also, many studies across different contexts find significant positive wage returns related to height. Country studies that show increased wage returns related to height include China [30], Ghana, Brazil the United States [31] and Mexico [32]. In addition to individual wage losses, malnutrition also imposes great costs on society due to output and productivity losses. It is estimated that malnutrition costs African economies between 3% and 16% of gross domestic product (GDP) annually [33].

Methodology

Data and sources

The DHS and Global Dietary Database (GDD) were the main sources of data used in the analyses to address the first objective. Econometric analyses (objective two) were performed using the World Development Indicators (WDI) and the International Labour Organization databases (ILOSTAT). The DHS produces nationally representative data on key nutrition and health-related variables approximately every five years for countries where they are undertaken. For most SSA countries for which DHS data are available, data were collected once or twice in a decade. Due to challenges with data availability only three decades, spanning 1990 to 2018 (1990–1999, 2000–2009 and 2010–2018), were used in the analyses for objective one. Where data were available, the latest time period (data point) within a decade in which data were collected for a country was taken as the representative data point for the country and the decade. Countries with available data points for each decade of DHS data used in the analysis is provided in Appendix 1. The WDI database provides data on health systems (out-of-pocket spending on health as a percentage of GDP, capital expenditure on health, domestic general government health expenditure per capita, current health expenditure per capita in current US$) and education outcomes, i.e., school completion rates. The data are available every year for selected countries for between two and three decades. There were some variables for which only a few years of data were available for several countries. The measures of labour productivity available in the ILOSTAT include output per worker, annual growth rate of output per worker (GDP constant 2011, international $US in PPP) (%) and labour income as a percentage of GDP. The data are country-level panels for 48 countries in SSA [34]. For analyses related to objective two, we focus on the available data for three decades (from 1990 to 2019) as it was possible to aggregate a decent amount of data for variables of interest over that period, even though this was only true for some variables. The range of data availability was from 27 years to as few as 7 years.

Data analysis

Key variables of interest

We restricted the analysis to populations most vulnerable to malnutrition, namely, WRA (15 to 49 years) and children. While there was an interest to explore trends in overnutrition for all adults, very few countries had data on men across time for an analysis for trends.

We selected malnutrition indicators that have been consistently collected across SSA countries where the DHS is regularly conducted (generally every four years for most countries) and that are typically implicated in a triple burden of malnutrition for SSA in the literature. These are: (i) child anthropometric deficits (typically stunting and wasting among children under 5); (ii) micronutrient deficiencies (typically anaemia associated with iron deficiency); and (iii) overweight and obesity.

Economic welfare indicators of interest in this paper include: (i) child mortality (under-5 mortality, infants, and neonates, respectively); (ii) health systems (captured in terms of current health expenditure as a percentage of GDP and out-of-pocket expenditure as a percentage of total current health expenditure, respectively); (iii) education (completion rates for primary school and secondary school); and (iv) economic productivity, evaluated using output (GDP) per worker. The nutrition and economic welfare variables used in the analyses are summarized in Appendix 2.

Descriptive analyses

We computed the mean prevalence of malnutrition indicators across SSA countries for each decade (i.e. 1990s, 2000s and 2010s) to describe the distribution of these indicators over time for SSA and its four subregions (West Africa, East Africa, Central Africa and Southern Africa). To determine shifts in these indicators over time, we calculated the percentage-point difference between the earliest available data point (2000s for anaemia and 1990s for the others) and the most current data point (2010s for all) for each indicator per country and computed the average percentage-point change for all of SSA and the four subregions. To ascertain the presence of multiple burdens of malnutrition we first determined whether country-level prevalence constituted a problem of public health significance based on established prevalence thresholds for defining public health significance of undernutrition [35], anaemia [7] and overweight/obesity among children and women [36]. We defined the triple burden of malnutrition as a country having concurrently at least a:

i. high burden of undernutrition: child stunting of ≥ 20% or child wasting prevalence ≥10;
ii. moderate burden of micronutrient deficiency: women or child anaemia prevalence ≥ 20%; and
iii. moderate burden of child overweight or women's overweight and obesity prevalence ≥30%.

A double burden of malnutrition is defined as having either i) or ii) plus iii). It is recognized that countries could have both i) and ii) and this would be classified as the coexistence of undernutrition and anaemia. We conducted a similar descriptive analysis for other key indicators such as infant mortality, school enrolment and health expenditures.

Multivariate analyses

To determine predictors of the shifts in malnutrition indicators based on DHS, we use linear regression to model the association of some country-level sociodemographic indicators and the changes (shift) in the prevalence of malnutrition indicators between the latest (2010s for all) and earliest (2000s for anaemia and 1990s for the rest) decades. Thus, a negative change denotes a decline in prevalence between the decades and the greater the difference between decades, the greater the reduction in prevalence.

Estimation strategies for econometric analyses

The analysis focussed on exploring the relationship between malnutrition and the economic welfare indicators of interest. The primary regressors of interest were the child malnutrition indicators. Other determinants are also controlled for, but their inclusion was determined by availability of data (over time and at the country level), as well as their relevance to the equation. Due to inconsistent availability of data across countries and for different time periods, observations vary across models. The econometric (panel fixed effects) model estimated for each of the outcome variables in this study can be specified as:

$$EOit=\gamma Mit\text{-}15.kXkit + i+eit \quad (1)$$

Where: EO_{it} represents economic outcomes, I = country and t = time. As mentioned earlier, economic outcomes considered in this study include different measures of child mortality, health systems (expenditure), education outcomes and productivity. The different measures of child (under-5) malnutrition considered in this study are denoted by M_i. The five measures of child malnutrition-related variables examined are child wasting, stunting, overweight, underweight and anaemia prevalence. It follows that five different regressions (each featuring a different but specific measure of child malnutrition outcome) were estimated for each economic outcome (dependent variable). Xk represents other regressors as conceptually applicable to a specific outcome variable. αi is the unknown intercept for each country capturing country specific heterogeneity and ui is the random error term.

For productivity models, we recognize that childhood malnutrition will affect productivity in later years. Consequently, we regressed current period (year t) productivity on the malnutrition rate of 15 years ago (year t-15), and other current period (year t) covariates.

$$EOit=\gamma Mit\text{-}15.kXkit + i+eit \quad (2)$$

We believe that the effects of economic outcome variables such as current productivity or health spending may be related to past productivity and previous health spending.

This therefore calls for the use of a dynamic panel. In attempting the dynamic panel estimation, the estimation approach involved inclusion of the lagged value of the dependent variable and some independent variables on the right-hand side, differencing of variables and use of lagged values as instruments. Resulting observations were too few to be used, and this approach was abandoned. We used STATA version 15 for the data analysis.

Results

Current state of triple burden of malnutrition in sub-Saharan Africa

Based on the most current DHS available (between 2010 and 2018), approximately 33%, 16% and 7% of children in SSA are stunted, underweight or wasted, respectively (Figure 3). East Africa has the highest burden of stunting (approximately 37%), while West Africa has the highest prevalence of wasted children (about 7%). At least one out of every two children in SSA and all its subregions has some form of anaemia (mild to severe) (Figure 4). The overall mean anaemia prevalence is 64% and 42% among WRA and preschool age children, respectively. Overweight and obesity affects about 35% of WRA in Southern Africa, while the average prevalence for all SSA countries is approximately 26% (Figure 5). The average child overweight prevalence for SSA is just under five per cent. The highest prevalence of child overweight is in the Southern Africa region (about 7%) while the West Africa region has the lowest burden (about 3%) among the countries included in the analyses.

Of the 28 countries with data on child undernutrition, only three (Gabon, Ghana, and Senegal) have stunting and wasting prevalence that is less than 20% and 10%, respectively (Appendix 3). All 23 countries with data on anaemia have a public health burden of anaemia. Of the 27 countries with data on child or women's overweight/obesity, 25 (93%) have a significant public health burden of overnutrition. Of these countries, 13 have a triple burden of malnutrition, four have a double burden of underweight and overnutrition and two have a double burden of anaemia and overnutrition. Without available data on anaemia and a low prevalence of overweight/obesity, Chad seemingly has a single burden of child undernutrition.

Figure 3: Prevalence of child undernutrition across SSA (2010–2018)

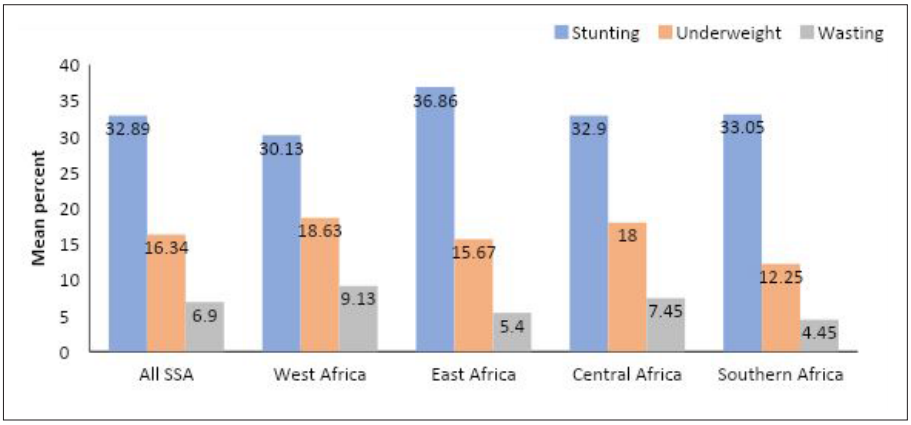


Figure 4: Prevalence of anaemia among women and children (2000–2018)

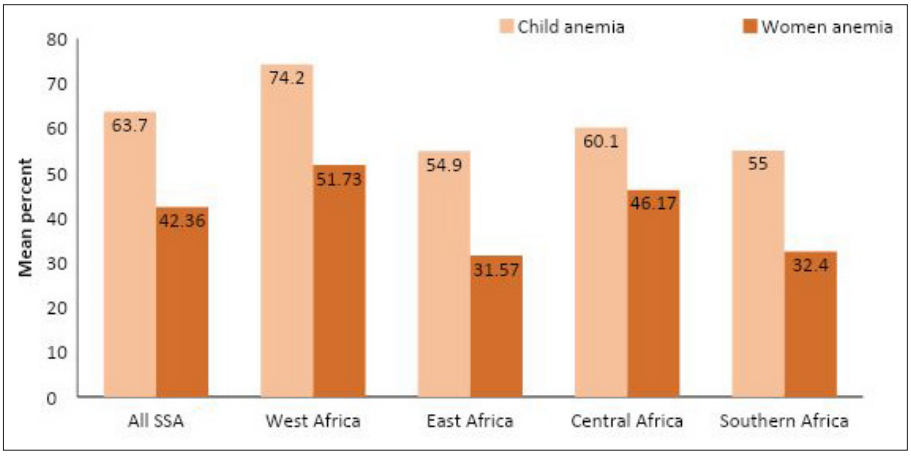
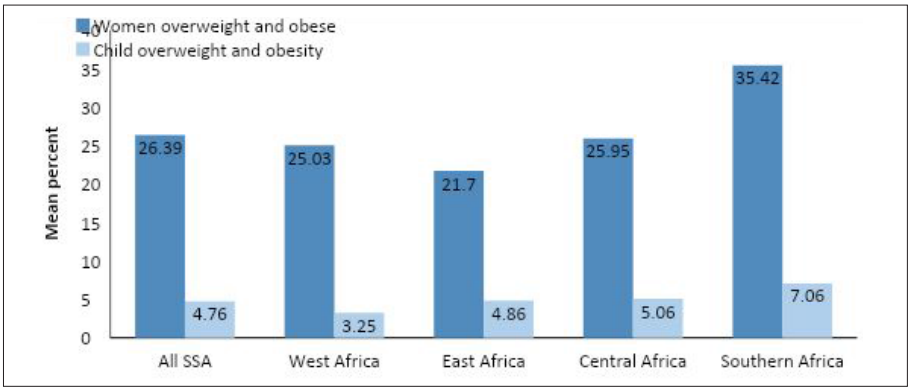


Figure 5: Prevalence of overnutrition among women and children across SSA (2000–2018)



Shifts in triple burden malnutrition indicators

Over the past three decades (1990s to 2010s), the mean prevalence of undernutrition and anaemia has declined in SSA while overnutrition among women has increased steadily (Appendix 4). As income and urbanization are often implicated as drivers of trends towards overnutrition, we explored trends in undernutrition (stunting) and women's overnutrition across household wealth quintiles and place of residence (rural vs urban). Across all wealth quintiles stunting increased slightly from the 1990s to 2000s and declined between the 2000s and 2010s (Figure 6). For all three decades, stunting is more prevalent among households in the lower wealth quintiles. However, stunting prevalence has remained significant even among the wealthiest households from the 1990s (28%) to the 2010s (21%). In contrast, women's overweight and obesity have increased steadily across all wealth quintiles with the greater average prevalence among higher wealth households for all three decades (Figure 7). In the 2010s nearly 42% of women from the highest wealth households were overweight or obese compared to 10% of women in the lowest wealth quintile households. Trends in child stunting were similar for rural and urban households, with stagnant rates between the 1990s and 2000s and a decline between the 2000s and the 2010s. Although child stunting is higher in rural households, the prevalence in urban households is not insignificant; in the 2010s about one in four SSA children was stunted (Figure 8). Trends in women's overnutrition in the past three decades show a similar pattern among urban and rural households with a decrease between the 1990s and 2000s and an increase between the 2000s and 2010s (Figure 9). Women's overweight and obesity is more prevalent among urban households, with a mean prevalence of about 34% in the 2010s, while rural households in SSA also have a significant public health burden of women's overnutrition.

Based on the difference between the earliest and latest available data points for each of the country-level TBM indicators, Figure 10 shows that the percentage-point declines in undernutrition and anaemia in SSA were less than 10% while there was a double-

digit increase in overnutrition among women. The overall increase in child overweight and obesity over the past three decades has been minimal. Changes in malnutrition indicators vary across the different SSA countries. Although, overall, undernutrition and anaemia rates declined between the 1990s and 2010s, wasting prevalence increased in the Comoros and Zambia, and the prevalence of anaemia increased in Lesotho and Mali during the same period.

Factors associated with shifts in malnutrition between 2000s and 2010s

In Table 1 we show how country trends (change from 2000s to 2010s) in different covariates commonly associated with child nutritional status influenced reductions in child stunting and wasting between the 2000s and 2010s. There was an increase in the percentage of women deciding for themselves how to use their income, which tended ($p<0.1$) to increase the percentage-point reduction in stunting by 0.21. Overall, the percentage of male-headed households reduced in SSA and this was inversely associated with stunting reduction (i.e., lower reduction in stunting). Only the time between surveys was a significant determinant of wasting. Unfortunately, there were insufficient observations for a meaningful analysis of anaemia and there were no significant associations with the increase in women's overnutrition.

Figure 6: 1990s to 2010s Trends in child stunting indicators

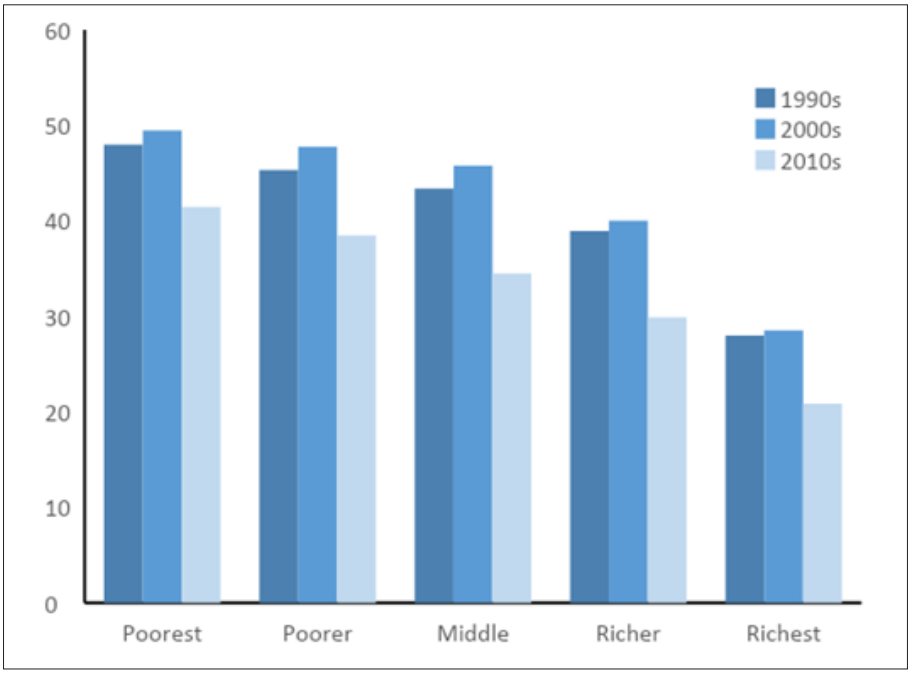


Figure 7: 1990s to 2010s Trends in womens overweight and obesity in SSA

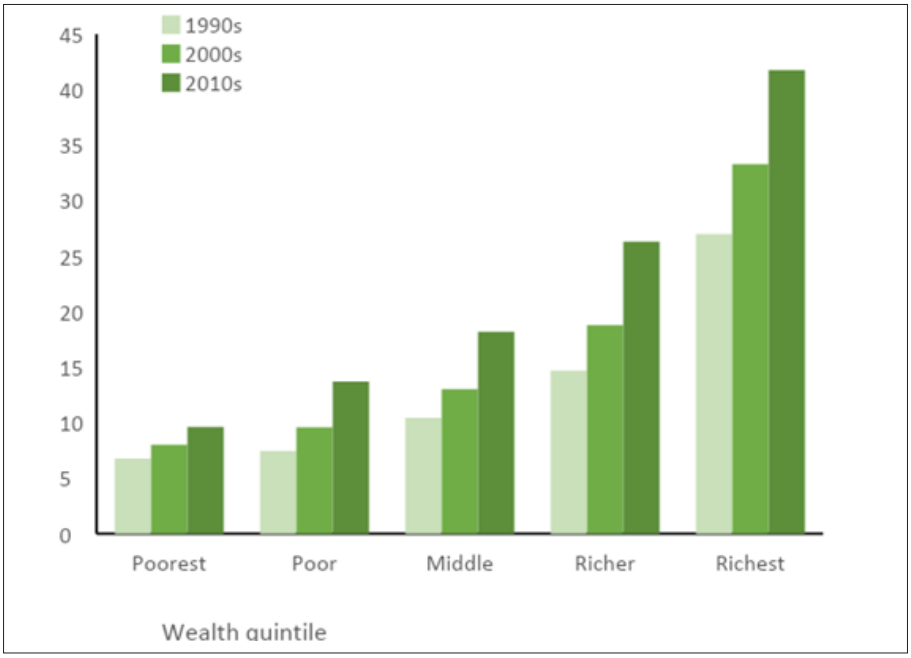


Figure 8: Trends in mean prevalence of child stunting in SSA rural/urban households

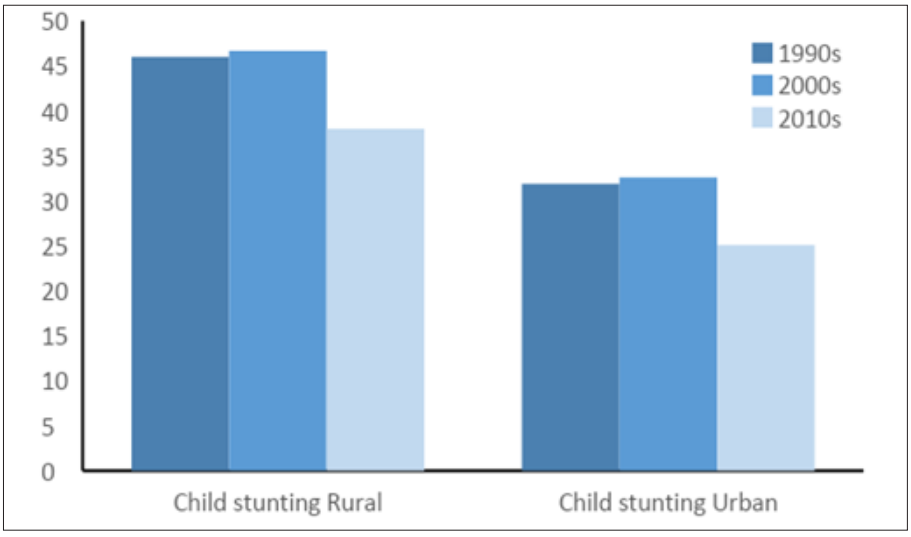
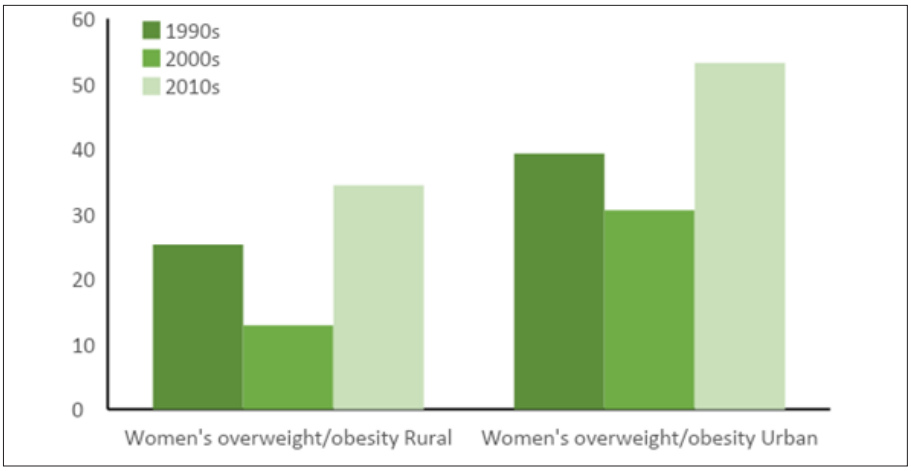


Figure 9: Trends in women's overweight/obesity in SSA rural/ urban households



Based on the difference between the earliest and latest available data points for each of the country-level TBM indicators, Figure 10 shows that the percentage-point declines in undernutrition and anaemia in SSA were less than 10% while there was a double-digit increase in overnutrition among women. The overall increase in child overweight and obesity over the past three decades has been minimal. Changes in malnutrition indicators vary across the different SSA countries. Although, overall, undernutrition and anaemia rates declined between the 1990s and 2010s, wasting prevalence increased in the Comoros and Zambia, and the prevalence of anaemia increased in Lesotho and Mali during the same period.

Figure 10: Percentage point changes in malnutrition indicators in SSA between 1990s and 2010s

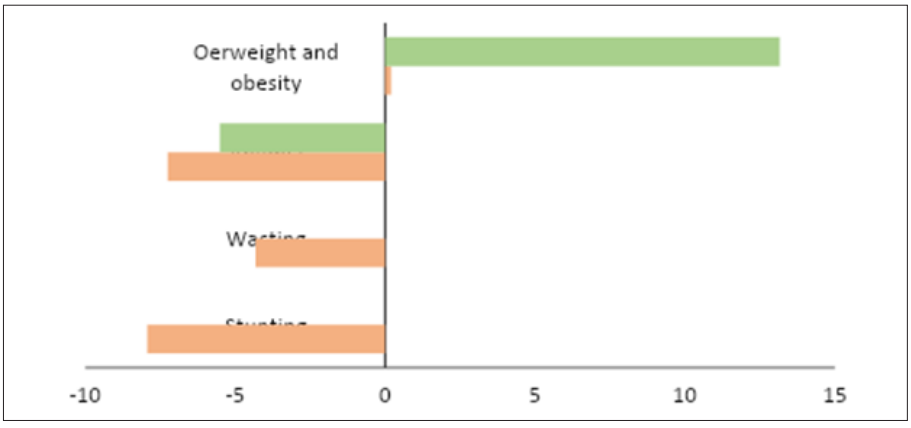


Table 1: Linear regression results on determinants of reduction in child stunting and wasting in SSA between 2000s and 2010s.

Change in covariate (direction of change)	Change in indicator between 2000s and 2010s	
	Stunting Coef. (SE)	Wasting Coef. (SE)
% literate women (↑)1	-0.08 (0.22)	0.03 (0.17)
% women making own income decisions (↑)	0.21 (0.12) *	-0.15 (0.10)
% households with improved water source (↑)	-0,.11 (0.10)	0.14 (0.10)
% households with toilet (↓)2	0.17 (0.08)	-0.01 (0.08)
% households with electricity (↑)	-0.02 (0.09)	0.04 (0.10)
% male-headed households (↓)	-0.46 (0.22) **	-0.12 (0.24)
Duration between surveys	-0.15 (0.43)	-0.51 (0.28) *
Observations	24	23

1 Increase between 2000s and 2010s2; decrease between 2000s and 2010s; **p<.05; *p<0.1.

Multivariate analyses on contribution of malnutrition to health, education and economic welfare outcomes in sub-Saharan Africa

Infant/child/neonatal mortality

Over time, mortality rates have fallen for the different measures of child mortality for Africa as a continent, although prevalence is still high (Appendix 5). The first set of results (Tables 2A and 2B) present the impact of the different measures of malnutrition on child under-5 mortality and infant mortality, with each analysis table containing a different child mortality regressor. Consistent with the literature, measures of stunting, wasting, underweight and child anaemia all have a strong positive impact on under-5 mortality. Findings reveal that a one-per-cent increase in the prevalence of each measure of malnutrition (except overweight) will increase the prevalence of under-5 mortality by 1 and 2 per 1,000 live births.

Infant mortality is not significantly impacted by any of these variables except prevalence of under-5 anaemia. Children with anaemia are more likely to die before the age of one. Other covariates that have a significant impact on under-5 mortality across all specifications include consumption expenditure as a percentage of GDP, which measures spending decisions in the economy. This is perhaps a hint that spending is mostly on subsistence living, which does not help to reduce stunting. The age-dependency ratio (the percentage of older people dependent on the working age population) also increases under-5 mortality – giving some idea of the pressure on the household allocation of resources, and how tough decisions may need to be made regarding how to prioritize care for old and young dependents. Having access to clean water is also particularly

important in reducing child mortality, as can be seen across all regressions. Finally, a rough estimate of maternal care is also an important predictor of under-5 mortality. This suggests that policies that increase the odds of women surviving childbirth will also reduce under-5 mortality. Most of the covariates above were also relevant for infant mortality in the same fashion. In addition, a child receiving treatment for diarrhoea (oral rehydration and continued feeding) was less likely to die before the age of one.

Finally, the impact of maternal anaemia on neonatal mortality is examined in Table 2C. The impact is positive, as women in suboptimal health are more likely to have a child who dies in the first month. Other factors that increase the chances of neonatal mortality include a high-age dependency ratio and poor sanitation (the practice of open defecation). As with previous iterations of this model, access to basic drinking water services reduces the chances of a child dying within the first month.

Table 2A: Malnutrition and under-5 mortality

	Mortality rate, under 5 (per 1,000 live births)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	***1.020	3.080	*1.140	1.970	***2.038	3.830	0.572	1.240	***1.683	3.060
Net foreign direct investment, net (% of GDP)	-0.200	-0.600	-0.253	-0.640	-0.216	-0.580	-0.248	-0.740	-0.030	-0.110
Diarrhoea treatment (% of children under 5 receiving oral rehydration and continued feeding)	-0.079	-0.510	-0.118	-0.820	-0.069	-0.550	-0.126	-0.820	-0.083	-0.520
Final consumption expenditure (% of GDP)	**0.360	2.650	***0.296	2.790	***0.286	3.180	***0.342	2.850	0.152	1.440
Current health expenditure as percentage of GDP	-2.274	-1.610	-1.178	-0.650	-1.390	-0.910	-1.669	-0.940	*-2.612	-1.890
Age-dependency ratio, old (% of working-age population)	**15.671	2.490	**15.692	2.560	**13.746	2.420	**16.909	2.630	**15.327	2.330
People practicing open defecation (% of population)	1.177	1.500	1.196	1.440	1.122	1.540	1.187	1.370	1.195	1.390

continued next page

Table 2A Continued

	Mortality rate, under 5 (per 1,000 live births)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
People using at least basic sanitation services (% of population)	0.757	1.240	0.588	0.930	0.617	0.960	0.576	0.920	0.357	0.490
People using at least basic drinking water services (% of population)	***-1.946	-3.290	***-2.195	-3.760	***-1.940	-3.620	***-2.211	-3.900	-1.198	-1.680
Maternal mortality ratio (modelled estimate, per 100,000 live births)	***0.053	2.850	***0.060	3.360	***0.054	3.360	***0.059	3.090	**0.038	2.330
_cons	-4.052	-.060	40.022	0.670	9.722	0.170	40.255	0.650	-81.888	-1.220
F-value	21.75		22.76		29.4		28.11		28.38	
P-value	0.00		0.00		0.00		0.00		0.00	
Obs	123		121		121		120		142	
Grps	40		40		40		40		41	

Table 2B: Malnutrition and infant mortality

	Mortality rate, infant (per 1,000 live births)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	0.077	0.840	0..033	0.240	0.180	1.330	-0.119	1.080	*0.230	1.820
Net foreign direct investment, net (% of GDP)	0.090	1.390	0.110	1.670	0.114	1.600	0.113	1.640	0.048	0.920
Diarrhoea treatment (% of children under 5 receiving oral rehydration and continued feeding)	***-0.119	-3.190	***-0.132	-3.410	***-0.125	-3.470	***-0.141	-3.330	***-0.109	-4.010
Final consumption expenditure (% of GDP)	0.016	0.650	0.008	0.360	0.005	0.240	0.007	0.300	0.003	0.160
Current health expenditure as percentage of GDP	-0.270	-0.670	-0.291	-0.700	-0.278	-0.770	-0.322	-0.800	-0.125	-0.400
Age-dependency ratio, old (% of working-age population)	**2.634	2.580	**2.580	2.440	**2.360	2.170	**2.494	2.550	*2.340	1.980
People practicing open defecation (% of population)	**0.265	2.110	**0.294	2.340	**0.285	2.190	**0.308	2.480	0.171	1.530

continued next page

Table 2B Continued

	Mortality rate, infant (per 1,000 live births)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
People using at least basic sanitation services (% of population)	0.061	0.560	0.017	0.150	0.027	0.240	-0.010	-0.080	0.007	0.060
People using at least basic drinking water services (% of population)	0.166	1.450	0.171	1.450	*0.188	1.700	*0.198	1.730	0.154	1.570
Maternal mortality ratio (modelled estimate, per 100,000 live births)	***0.009	3.790	***0.009	4.300	***0.008	3.830	***0.009	4.390	**0.006	2.160
_cons	42.277	3.910	***47.100	4.080	***44.256	4.130	***47.683	4.090	***39.178	3.400
F-value	12.02		12.73	0.240	14.16		13.7		10.32	
P-value	0.00		0.00		0.00		0.00		0.00	
Obs	123		121		121		120		142	
Grps	40		40		40		40		41	

Table 2C: Effects of anaemia on neonatal mortality

	Mortality rate, neonatal (per 1,000 live births)	
Variables	**coeff**	**t-value**
Prevalence of anaemia among pregnant women (%)	0.251*	1.720
Net foreign direct investment, net (% of GDP)	-0.005	-0.140
Diarrhoea treatment (% of children under 5 receiving oral rehydration and continued feeding)	-0.013	-0.540
Final consumption expenditure (% of GDP)	0.003	0.170
Current health expenditure as percentage of GDP	-0.165	-0.650
Age-dependency ratio, old (% of working-age population)	3.229***	3.090
People practicing open defecation (% of population)	0.282**	2.060
People using at least basic sanitation services (% of population)	0.023	0.130
People using at least basic drinking water services (% of population)	-0.224**	-2.120
Maternal mortality ratio (modelled estimate, per 100,000 live births)	0.005	1.340
_cons	5.101	0.400
F-value	20.67	
P-value	0.00	
Obs	142	
Groups	41	

Education

Educational attainment is proxied by primary and lower secondary school completion rates, which have both improved over time in Africa although less than half of lower secondary students complete that level of education (Appendix 6). There were some data availability constraints for some years and countries for lower secondary completion. Despite that, the equations tell a very consistent story: malnutrition significantly reduces school completion at both levels of schooling, and this finding was consistent across all five measures of malnutrition, including overweight (Table 3A). A one-per-cent increase in

each measure of malnutrition reduces the percentage of children that complete primary school by between 1.2% to 2.2%. Interestingly, the biggest drop was in obesity, reducing the percentage of children completing primary school by 2.25%. As pointed out earlier, malnutrition has been found to negatively impact a child's ability to learn, and this is evident across all models. The higher the prevalence of all measures of malnutrition, the lower the percentage of children who complete that level of schooling. the school completion rate (Table 3B). The percentage drops in school completion rates are lower for lower secondary schooling, ranging from 0.8% (impact of stunting) to 1.5% (impact of anaemia). Net foreign investment increases primary school completion rates but has no impact on lower secondary school rates. A high pupil-teacher ratio reduces completion rates – probably because it is too hard to learn under those circumstances, and a high debt burden also reduces completion as debt servicing is likely to crowd out spending on education.

Table 3A: Impact of malnutrition on primary school completion

	Primary school completion rate, total (% of relevant age group)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	***-1.280	-5.180	***-2.306	-5.160	***-1.645	-5.530	***-2.257	-4.000	***-1.523	-5.300
Net foreign direct investment, net (% of GDP)	**0.639**	2.070	***1.030	4.500	***0.863	3.420	**0.930	2.640	0.105	0.980
Final consumption expenditure (% of GDP)	0.064	0.450	-0.079	-0.710	0.060	0.470	-0.152	-0.690	-0.034	-0.260
Pupil-teacher ratio, primary	-0.337	-0.980	**-0.786	-2.340	**-0.825	-2.630	-0.458	-1.040	-0.107	-0.630
Total debt service (% of GNI)	*-0.609	-1.790	***-1.194	-6.370	-0.567	-1.510	***1.329	-4.740	**-0.696	-2.650
_cons	***112.263	5.890	***117.209	7.300	***119.149	8.340	***101.098	3.970	***170.154	9.210
F-value	13.26		43.5		17.26		16.05		12.25	
P-value	0.00		0.00		0.00		0.00		0.00	
Obs	113		110		112		98		539	
Grps	35		33		34		32		39	

Table 3B: Impact of malnutrition on lower secondary school completion

	Lower secondary school completion rate (% of relevant group)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	***-0.825	-3.520	**-1.035	-2.120	***-1.195	-3.300	-2.244	-1.570	***-1.562	-8.110
Net foreign direct investment, net (% of GDP)	0.033	0.060	0.273	0.460	0.143	0.250	0..378	0.420	0.063	0.550
Final consumption expenditure (% of GDP)	0.045	0.260	-0.060	-0.330	0.004	0.030	0.003	0.010	0.143	1.380
Pupil-teacher ratio, primary	-0.188	-0.570	-0.033	-0.080	-0.034	-0.090	-0.174	-0.470	0.007	0.060
Total debt service (% of GNI)	-0.668	-0.980	-1.475	-1.740	-0.702	-1.140	-1.581	-1.400	*-0.351	-1.810
_cons	***63.567	3.660	**49.678	2.370	***57.919	3.150	*50.165	2.070	***128.423	10.430
F-value	10.17		9.42		18.38		4.27		31.64	
P-value	0.0002		0.0002		0.000		0.0117		0.00	
Obs	42		42		42		36		142	
Grps	17		17		17		17		25	

Health expenditures

The relationship between malnutrition and health expenditures is quite enlightening. It would have been expected that high rates of malnutrition would lead to increases in health expenditure. However, African governments spend too little on health on average, much less than the rest of the world (Appendix 7A and 7B). This is evident from the results where there is no relationship between government health expenditure and all measures of malnutrition (Table 4A). A large percentage of health spending also comes from out-of-pocket expenditures (Appendix 7). However, it appears that it is mostly not effective spending, as there is almost no relationship between out-of-pocket spending and malnutrition either (Table 4B). Wasting is an exception as it reduces out-of-pocket spending. It appears that poor households, believing that there is no hope and being constrained by resources, may be unable to try to make the effort to save a malnourished child.

However, there is a positive relationship between health expenditure and other high-prevalence diseases, namely tuberculosis and malaria, which raises health expenditures. Utilization of sanitation services reduces health expenditures (as it reduces morbidities). Unexpectedly, access to clean water increases health expenditures, a finding that requires further investigation. The age-dependency ratio decreases government expenditure on health, but increases out-of-pocket expenditures, showing that households take responsibility for the health of the elderly, which can become overwhelming for resource-poor households.

Table 4A: Impact of malnutrition on health expenditures

	Current health expenditure (% of GDP)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	0.042	0.850	-0.076	-1.500	-0.013	-0.280	-0.071	-0.630	0.015	0.330
Net foreign direct investment, net (% of GDP)	0.006	0.300	0.004	0.180	0.003	0.140	0.009	0.440	0.002	0.340
Final consumption expenditure (% of GDP)	0.022	1.200	0.026	1.320	0.024	1.190	0.020	1.100	**0..019	2.230
Incidence of tuberculosis (per 100,000 people)	**0.002	2.080	**0.002	2.300	**0.003	2.310	**0.002	1.100	**0.001	2.040
Incidence of HIV (per 1,000 uninfected population aged 15–49)	-0.224	-0.690	-0.105	-0.320	-0.147	-0.430	-0.034	-0.120	-0.195	-1.110
Incidence of malaria (per 1,000 population at risk)	*0.007	1.730	*0.007	1.770	*0.007	1.740	**0.009	2.320	0.001	0.860
Age-dependency ratio, old (% of working-age population)	-0.520	-1.100	-0.480	-1.040	-0.485	-1.050	*-0.750	-1.690	-0.214	-0.750
People practicing open defecation (% of population)	-0.041	-0.670	-0.004	-0.070	-0.012	-0.220	0.016	0.280	-0.047	-1.290

continued next page

Table 4A Continued

	Current health expenditure (% of GDP)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
People using at least basic sanitation services (% of population)	**-0.116	-2.080	**-0.134	-2.280	**-0.125	-2.250	***-0.179	-3.540	-0.045	-1.350
People using at least basic drinking water services (% of population)	***0.189	3.140	*0.200	3.130	***0.190	3.010	***0.242	3.600	0.069	1.500
_cons	-3.055	-0.560	-3.187	-0.610	-2.572	-0.470	-3.773	-0.700	2.322	0.540
F-value	3.14		3.54		3.14		5.56		4.27	
P-value	0.0054		0.0023		0.0053		0.0001		0.0004	
Obs	95		94		94		90		308	
Grps	38		38		38		38		41	

Table 4B: Impact of malnutrition on out-of-pocket expenditures

	Out-of-pocket expenditure (% of current health expenditure)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	0.007	0.030	*-0.774	-1.720	-0.312	-0.870	0.065	0.180	-0.049	-0.200
Net foreign direct investment, net (% of GDP)	-0.088	-1.110	-0.081	-0.890	-0.093	-1.120	-0.081	-1.020	-0.021	-0.0230
Final consumption expenditure (% of GDP)	**-0.137	-2.120	*-0.113	-1.700	*-0.128	-1.990	**-0.141	-2.110	0.061	0.860
Incidence of tuberculosis (per 100,000 people)	0.002	0.340	0.001	0.210	0.003	0.420	0.001	0.270	-0.002	-0.480
Incidence of HIV (per 1,000 uninfected population aged 15–49)	-1.325	-1.460	-0.757	-0.730	-1.018	-0.990	-1.225	-1.190	1.055	1.400
Incidence of malaria (per 1,000 population at risk)	-0.003	-0.170	0.002	0.150	-0.0033	-0.180	-0.000	-0.030	0.008	0.850
Age-dependency ratio, old (% of working-age population)	***7.831	3.980	***7.976	4.360	**8.034	4.100	***7.520	3.460	***4.180	3.110
People practicing open defecation (% of population)	0.342	0.920	0.478	1.710	0.449	1.380	0.356	1.050	0.067	0.410

continued next page

Table 4B Continued

	Out-of-pocket expenditure (% of current health expenditure)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
People using at least basic sanitation services (% of population)	0.283	0.880	0.170	0.530	0..250	0.800	0.235	0.570	-0.039	-0.200
People using at least basic drinking water services (% of population)	**-0.599	-2.090	*-0.500	-1.980	**-0.603	-2.060	*-0.576	-1.690	**-0.546	-2.600
_cons	35.617	1.140	29.862	1.070	36.788	1.180	37.488	1.170	*42.170	1.740
F-value	9.67		7.44		8.09		8.48		6.28	
P-value	0.00		0.00		0.00		0.00		0.00	
Obs	95		94		94		90		308	
Grps	38		38		38		38		41	

Productivity

The main purpose of the productivity models is to establish the impact of different measures of malnutrition on societal productivity. However, the relationship between the two is not contemporaneous as young people need to be able to enter the labour market before, they can contribute to output. To try to capture this reality, the prevalence of the different measures of malnutrition were lagged 15 years and regressed on our measure of productivity (log of GDP per capita). This drastically reduced the number of observations available for the estimations, and the results must be interpreted accordingly. Also, productivity growth in sub-Saharan Africa has been slow over the past three decades (Appendix 8), despite some individual country success stories (e.g., Ghana and Rwanda).

Results are not as robust as hoped, probably due to the loss of observations. Both wasting and anaemia prevalence 15 years prior has a significantly negative relationship with current productivity (in line with the literature). The size of these effects is very small, with a percentage increase in childhood malnutrition prevalence reducing GDP per capita by less than one per cent. Other covariates have the expected relationship: capital formation raises total output, as does employment in the key industrial sector, while employment in the services sector has no impact. However, higher debt service obligations lower productivity as debt servicing likely crowds out productive activities. Employment in the agricultural sector, usually a low productivity activity in Africa, also does not increase productivity (Table 5).

Table 5: Impact of childhood malnutrition on per capita output

	Log of output per worker (GDP constant 2010 US$)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Malnutrition measure	0.001	0.330	**-0.006	-2.150	-0.004	-1.460	0.003	1.130	**-0.009	-2.37
Gross fixed capital formation (% of GDP)	0.004*	1.770	*0.004	1.880	*0.005	1.910	0.000	0.160	***0.003	2.74
Net foreign direct investment, net (% of GDP)	***-0.006	-2.900	***-0.007	-2.840	***-0.007	-3.160	-0.011	-1.340	-0.002	-1.23
Total debt service (% of GNI)	***-0.023	-3.370	***-0.036	-2.900	***-0.028	-3.760	0.021	0.620	***0.003	2.87
Employment in agriculture (% of total employment) (modelled ILO estimate)	-0.005	-0.800	-0.007	-0.990	-0.007	-0.990	-0.007	-0.950	0.000	-0.05
Employment in industry (% of total employment) (modelled ILO estimate)	***0.066	4.210	***0.072	5.250	***0.065	4.260	***0.066	4.340	**0.013	2.56
Employment in services (% of total employment) (modelled ILO estimate)	0.007	0.500	0.005	0.340	0.005	0.330	-0.002	-0.160	0.016	1.62

continued next page

Table 5 Continued

	Log of output per worker (GDP constant 2010 US$)									
Malnutrition measure definition	**Under-5 stunting**		**Under-5 wasting**		**Under-5 underweight**		**Under-5 overweight**		**Under-5 anaemia**	
Variables	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**	**Coeff**	**t-value**
Industry, value added per worker (constant 2010 US$)	***0.249	2.880	***0.261	2.880	**0.219	2.450	***0.385	4.340	***0.244	4.06
_cons	4.045	4.330	4.130	3.720	4.588	4.360	3.309	3.230	4.698	5.450
F-value	9.22		7.83		8.49		8.99		16.89	
P-value	0		0		0		0		0	
Obs	74		71		73		53		365	
Grps	39		37		37		35		39	

Discussion

Despite data limitations, the current analyses provide some meaningful insights on the current situation and trends in the burden of malnutrition in SSA and associated implications. The findings show that a decline in undernutrition and anaemia (proxy for micronutrient deficiencies) since the 1990s has been relatively small, together with a greater increase in overnutrition among women. Thus, more than two-thirds of the countries that have data on women's overweight and obesity have either a double or triple burden of malnutrition. The analyses also show that while wealth and rural-urban disparities exist in under- and over-nutrition, stunting still affects about one out of every four preschool age children in higher wealth households, while rural households also have a significant public health problem of women's overweight and obesity. In contrast to other low and middle-income countries where overnutrition is becoming more prevalent in poorer households [36], higher wealth households have the greater burden of women's overweight and obesity in the SSA countries assessed in this paper.

The limited dietary data analysis performed suggests that diets in SSA may be changing in a negative direction, with stagnant or decreasing intakes of healthier foods. There appears to be a trend towards increased consumption of sugar-sweetened beverages, which may indicate food environments in SSA moving towards the increased availability of more energy-dense foods that are characteristic of ultra-processed foods. Increased consumption of ultra-processed foods is implicated as an important feature of the nutrition transition and a key driver in the trend towards overnutrition [37].

Although effect sizes are small due to data limitations and aggregation, the econometric analyses suggest that undernutrition in SSA is diminishing human capital potential, as evidenced by the significant negative impacts of child undernutrition on school completion and under-5 mortality. Economic effects of overnutrition were not covered in our analyses, however, [38] reported that in 2017 the age-standardized DALY (disability-adjusted life year) rate attributable to noncommunicable diseases in SSA was almost similar to that of infectious diseases and maternal and child nutritional disorders. Diet-related chronic diseases (especially cardiovascular diseases and diabetes) associated with overnutrition in SSA pose a significant threat to health systems through their contribution to noncommunicable disease risk. As shown in our findings, health expenditures in SSA are inadequate and not influenced by undernutrition. The growing burden of overnutrition thus presents significant challenges to health systems already struggling to overcome undernutrition and infectious disease challenges.

Research, programmatic and policy implications/ considerations

Based largely on experiences from Latin America and Asia, about 30 years ago Popkin (1993) warned of rapid trends towards overnutrition in LMICs fuelled by changes in dietary and physical activity patterns associated with the nutrition transition [39]. This paper contributes to the evidence base that overnutrition is now an important aspect of the nutrition landscape for many SSA countries. While overnutrition and associated NCDs are consequences of the nutrition transition they are not a direct indication of the nutrition transition but rather, as explained by [37], they only serve as a proxy for it. The unavailability of detailed representative dietary intake data for SSA does not allow an effective exploration of the nutrition transition and its contribution to the growing burden of overnutrition, especially among women in SSA. As expressed by others [37, 40] there is an urgent need for quality dietary intake data (particularly on foods associated with the nutrition transition) for SSA populations. This could provide a better understanding of the dietary changes that may be occurring and their effects on body composition changes in the context of other concurrent transitions (e.g. demographic and epidemiologic transitions) and on lifestyle changes such as physical activity. With the exception of South Africa, where dietary data are more readily available, which suggest dietary changes towards consumption of more refined macronutrients [40], quality consumption data to clearly define these changes are largely unavailable for SSA countries [37], indicating a major research gap in understanding the nutrition transition in SSA.

Child undernutrition and anaemia rates are not declining fast enough, while women's overnutrition is a looming crisis that is largely ignored. The Africa Region Nutrition Strategy 2015–2025 [41] acknowledges the complexities of multiple malnutrition burdens and early life undernutrition as a risk factor for later obesity and NCDs, but overnutrition among WRA is overlooked in the impact objectives set for the strategy. Awareness building and advocacy to increase recognition of overnutrition as an important development issue are required to prompt a commitment to holistically addressing all forms of malnutrition in SSA. A lopsided focus on addressing undernutrition while relegating overnutrition contradicts the Sustainable Development Goal of ending all forms of malnutrition by 2030 [42]. Therefore, national nutrition policies and strategies in SSA should include reducing overnutrition. A good example is the Tanzanian National Multisectoral Nutrition Action Plan, which includes targets for reducing both child and adult overweight [43]. However, cultural perceptions of overweight as a sign of well-being may be an important hurdle to overcome in advocacy efforts to address women's overweight and obesity in SSA [44].

There is a need to strengthen efforts to curb the burdens of persisting child undernutrition and micronutrient deficiency. Effective solutions have been described in the 2008 The Lancet series on maternal and child nutrition [45] that comprise interventions to enhance early life nutrition, one of the key drivers of both

undernutrition and overnutrition. While many of these maternal and child health interventions targeting the first 1,000 days have been widely implemented across SSA, progress in reducing undernutrition has been slow or remained stagnant for many countries. Countries that have achieved significant reductions in child stunting in recent years provide learning opportunities on the strategies that yield the best dividends. In an effort to understand the determinants of stunting reduction in countries with significant reductions between 2005 and 2014 [46], the DHS for 9 countries found that for the 7 countries (Ethiopia, Ghana, Kenya, Liberia, Namibia, Niger and Rwanda) with the biggest reductions (at least 7% reduction), improvements made in maternity care indicators (achieving at least 4 ANCs, delivery of skilled birth attendance and taking iron supplements during pregnancy) contributed most to determinants of stunting reduction. While our analyses suggest general gaps in health spending for undernutrition by SSA governments, interventions to address undernutrition have been shown to be relatively affordable and produce disproportionately huge returns for both individuals and society at large [47].

Given that undernutrition and overnutrition affect the same vulnerable groups (women and children) and have similar key drivers, existing interventions targeting undernutrition can be realigned to simultaneously address overnutrition as well, so-called double duty actions [4, 10]. Double-duty actions in health service interventions that have traditionally targeted undernutrition will include strengthening these interventions to identify ways to realign them to also support overweight/obesity prevention. Provision of nutrition education and counselling is often a feature of maternal and child health programmes. This adjustment for double-duty actions may include simply incorporating messaging that build awareness about the dangers of overnutrition and provide education on healthy food choices for optimal nutrition and healthy weight maintenance across the life cycle. Double-duty actions can be extended beyond the health sector to other sectors with programmes that address the underlying causes of malnutrition such as school feeding programmes, food security interventions and poverty alleviation programmes through the education, agriculture, and social protection sectors, respectively.

An enabling environment that supports a healthy food environment is needed to support actions to address all forms of malnutrition. The World Health Organization (WHO) Global Nutrition Policy Review 2016–2017 reports that globally, country efforts to support a healthy food environment centre around actions and policies related to dietary guidelines, regulation for nutrition labelling and nutrition and health claims, media campaigns on healthy diets, and counselling on nutrition and healthy diets through primary health care [48]. However, Africa lags in many of these actions and further regulatory measures to drive healthier choices are lacking [44]. For example, several countries in SSA do not have legislation to control the marketing of breast milk substitutions, which is an important measure to support optimal infant feeding. SSA can learn from other regions on actions to mitigate against the increasing availability of obesity-promoting foods such as sugar-sweetened beverages.

The causes of all forms of malnutrition are multisectoral and therefore necessitates integrated policies and strategies that involve all sectors taking responsibility for promoting nutrition and wellbeing nutrition-specific and nutrition sensitive that address the immediate, underlying, and basic causes concurrently. Socioeconomic and knowledge barriers to making healthy choices for optimal wellbeing also need to be addressed through all sectors.

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Appendixes

Appendix 1: Availability of data per country and time point

Countries	1990–1999 (+)	2000–2009 (+)	2010-2019 (+)	All time points	Missing 1990s data
Benin	+	+	+	√	
Burkina Faso	+	+	+	√	
Cameroon	+	+	+	√	
Chad	+	+	+	√	
Congo		+	+		√
Comoros	+		+		
Eritrea	+	+			
Ethiopia		+	+		√
Gabon		+	+		√
Ghana	+	+	+	√	
Guinea	+	+	+	√	
Kenya	+	+	+	√	
Lesotho		+	+		√
Liberia		+	+		√
Madagascar	+	+			
Malawi	+	+	+	√	
Mali	+	+	+	√	
Mozambique	+	+	+	√	
Namibia	+	+	+	√	
Niger	+	+	+	√	
Nigeria	+	+	+	√	
Rwanda	+	+	+	√	
Senegal	+	+	+	√	
Sierra Leone		+	+		√
South Africa	+		+		
Tanzania	+	+	+	√	
Togo	+		+		
Uganda	+	+	+	√	
Zambia	+	+	+	√	
Zimbabwe	+	+	+	√	
Total	24	27	28	19	6

Appendix 2: Key variables and their definitions

Indicator	Description
Stunting	Percentage of children with height-for-age ≤-2SD of the WHO standard
Wasting	Percentage of children with weight-for-height ≤-2SD of the WHO standard
Underweight	Percentage children with weight-for-age ≤-2SD of the WHO standard
Child anaemia	Percentage of children under 5 years with anaemia (haemoglobin (Hb) level of less than 11.0 mmol/L n children)
Women's anaemia	Percentage of WRA with anaemia (haemoglobin concentration level than 7.0–9.9 g/dl)
Child overweight	Percentage of children under 5 years with weight-for-height (> 2 SD of the WHO standard)
Women with normal body mass index (BMI)	Percentage of women with BMI of 18.5 kg/m2 – 25 kg/m2
Women overweight/obese	Percentage of WRA with BMI 25.0 to 29.9 (overweight) or BMI ≥30 (obese)
Female-headed households	Percentage of households headed by women
Women with height below 145cm	Percentage of women aged 15–49 with height below 145 cm
Median duration of exclusive breastfeeding	Median duration of exclusive breastfeeding
Percentage of women who decide themselves how their earnings are used	Percentage of currently married or in union women employed in the 12 months preceding the survey receiving cash earnings who decides herself how the earnings are used
Households with (improved), non-shared toilet facilities	Percentage of households with improved, non-shared toilet facilities
Households using an improved water source	Percentage of households whose main source of drinking water is an improved source
Proportion of population in the lowest wealth index quintile (status)	Percentage of the de jure population in the lowest wealth quintile
Dependency ratio	Number of dependents in a population divided by the number of working-age people

continued next page

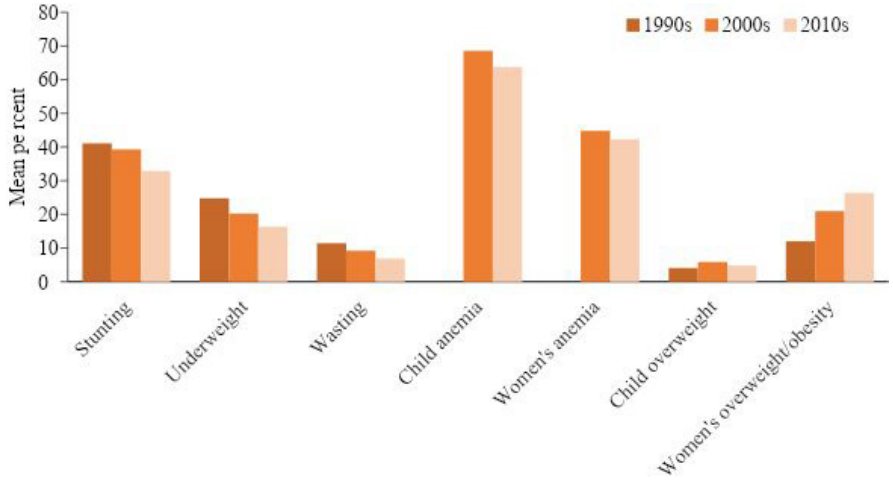
Appendix 2 Continued

Indicator	Description
Percentage of household in the 5th income quintile	The fifth quintile group represents the 20% of the population with the highest income (an income greater than the fourth cut-off value)
GDP growth	Measures how fast the economy is growing by comparing one quarter of the country's GDP to the previous quarter
Antenatal care from a skilled provider	Percentage of women who had a live birth in the five (or three) years preceding the survey who received antenatal care during the pregnancy for the most recent live birth from a skilled provider
Place of delivery: Health facility	Percentage of live births that were delivered in a health facility
Infant mortality	Probability of dying before the first birthday in the five or ten years preceding the survey, per 1,000 live births.
Child mortality	Probability of dying between the first birthday and the fifth birthday in the five or ten years preceding the survey, per 1,000 children surviving to their first birthday
Under-5 mortality	Probability of dying before the fifth birthday in the five or ten years preceding the survey, per 1,000 live births

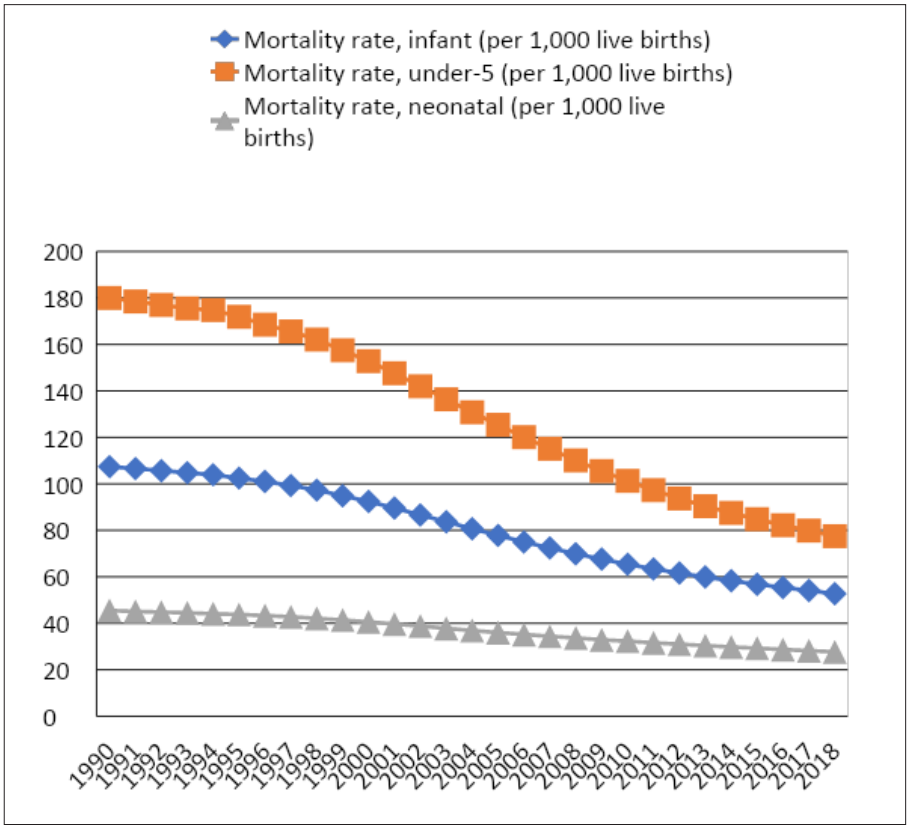
Appendix 3: SSA countries and their malnutrition burden

Single burden		Double burden		Triple burden
Under-nutrition	**Anaemia**	**Undernutrition + overweight**	**Anaemia + overweight**	**All three**
Chad	Senegal	Comoros	Gabon	Benin
		Kenya	Ghana	Cameroon
		Liberia		Guinea
		Zambia		Lesotho
				Malawi
				Mali
				Namibia
				Nigeria
				South Africa
				Tanzania
				Togo
				Uganda
				Zimbabwe
1	1	3	3	13

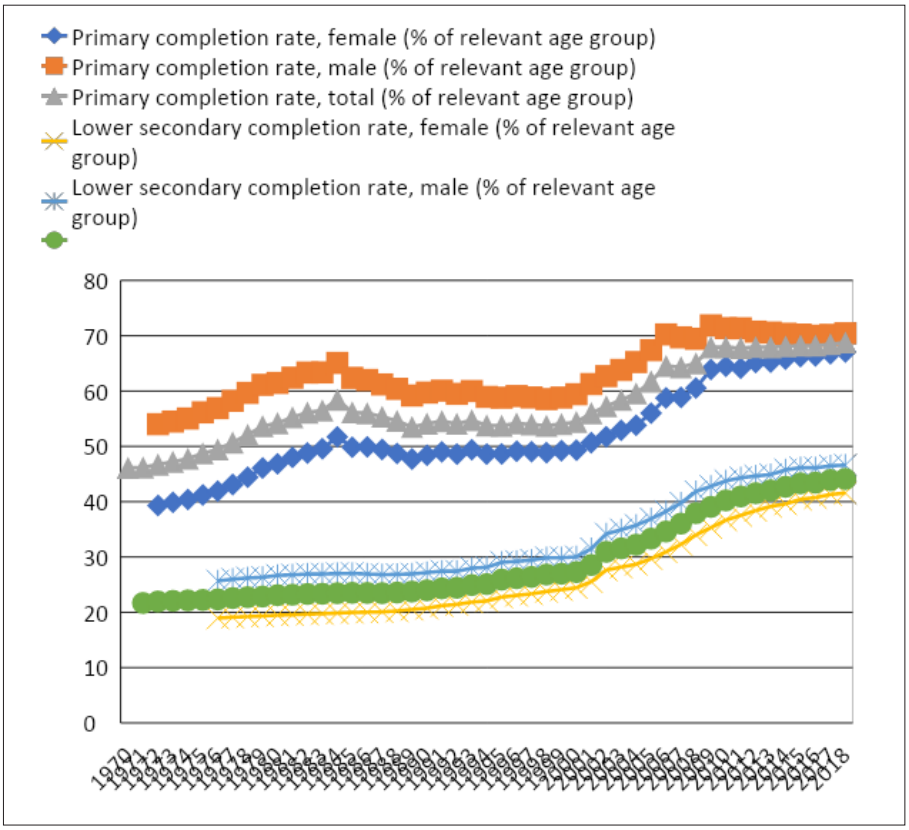
Appendix 4: Trends in malnutrition indicators in SSA between 1990s and 2010s



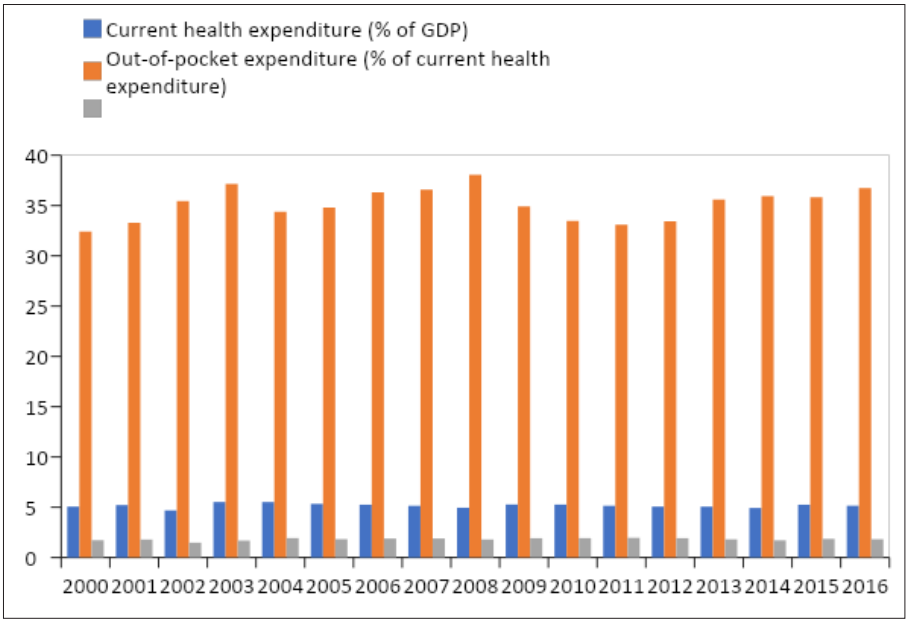
Appendix 5: Trends in mean prevalence of infant, child, and under-5 mortality (1990-2018)



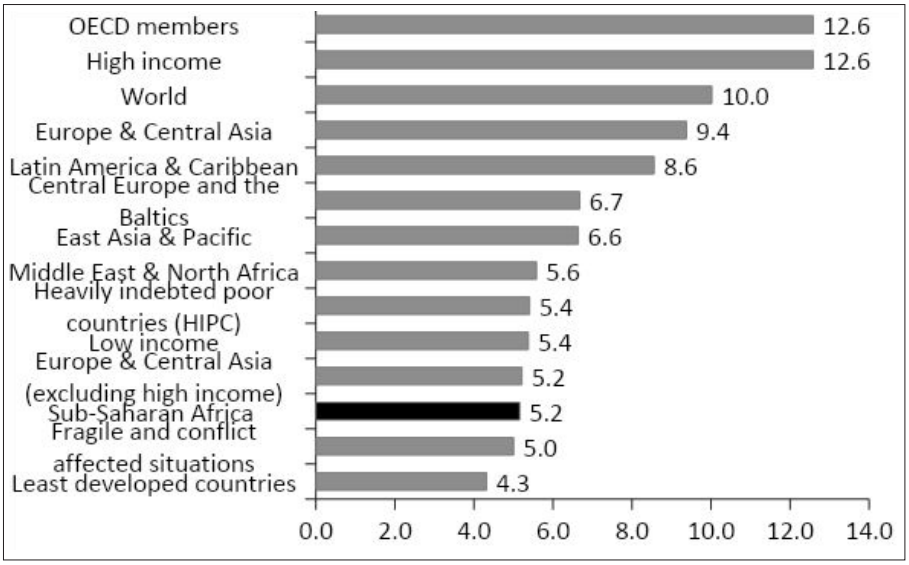
Appendix 6: Trends in primary school and lower secondary school completion rate (1970–2018)



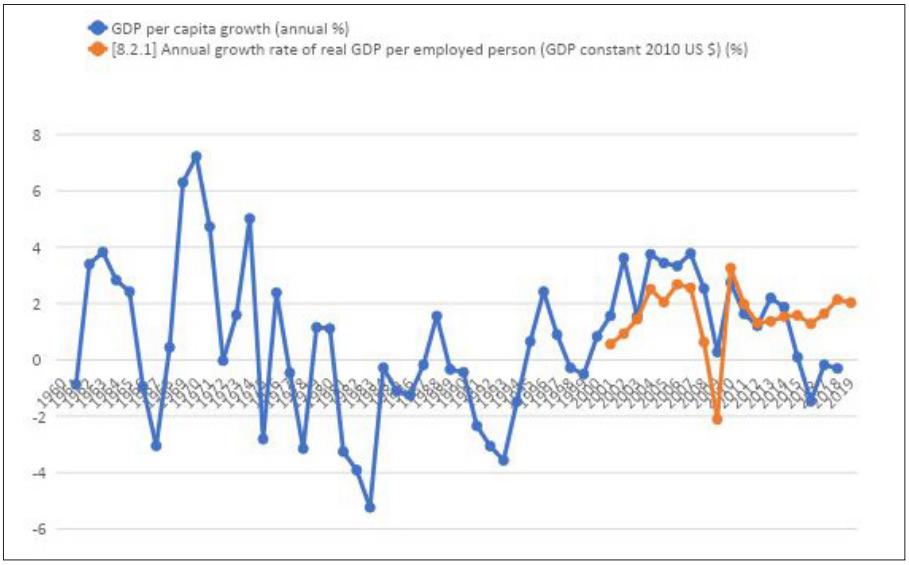
Appendix 7A: Trends in current, government and out-of-pocket health expenditures (2000-2016)



Appendix 7B: Health spending as percentage of GDP by selected world regions



Appendix 8: Trends in annual growth rate of real GDP per employed person (GDP constant 2010 US $) (%)



Combating Africa's Malnutrition through Food, Agriculture and Targeted Policies

Mekbib Haile

and

Wilson S. K. Wasike

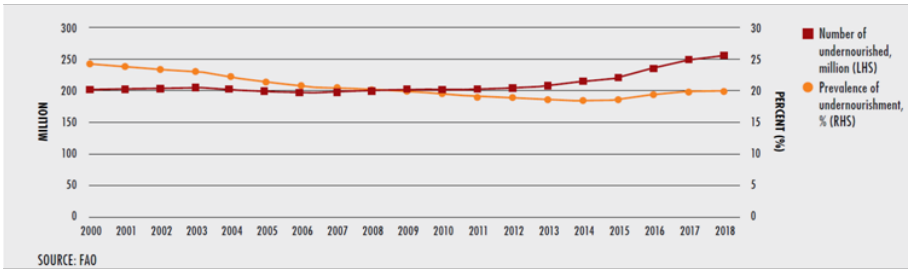
Abstract

This paper provides an overview of the drivers and causes of both household (and individual) and market (macro) level food and nutrition insecurity in Africa. These factors relate to demography, income and food prices, markets, and domestic and global policies. Moreover, climatic risks and conflict and instability serve to accentuate food insecurity in several African countries. This paper then presents an overview of the current knowledge and lessons learnt from implementing agricultural and food security related policies in Africa. Specifically, the paper provides an overview of lessons and challenges associated with implementing policies and strategies in diverse fragility-affected situations and states. In so doing, the synthesis presents findings from several country cases studies, most of which were supported by the African Economic Research Consortium (AERC) and the Bill & Melinda Gates Foundation (BMGF) under a collaborative research programme. While policies at different parts of the food system can shape the food and nutrition security (FNS) situation, most African policies designed to improve FNS predominantly focus on agricultural production. This synthesis, for example, provides evidence that the economic benefits of investing in households' access to food markets can significantly improve FNS in developing countries, particularly in Africa.

Overview of food and nutrition (in) security situation in Africa

Food insecurity, malnutrition and poverty are interconnected and long-standing challenges in several sub-Saharan Africa (SSA) countries. Malnutrition represents the number one risk factor in the global burden of disease, affecting over one in three persons (GLOPAN, 2016). After a long period of improvement, hunger in Africa—as measured by the prevalence of undernourishment—worsened in 2014–2018 (Figure 1). Today 256 million Africans, or 20% of the population, are undernourished. Of these, 239 million are in sub-Saharan Africa and 17 million in Northern Africa. Diets lacking in nutrients and digestive conditions that impair absorption of nutrients are the main causes of malnutrition. Paradoxically, undernutrition persists in sub-Saharan Africa alongside new trends in over-nutrition, which result in obesity—a situation that has often been referred to as the "double burden of malnutrition" (Nugent et al., 2019). The other burden is micronutrient deficiency (Gómez et al., 2013). The rise in the prevalence of undernourishment has been highest in western Africa, followed by Central Africa.

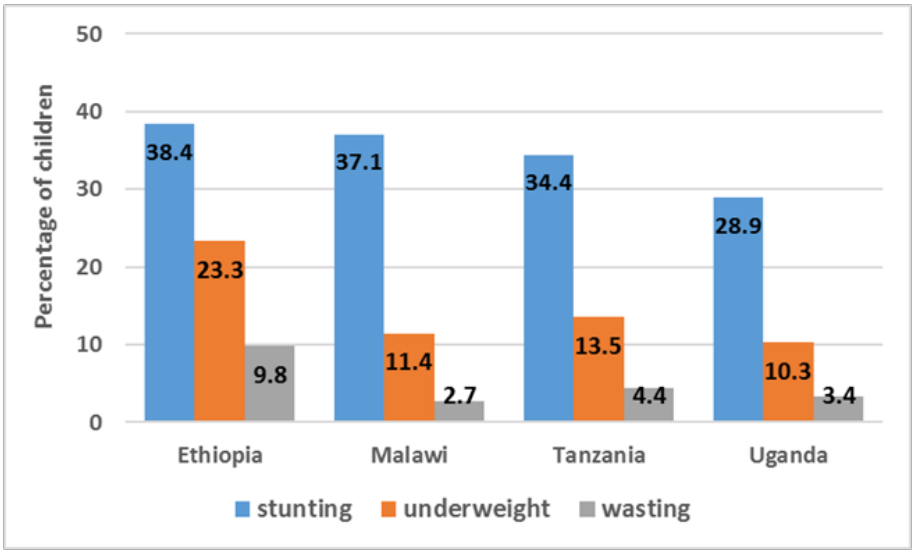
Figure 1. The prevalence of undernourishment has been on the rise since 2014



Most food insecure people are the poorest segments of the population who are already affected by undernourishment and live in rural areas of the region (Bhutta et al., 2013). Smallholder farmers constitute more than 80% of all farms in SSA and contribute up to 90% of food production in some countries (Wiggins and Keats, 2013). Furthermore, much of the effort done to improve the well-being of smallholders and to ensure food security in the region is largely constrained by lack of market access. Studies have shown that greater market access through improved road infrastructure is central to improve the well-being of rural populations in many developing countries (World Bank, 2012).

Food insecurity and undernutrition remain alarming in SSA and the region has the highest concentration of affected people in the world (UNDP, 2012). Based on estimates from the demographic health survey (DHS) data about a third of the children in Ethiopia, Malawi, Tanzania and Uganda were undernourished during 2014–2016 (Figure 2). The economic burden of food insecurity and undernutrition is estimated to be huge and its health effects long lasting and irreversible. For example, child undernutrition alone costs an estimated 16% of the gross domestic product (GDP) in Ethiopia (GLOPAN, 2014), while SSA loses 11% of its gross national product (GNP) (Bhutta et al., 2013). Undernourishment can impair proper cognitive and physical development, increase susceptibility to other illnesses due to weakened immune systems (Humphrey, 2009), which affects health outcomes, school performance and productivity in later life (Glewwe et al., 2001; Alderman et al., 2006). The economic benefits of investing in food and nutrition security can be substantial for SSA countries.

Figure 2. The triple burden of malnutrition in selected sub-Saharan African countries



Source: DHS 2015/16 data; GLOPAN, 2016

Moreover, the novel coronavirus disease (COVID-19) is having an unprecedented impact on food and nutrition security, especially for vulnerable population groups that have limited or no capacity to cope with either the health or socio-economic aspects of the shock. Africa's food systems are currently strained by a confluence of crises, including COVID-19 and related lockdowns, locust infestations, climate shocks and conflicts. Estimates prepared before the COVID-19 pandemic predict that 26 SSA countries will experience acute food insecurity—IPC Phase 3 or worse—in 2020. COVID-19 will only exacerbate existing pressures on food systems[6]. Compared to 2019, it was projected by the World Food Programme and FAO that in 2020 about 12 countries will face higher rates of acute food insecurity while there are at least 4 countries that will experience improved food security but will remain at a crisis or emergency level (IPC3-4) (WFP and FAO, 2020). The COVID-19 crisis has shown that SSA SUB-SAHARAN AFRICA faces significant long-term food and nutrition security challenges due to the compounded negative shocks affecting the sector as a result of production impacts, loss/decline of incomes and related decline in purchasing power.Agriculture is the primary source of livelihoods and a source of nutrients for improved dietary quality and diversity for most SSA rural households. It is also closely linked with nutrition and is considered as a key driving force to improve food security and acute malnutrition. The link between

6 Food insecurity is categorized by the Food and Agriculture Organization using Integrated Phase Classification's (IPC) Acute Food Insecurity (AFI) Classification, which ranks AFI from "Minimal/ None" (IPC Phase 1) to "Catastrophe/Famine" (IPC Phase 5).

agriculture and food and nutrition security appears intuitive and simple: growing more and diversified crops provides households with more quality and quantity of foods for a healthy and active lifestyle. It is, however, more complicated than that and there is little empirical evidence linking agricultural interventions and improved nutrition outcomes (Berti et al., 2004). Smallholder households may not always consume what they produce. Although most smallholders are subsistence farmers, they often buy and sell food from local markets. Consequently, identifying the key interactions between agriculture and nutrition outcomes and understanding how the different pathways operate to have an impact on nutritional status are far more complicated than is usually assumed.

The reminder of the paper is structured as follows. Section 2 details the key drivers and underlying causes of food and nutrition security. Section 3 presents the evidence on the effectiveness of multiple policy measures in improving food and nutrition security (FNS) in Africa. Section 4 concludes with some policy recommendations.

Drivers and underlying causes of food and nutrition insecurity

The major drivers of hunger and food insecurity in SSA are climate change, conflict and economic shocks. In most cases, the recent economic slowdowns and downturns were triggered by falling commodity prices, often leading to currency depreciation and staple food price inflation as well as lower government revenues available for social sector spending. The COVID-19 crisis contributed to existing economic shocks in the region where economic activity is estimated to reduce to 2.8% in 2020, the deepest on record (WFP and FAO, 2020). Agricultural commodity exporters are also expected to experience a collapse in economic activity this year as foreign direct investment and tighter financial conditions delay investment. All of these will have dire implications for food and nutrition insecurity in the region.

Climate change and weather extremes

Climate change and weather extremes with significant detrimental impacts on agricultural production and hence food insecurity include droughts, excessive rainfall, floods and cyclones. Extreme weather-related events not only affect crop and livestock production directly, they also affect infrastructure and access to input and output markets. In general, reduced precipitation and higher temperatures are already having a negative impact on the yields of staple food crops, although there is some spatial diversity.

Climate change is a present and growing threat to food security and nutrition in Africa and is a particularly severe threat to countries that rely heavily on agriculture. By 2050 climate change will cause another 71 million people to be food insecure in the world, over half of whom will be in sub-Saharan Africa. Adverse weather events are particularly grave for smallholder farmers who cannot afford to invest in the systems and inputs required to withstand and recover from the impacts of such shocks, and for pastoralists

who are vulnerable because they rely on rainfed rangeland for grazing livestock and have very few fixed assets. Poor harvests push up food prices and diminish agricultural employment opportunities, lowering income at a time when households are more market-reliant because of reduced food stocks.

Climate shocks played a major role in reducing availability and access to food for large parts of the population of Eastern and Southern Africa in the 2014–2017 period. They undermine or destroy livelihoods, reduce incomes and lead to lower food availability. The threat of climate shocks also leads households to adopt low risk–low return livelihood strategies with negative implications for longer-term household welfare.

Climate variability and extremes are key drivers of the recent rise in food insecurity and one of the leading causes of the severe food crises that have affected the continent. They undermine, directly and indirectly, food availability, access, utilization and stability with grave consequences for immediate and long-term nutrition outcomes, especially for children. The capacity to adapt, the scale and frequency of weather shocks and the level of people's and countries dependence on agriculture determine the extent of their vulnerability to these shocks. Repeated events further erode capacity to withstand future shocks. Building the resilience of households against climate change and weather shocks is therefore a critical policy.

Conflicts and insecurity

Interstate conflicts, internal violence, regional or global instability, civil unrest or political crises have put a significant toll on the SSA region. These situations result in deprivation of civilians of their assets, incomes, or jobs and push them into acute food insecurity. Food systems and markets are disrupted, pushing up food prices and sometimes leading to scarcities of water and fuel, or of food itself. They also affect access to markets and agricultural activities that are critical for the adequate functioning of the food system. Conflict prevents businesses from operating and weakens the national economy, reducing employment opportunities, increasing poverty levels and diverting government spending towards the war effort. Food insecurity itself can also become a trigger for violence and instability, particularly in contexts marked by pervasive inequalities and fragile institutions. Sudden spikes in food prices tend to exacerbate the risk of political unrest and conflict (FAO et al., 2017).

Economic shocks

In most cases, the recent economic slowdowns and downturns were triggered by falling commodity prices, often leading to currency depreciation and inflation of staple food prices as well as lower government revenues available for social sector spending. Economic shocks can affect the food insecurity of households or individuals through various channels. Macroeconomic shocks, characterized by high inflation or hyperinflation, significant currency depreciation, worsening terms of trade, high

unemployment rates and loss of income, a significant contraction in exports and a critical decrease in investments and other capital inflows tend to coincide with increases in acute food insecurity. Increases in prices of staple grains, oil or agricultural inputs can affect food availability, food prices and incomes. Microeconomic shocks are characterized by rising food prices, lack of income sources and consequent reduction in purchasing power, which directly affect household food security.

For example, according to the 2020 Global Report on Food Crises (FSIN, 2020), economic shocks were the primary driver of acute food insecurity for 5.9 million people in the Sudan, where the economic crisis worsened in 2019. Strong inflationary pressures, the sharp currency depreciation that dampened private consumption and deterred investment and reduction of GDP, coupled with sanctions and shortages, pushed up fuel prices to exceptionally high levels. Prices of cereals, which started to surge in October 2017, were at record highs by the end of 2019. Some 58% of households were estimated to be unable to afford the local food basket. Notably, in Khartoum state, the number of people in crisis or worse (IPC Phase 3 or above) almost doubled between 2018 and 2019, indicating increasingly severe food access constraints for market-dependent urban households.

Immediate sources of FNS risks

The abovementioned underlying factors for food insecurity (climate change, conflict and economic shocks) manifest themselves in the form of immediate drivers. Table 1 provides the main drivers of individual, household and market level FNS situation.

Table 1. Key drivers of household and macro level FNS situation

Individual and household level drivers	**Impact on FNS**	**Market equilibrium drivers**	**Impact on FNS**
Income, food availability/ production, yield	**Improves FNS,** if income growth is matched by a better distribution of income	**Global vs domestic prices**	Trade policy liberalization would improve FNS for consumers and reduce FNS for producers. If terms of trade improve for a food net importer, FNS improves. An undervalued exchange rate for a net food importer would reduce FNS.

continued next page

Table 1 Continued

Individual and household level drivers	Impact on FNS	Market equilibrium drivers	Impact on FNS
Food prices, affordability/ access	**Improves FNS,** if purchasing power improves with lower prices. Weakens FNS, if household is a food producer in a lower price environment	**Aggregate food demand**	Population growth increases mouths to feed and reduces overall FNS. Income growth leads to changes in diets towards protein rich goods and improves overall FNS. Income growth leads to higher prices and lower food price elasticity which reduces FNS.
Sanitary conditions	**Improves FNS:** through reduced disease pressure and absorption of nutrients in the body, and labour productivity	**Aggregate food supply**	Lower food waste improves FNS; increase in the overall amount of agricultural land will shift agricultural supply, reduce food prices and ease the FNS constraint. Higher yields will shift agricultural supply, reduce food prices and ease the FNS constraint.
Education	**Improves FNS:** better nutrition increases cognitive capacities and increases the returns to investments in education and schooling.		
Transaction and markets access costs	**Improves FNS,** if lower costs reduce price distortions. **Weakens FNS,** as easier access to ultra-processed food increases risk of over-nutrition and unbalanced diets.	**Governance and institutions**	Macroeconomic stability, public expenditure, and governance as well as quality of institutions are among the crucial "basic causes" of malnutrition and can improve FNS.

Source: Adopted from FOODSECURE CONSORTIUM(FAO et al., 2017).

Agriculture can be part of the solution, but challenges remain

Agriculture is crucial to reducing poverty, malnutrition and hunger in the region. Farmers need more than increased agricultural production to ensure food and nutrition security and to diversify household consumption. Increasing production diversity is shown to be positively associated with greater household consumption diversity (Dillon et al., 2015; Sibhatu et al., 2015; Bellon et al., 2016). In some situations, however, this may not hold as forgone income benefits from specialization outweigh the gain from on-farm production diversity (Sibhatu et al., 2015).

Smallholder farmers also face several constraints that prevent them from expanding and diversifying their production beyond subsistence level. Most smallholder farmers in the region reside in remote areas with poor transport connectivity, lack of market information, high transaction costs and poor linkages with marketing outlets. All such factors could constrain smallholder farmers from receiving better prices for their produce and raising their farm income. Considering the key role of smallholder farms in the SSA SUB-SAHARAN AFRICAN country's economy (such as securing food and nutrition), expanding market access can bring many benefits to farmers and the population as a whole.

Even though improved market access is important to increase household income and to reduce poverty among smallholders, access to dynamic markets is one of the major constraints to smallholder farmers in most SSA countries. Smallholder farmers are poorly linked to markets for several reasons such as lack of information, low production and farm-gate prices and remoteness (Wiggins and Keats, 2013). This is a barrier to the commercialization of smallholder farming and may cause them to produce a narrow range of products for the market or to limit production for home consumption only (Bellon et al., 2016). In the same way, lack of market access can discourage smallholders from investing in high value agricultural output such as fruits and vegetables or dairy products, which are rich in micronutrients and can improve nutritional status. Marketing problems along the value chain can also result in inefficiencies, excess costs and exclusion of smallholders, particularly women and young farmers.

The following section reviews multiple policy measures that SSA countries undertake to improve FNS in the region and the evidence on the effectiveness of these agricultural and food security related policies.

Evidence on agriculture and food policies

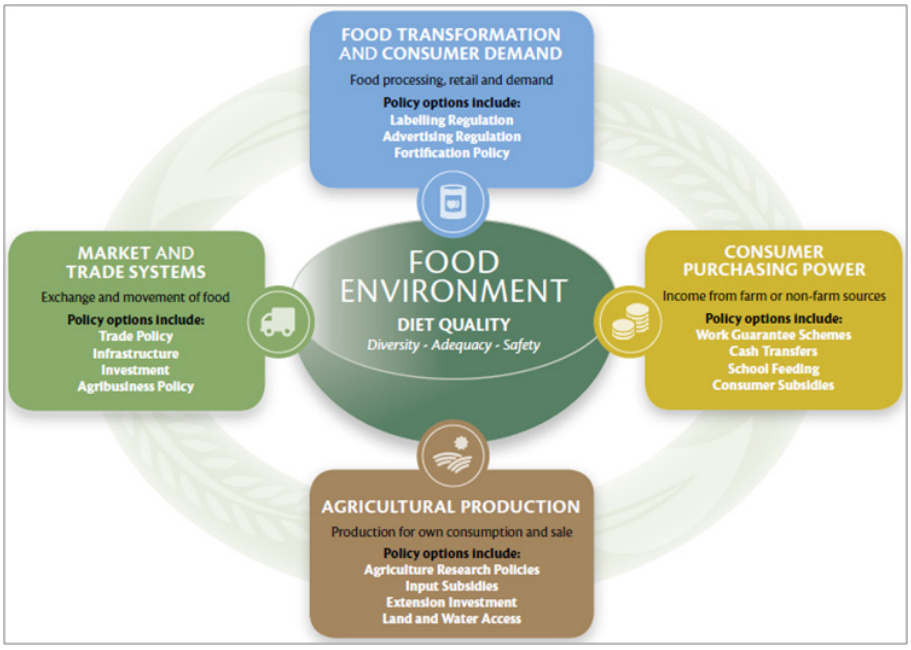
The food system approach to agricultural and food policies

According to the Global Panel on Agriculture and Food Systems for Nutrition, agricultural and food policies at different parts of the food system can shape the food environments and improve FNS (GLOPAN, 2014; GLOPAN 2016). When designing national agriculture and food policies to enhance FNS outcomes, governments must look beyond the

provision of incentives to produce staple crops towards governance of a complex, market-driven system. Policies that shape national food systems must also consider the trade environment, the potential for development of an agribusiness industry to add value and employment locally, governance of the wholesale/retail segments of the value chain, and the overall affordability of food to key groups of consumers, including the most nutritionally vulnerable. Agricultural policies affect the FNS of households through various channels, including changes in the structure of farm costs and benefits, returns to family labour, and crop and livestock prices that affect farmers' production decisions and choices.

For each of the system elements shown in Figure 3, there are multiple policies or programme interventions that can influence FNS in various ways. The food environment is where products of many kinds, quality, price and appeal represent the portfolio of choices characterizing dietary patterns. Public policies governing the operations of national food systems map to specific segments of the system. Improving the "nutrition sensitivity" of policies therefore requires that technocrats and policymakers consider two factors, namely: the pathways by which each policy could affect the quantity or quality of nutrients available and/or accessed by consumers (or possibly specific groups of consumers judged to be nutritionally vulnerable), and how policies may interact.

Figure 3: Agriculture and food policies to improve FNS



Source: Global Panel on Agriculture & Food Systems for Nutrition (2014)

Lessons from implementing agriculture and food policies in Africa

Most African policies designed to improve FNS focus predominantly on one of the four domains of the food system indicated in Figure 1. Several of the agriculture and food policies are related to boosting local agricultural production. For example, multiple SSA countries have used agricultural input subsidies, expanded access to credit and agricultural extension services to boost national production. Here, we take the example of a policy that has been widely promulgated across nations in the region—the fertilizer (input) subsidy.

Agricultural input (fertilizer) subsidy: Evidence is mixed on its impact on FNS

Fertilizer subsidy is one of the most consistently practised agricultural policies in SSA. The main objectives of this subsidy policy are generally to boost agricultural productivity through improved access to fertilizer, contributing to food and nutrition security via higher income and lower consumer prices.

A study by Gine et al. (2015) assessed the effectiveness of a voucher-based fertilizer subsidy in improving FNS—defined as dietary diversity—in Tanzania. The study did not find a significant positive impact of the fertilizer subsidy on household FNS indicators, such as incomes and welfare. The study recommends that the fertilizer subsidy programme could be more effective through improving the targeting and including a provision for transfer and sale of vouchers.

Snapp and Fisher (2015) showed that Malawi's input subsidy programme positively affected household FNS outcomes, measured by dietary diversity. The study identified that the positive FNS impact was channelled through its effects on crop diversification and income generation from greater commercialization of corn. The study also provided evidence supporting the need for complementary investments in both education and employment creation, particularly for female heads of households. Similarly, Harou (2018) examined whether and how fertilizer subsidy programmes can increase dietary diversity and child nutrition in Malawi.. This study found that children under five who lived in households that received a voucher-based input subsidy had a higher nutrition measure (i.e., weight-for-age, weight-for-length/height and body mass index) than children living in non-recipient households. In addition, it was found that households having received a voucher consume cereals, nuts, vegetables, meats and fruits more frequently than non-recipient households. The results indicate that past studies evaluating FISP failing to account for the positive gains in child nutrition and household food consumption diversity may be underestimating its benefits.

According to Smale et al. (2020), subsidized fertilizer contributes only minimally to the quality of women's diets in Mali. The study reported that agricultural input subsidy had positive impacts on yields of some staple crops (such as maize and rice), but the effects on dietary quality were inconclusive. With respect to on-farm production, for example, the policy is likely to create disincentive to grow nutrient-dense foods that are not eligible

to receive subsidy. If purchased food, rather than farm production, is the primary source of food for the households then policies that enhance incomes, instead of productivity, are crucial to enhancing FNS.

In summary, investment in agricultural input subsidy has the potential to raise agricultural productivity, with positive implications for FNS. However, the impacts of these subsidy programmes on nutrition and related health are conditional on the wider context the subsidy programme's implementation and the targeting mechanism. The evidence is rather mixed on the impact of agricultural input subsidy programmes on household dietary choices and consumption, and on intra-household nutrition outcomes.

Access to credit has a positive effect on household FNS

A study by Annim and Frempong (2018) examined the relationship between dietary diversity and household income and access to credit. Using the Food Diversity Index and Food Consumption Score to proxy dietary diversity, they showed that access to credit contributes to the consumption of a diversified diet in Ghana. The positive association of access to credit and FNS indicators suggests that policy makers should consider access to credit as an important instrument for promoting income generation and human capital development. Furthermore, Aidoo et al. (2013) showed a positive effect of access to credit on a household's food security in Ghana.

Similarly, Awotide et al. (2015) demonstrated that households with access to credit had higher cassava productivity, which in turn contributes to higher incomes and hence improved household FNS. In support of alleviating the constraints related to credit access for smallholder farmers, it is therefore vital for agricultural policies to strengthen microcredit and microfinance institutions in rural areas.

Agropastoral policies (such as extension services, veterinary services and input/feed subsidies) contribute to improved FNS

Muller and Sayouti (2018) studied the effect of national agricultural policies (extension services, private veterinary services and low-cost livestock feed) on nutrition security of households in Niger. Their study indicated that agricultural policies, including extension services, private veterinary services and livestock feed subsidies, had a significant and positive impact on pastoralist household's well-being, especially measured in terms of nutrition intake from animal food products intake. However, some of these policies may have detrimental consequences on household overall calorie intake, exacerbating food insecurity. Thus, such policies should account for agropastoralists' access to markets for non-animal food products.

Agricultural extension policy on crop agricultural has positive but small effect on FNS
Adong and Achola (2019) tested whether agricultural extension policies enhance FNS by increasing food consumption. Their results showed a positive but insignificant impact of extension policies on household nutrition security, as measured by anthropometric nutrition indicators. For example, extension policies had negligible impacts on household

consumption of food purchased from the market. However, receiving extension training had a positive and significant impact on own food consumption.

Agriculture policies that improve land tenure security also improve FNS in Africa

Several studies assessed the relationship between land tenure security and household FNS in Africa. For example, Holden and Ghebru (2016) explored the conceptual linkages between land tenure reforms, tenure security and food security. This study showed that land tenure insecurity can lead to poor land management and land degradation which eventually reduces agricultural productivity and hence household food security. Both Deininger and Jin (2006) and Deininger et al. (2008), for example, found that land tenure security (and land certification) was associated with higher investment in Ethiopia. Similarly, Holden and Ghebru (2013) found that the land tenure security had resulted in increased food production and food access for poor female-headed households, with positive implications for their FNS.

Access to food markets improves household FNS in sub-Saharan Africa

The effectiveness of several of the agriculture and food policy initiatives in ensuring FNS in SSA is largely constrained by lack of market access. Evidence shows investment in enhanced market access and infrastructure is a vital tool to ensuring FNS in the region. Improved market access can influence household food and nutrition security through multiple pathways. Market access can increase smallholder farmer's income through decreased transaction costs, improve food consumption, and reduce poverty and household food insecurity. Improved market access also increases the variety of available foods, thereby increasing opportunities for consumption diversification. Increased income due to greater market access can increase households' ability to buy micronutrient-rich foods.

Usman and Haile (2018) examined the association between market access and household food and nutrition security in two Eastern African countries (Ethiopia and Tanzania) using nationally representative panel data from the World Bank's Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA). They found that households located closer to market centres spend more on household consumption, consume diets that are more diverse and are less food insecure than those households located farther away from markets. Similarly, Headey et al. (2019) showed that children from households in proximity to markets that sell a larger number of non-staple food groups have more diverse diets. The pathways for this positive impact include that greater market access can: (i) increase the availability of variety in local food environment, which enhances household dietary diversity; and (ii) help smallholder farmers maximize their income from sale of agricultural produce, which improves household FNS.

In conclusion, investments in market developments and rural infrastructure that link smallholder farmers to markets are important for improving household food consumption diversity and security in SSA.

Conclusions and policy recommendations

Improving food and nutrition security among smallholder farmers is one of the most pressing issues in many developing countries, especially in sub-Saharan Africa. The deterioration in the food security situation in Africa is stabilizing but the situation remains a challenge. The outlook, however, seems mixed, especially due to the COVID-19 pandemic. Countries in the region should address the main underlying sources of food and nutrition insecurity—namely conflict, climate extremes and economic shocks. These drivers, which sometimes overlap and are often connected through their negative impact on livelihoods, continue to undermine the region's FNS. They are also bottlenecks to achieving zero hunger in the region by 2030.

Households respond to shocks by adopting negative coping strategies, which may be difficult to reverse. This further undermines livelihoods, trapping many households in chronic poverty, and contributing to food insecurity and poor nutrition for generations to come. Such shocks not only worsen FNS situations, but they also undermine the socio-economic fabric of communities and households. It is therefore essential to strengthen the resilience of agricultural livelihoods, food systems and nutrition through climate resilience strategies, programmes and investments which address the direct impacts but also the underlying vulnerabilities.

To ensure FNS in the region, governments have implemented several agriculture and food policies in Africa. Among others, agricultural input subsidy programmes, crop-specific food vouchers to promote dietary diversity, agricultural extension, expanding access to credit and land tenure programmes are the most implemented agriculture and food policies for improving FNS. This synthesis paper has provided the evidence on the effectiveness of these policies in improving FNS in selected countries.

For example, the evidence is mixed on the impact on household FNS of fertilizer subsidy programmes implemented in several African countries, whereas access to credit positively contributes to FNS. Several studies have also showed that improving access to an efficient and dynamic market for smallholder farmers is a better strategy to enhance food security and sustain livelihoods in SSA than focusing on only agricultural production. As income from agriculture is the main contributor of household income, access to better market could help smallholder farmers maximize their income from crop and livestock production. However, further evidence is required to explore the pathways through which market access can improve household food security and nutritional status.
Key policy considerations

- Agriculture and food policies need to have a broader food systems perspective. The nexus of policies at each part of the food system (production processing, marketing and retail/consumption) are important in shaping FNS.
- Improving access to market of rural households can improve their food and nutrition security. Investments in rural connectivity, lowering transaction costs,

improved market logistics/facilities are critical to improving FNS. The evidence is clear that investing in market infrastructure and linking farmers to markets can improve FNS.

- Trade policies can enhance food and nutrition security in the region. Trade allows the movement of food from surplus to deficit areas and potentially enhances food availability and also dietary diversity. Trade policies are important in terms of determining prices, availability, quality and ultimately food security and, with appropriate polices to ensure food safety and other standards, can improve nutrition outcomes. To this end, the establishment of the African Continental Free Trade Area Agreement (AfCFTA) can provide opportunities for expanded agriculture and food trade in Africa, thereby contributing to FNS on the continent. However, achieving nutrition-sensitive trade policies requires different actors working together to provide policy coherence.
- Well-designed climate adaptation and mitigation policies are critical for enhanced agricultural productivity and FNS. The threat of increasing poverty and hunger as a result of climate change makes adaptation and mitigation a priority for African policy makers. Government policies need to focus on building household resilience to climate change and extreme weather events.
- Building peace and inclusion of vulnerable population groups, including women, children, and the elderly, plays a key role in ensuring FNS in any country. Government programmes and policies should target vulnerable populations groups and aim at building peace to enhance FNS at macro level.

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Diet Diversity and Nutritious Diets in Africa: Effects of Farm Input, Trade Policies and Impact Profiling

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and

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Introduction

Africa's food system requires transformational change and innovation to sustainably end hunger, achieve food security and improve nutrition. This transformational change must also impact the farm sector to achieve these goals. The nutrition outcomes should be viewed along with ending undernourishment, stunting, child mortality, inadequate food consumption, food insecurity and volatile food prices. These challenges have motivated policy makers in sub-Saharan Africa (SSA) to put in place various agricultural policies (among others, farm input, agricultural credit, agricultural extension and education, land ownership, farm output prices, food and nutrition, and agricultural marketing and trade policies) with a view to improving nutrition outcomes.

The problem

Many people in SSA countries are experiencing changes in their lifestyle and diets driven, in part, by urbanization and income growth. Moreover, agricultural policies can change incentives to grow and/or consume one crop commodity rather than another, which can translate into changes in dietary intake among members of farm households. This synthesis paper is mainly based on African Economic Research Consortium (AERC) research reports for the Analysis of the Impact of Agricultural, Food and Nutrition Policies on Nutrition Outcomes in Africa (AFPON) programme, with support from the Bill and Melinda Gates Foundation. The paper addresses three questions, namely: What empirical evidence exists on whether diets in SSA are shifting toward more highly processed foods, with greater shares of food purchased away from home, containing more sugars and/or being potentially obesogenic? How do agricultural production and market policies affect the affordability of nutritious diets? Who lacks and benefits from dietary diversity?

In presenting evidence on these issues, this paper first presents a conceptual framework on the linkages between agricultural policy and household dietary intake in SSA. Second, it examines, at a macro scale, the distribution of consumption across food groups and processing content, and analyzes whether the distribution varies across urban and rural areas. At a micro scale, the paper presents the extent to which women's diets meet minimum adequate standards, contain key sources of micronutrients, include elements such as fats, sugars, protein, and include food purchased away from home. A comparison is made between food groups, and transformation in SSA in general, and country-specific evidence is studied. Third, the paper examines and presents empirical findings on: land reform, technology adoption and agricultural trade on nutrition outcomes, and the effect of fertilizer subsidies on diet quality among Africa's households. Because of a lack of contributions in the field, a third section on the impact of diet transformation on agricultural employment and productivity could not be included. Finally, the paper presents evidence on the effect of policy profiling/targeting of different/heterogeneous groups (i.e., agro-ecological, institutional, and socioeconomic settings) on the potential of improving nutrition outcomes.

Conceptual framework

The conceptual framework used in the paper to structure the review follows the livelihoods framework used by CARE International, an international NGO that uses this approach as its primary planning framework. This framework, represented in Figure 1, identifies three attributes of livelihoods (Drinkwater, et al., 1999):

(1) Human capabilities

(2) Access to tangible and intangible assets

(3) Existence of economic activities

Policies aiming at improving agricultural performance are in the left-hand column of Figure 1. Here the link with production and income activities will be reviewed, where while investments in education and improved access to credit, for example, have an impact on human and economic capital. Direct nutritional interventions impact on consumption activities. For the latter two interventions, the impact to review would be on livelihood outcomes, specifically the impact on food and nutrition security (right-hand column of the figure).

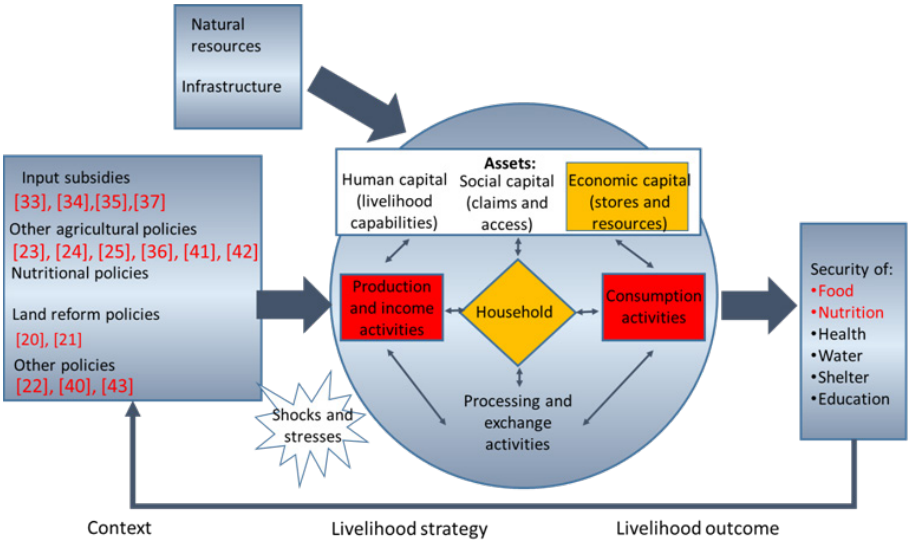
Distributional considerations between households are reflected in differences in assets of all three kinds depicted in Figure 1, which may cause a varying impact of policies implemented across different households.

As is clear from the positioning of the different AERC contributions reviewed in this paper, there is a substantial bias towards assessing agricultural policies, while there are no contributions that consider the impact of specific nutritional policies, for example school feeding or policies targeting specific groups such as AIDS/HIV victims, or pregnant and lactating women. No reference is made to policies that would implement the "1,000 day" approach, focusing on the period between conception and the child's second birthday as a crucial period for intervention.

Another gap in the synthesis of AERC contributions so far concerns the effect of changing diets on productivity and employment (the links within the central circle in Figure 1). Although many contributions do consider consumption and production activities (in red boxes), the linkages between household consumption and production activities are

not explored. The yellow boxes for "household" and "economic capital" indicate that various contributions include characteristics of households in the analysis, but only as an explanatory or controlling variable. The impact of consumption activities (including diet diversity) on human and social capital is not a topic of study in the contributions so far. A final shortcoming is that no contributions study the impact of shocks and stresses on the effect of policies and interventions, but that only the reverse impact is taken into consideration, at the very least, when improved diet diversity is interpreted as increasing the resilience of a household.

Figure 1: Conceptual framework and link to AERC contributions

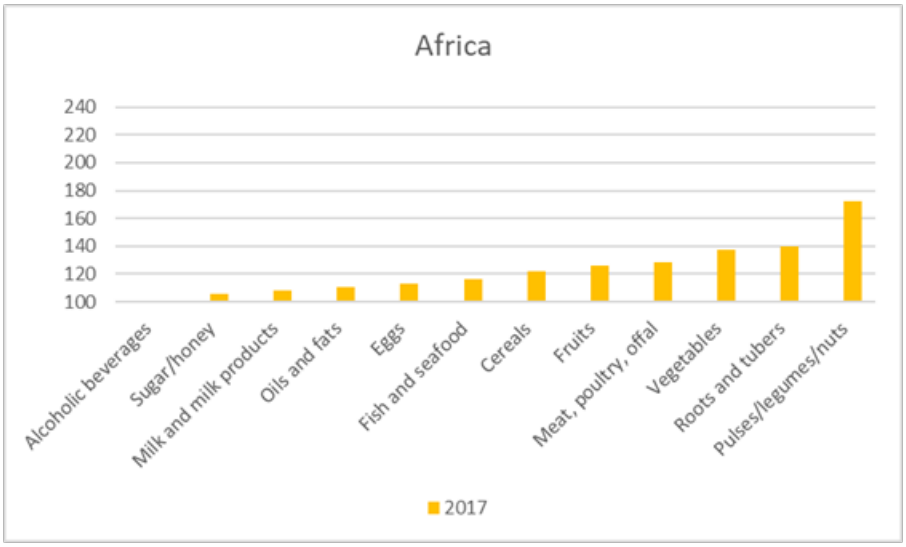


Analyses of the distribution of consumption across food groups

Dynamics in Africa/sub-Saharan Africa

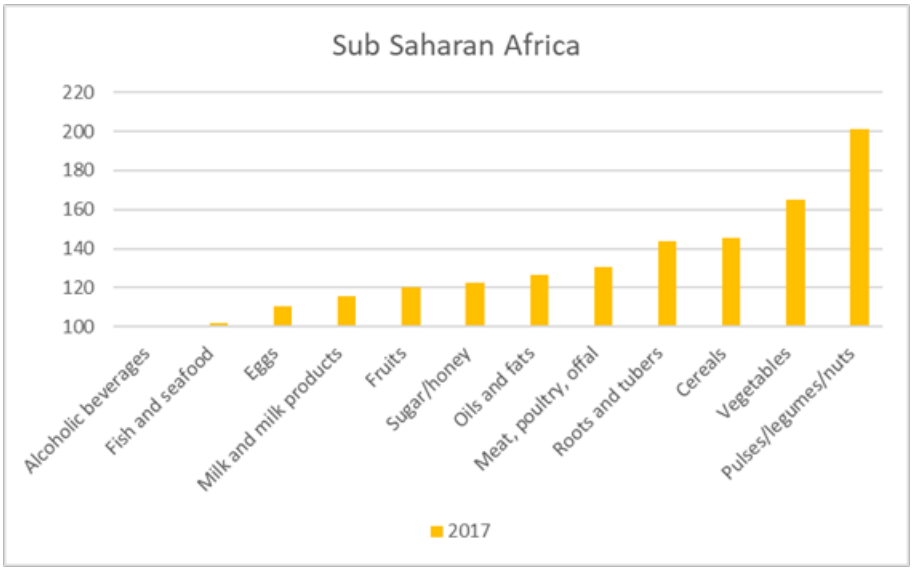
A first exploration of the Food and Agricultural Organization of the United Nations' (FAO) Food Balance Sheet (FBS) data for the whole of Africa and SSA in particular reveals that, on average, consumption of all food groups has increased substantially in the period 1990–2017 (see Figure 2), with the most notable increases in pulses, legumes and nuts, while noticeable increases can also be seen in vegetables, fruits and meat. This is consistent with the findings in Keyzer, et al., (2005) that once incomes cross a threshold value of around US$9,500 per capita, the consumption of meat in particular increases sharply. In the period under consideration, African countries have started to cross this threshold, but there are still many that are below this average. For SSA, the same basic pattern emerges, again for the same reasons (see Figure 3).

Figure 2: Trends in consumption of food groups, Africa, 1990=100



Source: (FAO)

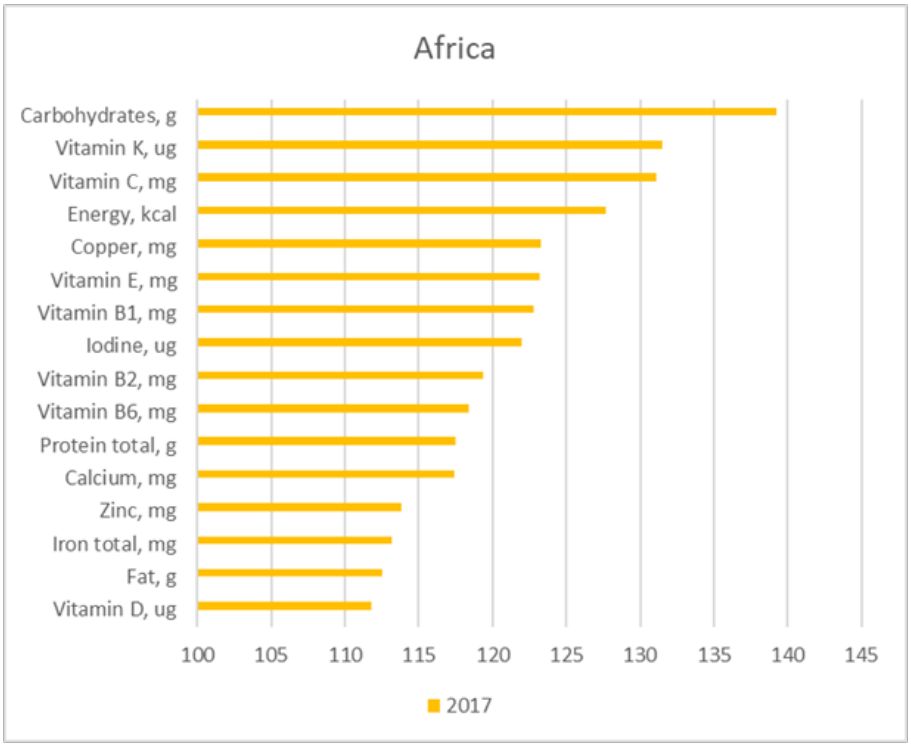
Figure 3: Trends in consumption of food groups, SSA, 1990=100



Source: (FAO)

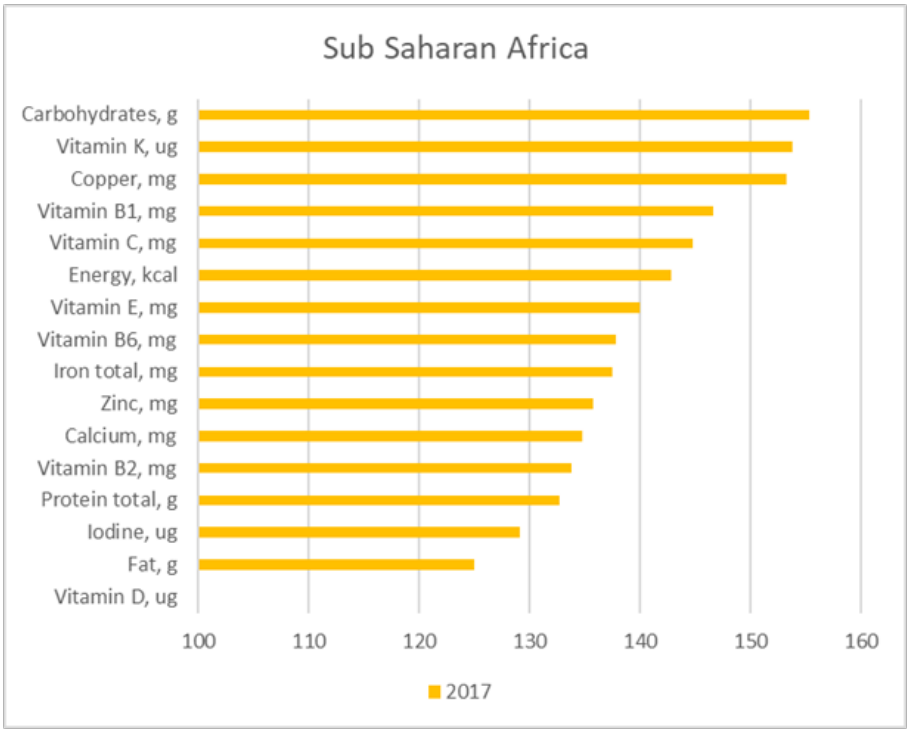
As mentioned earlier, it is also useful to look at the intake of nutrients, albeit at the aggregate national level at first. For both Africa (Figure 4) and SSA (Figure 5), the main increase in nutrient intake is in carbohydrates, while aggregate per capita consumption of fat also increased, but at a relatively low pace. Overall, the intake of all nutrients has increased.

Figure 4: Trends in nutrient intake, Africa, 1990=100



Source: Own calculations based on (FAO)

Figure 5: Trends in nutrient intake, SSA, 1990=100



Source: Own calculations based on (FAO)

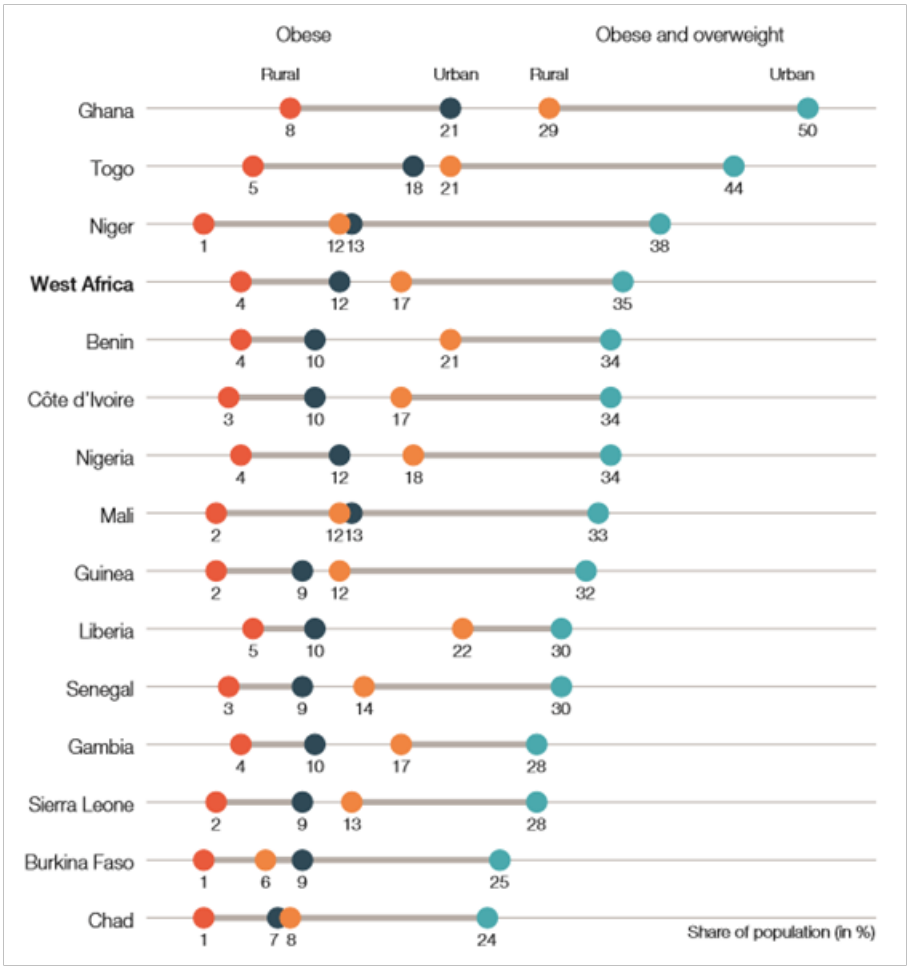
Overall, the aggregate picture confirms the earlier observation that the dietary transition in Africa is in the early stages, when the consumption of meat and processed food is still low. However, aggregate results of course mask underlying differences between rural and urban areas, as well as between households in different wealth classes.

Dynamics in West Africa

For West Africa, Van Wesenbeeck (2018) uses data from the Demographic and Health Surveys (DHS) on body mass index (BMI) for females, and weight-for-height/weight-for-age for children to study under- as well as overnutrition, broken down by rural and urban areas, and further by location-specific wealth status. The analysis reveals that almost 110 million people in West Africa are not receiving the correct nutrition for their needs. Over 58 million people in the region are underweight, 22 million of which live in cities. Another 52 million are either overweight or obese, the large majority of whom are adult urban dwellers. Clear trends appear when analyzing nutrition status by wealth quintiles. Adult obesity is a problem of the rich, predominantly in urban areas (Figure 6), while undernutrition is an issue faced by the poor, regardless of whether they live

in rural or urban settlements. The poorest urban households are as likely as any living in rural areas to be severely or moderately underweight (1.3% and 2.3%, respectively, in cities compared to 1.3% and 2.5%, on average, in rural areas). The prevalence of severely stunted children is considerably higher in poor urban areas (14.6%) than in rural areas (9.8%).

Figure 6: Overweight and obesity in West Africa



Source: (Van Wesenbeeck, 2018)

Diet composition and transformation in SSA using country-specific evidence

This section looks at relevant case studies. Specifically, we consider the case of Mali, where (Smale, et al., 2020) present an analysis on whether diets in Mali are shifting towards highly processed foods, meals away from home, and sugars and other potentially obesogenic food. They base their analysis on the Living Standard Measurement Surveys – Integrated Surveys on Agriculture (LSMS-ISA) for 2014/2015 and the Projet de Recherche sur les Politiques de Sécurité Alimentaire au Mali (PREPOSAM) dataset, collected by the Institut d'Economie Rurale and Michican State University, for 2017–2019. Primary data on consumption were collected during two visits to specific areas of Mali. Conceptually, the food-group approach is taken, where the Household Diet Diversity Score (HDDS) is computed at the household level, complemented by the Women's Dietary Diversity Score (WDDS) and the Minimum Dietary Diversity for Women (MDD-W) indicator.

The analysis does not present an analysis of trends, but uses a cross-section approach, corrected for seasonal influences, to assess current diets and sources of food. Methodologically, for the analysis at aggregate level, LSMS food expenditures on different types of food are classified (including highly processed and minimally processed foods). At the aggregate level, the authors find that even in rural areas, the share of on-farm production in the diet is relatively low (25% during the lean season and 36% after harvest). The share of processed foods in total consumption is substantially higher in urban areas (60% of the total budget) than in rural ones (48%), but there is still very low consumption of highly processed foods.

For the micro-level analysis, data on intake of food are used, based on seven-day recall interviews with females in the age group 15–60. About 53% of women in the study areas of the Delta du Niger and Plateau de Koutiala suffered from insufficient dietary diversity. After harvest, the MDD-W increases to 80%, indicating that only 20% of women in this period are consuming an insufficient diet. After harvest, there is a tendency to spend more cash on meals and snacks consumed outside the home, indicating a direct relation between income and diet patterns.

In conclusion, the Mali study seems to confirm the general observation that African countries are in transition but that, yet significant increases in consumption of meat and highly processed foods are limited to a few specific groups. It also confirms the general finding for West Africa, based on anthropometrics, that urban households consume richer diets. Overall, these households also have a higher intake of nutrients in general.

Dynamics of women's nutrition

The question whether women are adequately nourished is of utmost importance, because it is well-known that malnourished mothers will give birth to underweight children with a high probability of growing up to become malnourished teenagers and adults, leading to a vicious circle of inter-generational malnourishment (UNICEF, 2009).

Conversely, there is also ample evidence that an increased risk for overweight and obesity can be imprinted early in life through inter-generational and early life influences. During fetal and early life, undernutrition leads to changes in physiology and metabolism that not only stunt physical growth and negatively impact human capital, but also increase the risk of non-communicable diseases (NCDs) later in life (Victora, et al., 2008). To illustrate, there is ample evidence linking low birthweight to increased risk of coronary heart disease, stroke, diabetes and abdominal obesity (Barker, et al., 1986).

Information on the actual intake of food items by women is scarce. DHSs record the intake of food items for (small) children only (DHS), while the World Food Program publishes occasional country reports on the nutritional status of women and girls, based on primary data collection in combination with other sources (WFP). Living Standard Measurement Surveys record purchases of food items as well as consumption data based on recall; (FAO and World Bank, 2018) provide an overview of the guidelines to be used for the collection of food data in LSMS. To date, the coverage of these surveys remains limited.

More generally available indicators are anthropometric indicators, such as BMI for adults, anaemia prevalence among adult women, and weight-for-age, weight-for-height, and height-for-age for children (for example in DHS surveys).

A general (not gender specific) nationwide picture of nutrient deficiencies could be constructed based on food balance sheets (FBS) (FAO), although this requires additional assumptions about losses and waste, while the methodology to construct the FBS is also not uncontested (Klasen, 2008) (Nubé, 2001) (Svedberg, 1999). Nevertheless, some initial insights on nutrient adequacy can be obtained in this way for a wide range of countries, indicating where more efforts should be made to increase insights into the dietary diversity of all adult females and girls. A quick scan of the FBS, using nutritional information per food item from (RIVM), losses and wastes of food at the consumer level from (FAO, 2011), and recommended daily doses from (FAO/WHO, 1998), (Office of Dietary Supplements, US), provides first insights into deficiencies for different nutrients by country, or deficiencies of a single nutrient across countries. In addition, comparison of FBS data over time could reveal important shifts in dietary composition. Section 4 already presented some evidence on the dynamics for African countries and aggregates.

Conceptually, the usual approach taken to measure adequacy of diets is to aggregate the intake of specific food items to food groups, and then define a scoring schedule. For different measurements, there are different ways of collecting the data, with the most common approaches being based on recall of consumption (24 hours, 7 days, “typical month”), listing consumption in food diaries (last 7 days), or recording purchases of food/using own production. To answer the question of whether women’s diets are satisfactory, data must be collected at the level of individual household members, as household level measures such as the HDDS, and Food Consumption Score (FCS) are not appropriate measures. Instead, the WDDS or the MDD-W can be used, and/or nutritional intake of women can be tested against recommendations of individual nutrients.

In general, empirical evidence points at an increasing triple burden of malnutrition: increased obesity and overweight, coupled with stubborn undernutrition, but also accompanied by nutritional deficiencies. At a global level, (FAO, IFAD, UNICEF, WFP and WHO, 2019) is an example of an investigation into the relation between undernutrition in early life and obesity in adulthood. The inter-generational aspect of these transmission effects makes it ever more important to consider female food security as a separate topic. The next section presents empirical evidence of agricultural policy effects, starting from a generic perspective and then moving to country-specific findings.

Examination and presentation of empirical findings

Land reform, technology adoption and agricultural trade impact on nutrition outcomes

Increases in average living standards of the rural population are closely linked to the growth of agricultural productivity through the exploitation of resources available to the economy in Africa. Understanding the sources of (the increases in) the distribution in consumption patterns remains a challenge in Africa. The distributional implications of market-based incentives and their relative effects on gender differentials, technology uptake and market access of agrarian reforms and nutritional outcomes remain sketchy. With technological advances and improved farm practices/technologies, farm production increases have been (hypothesized), impacting on nutritional outcomes. Empirical analyses in Africa tend to support the view that technological advances promoted by agricultural policies impact distributional preferences (monetary income expenditures) among rural households, including nutritional outcomes. Technology adoption, agrarian reforms and trade have become critical sources of consumption distribution (income and expenditure patterns) among rural households in Africa. Trade, coupled with improved infrastructure, has increased market opportunities for the distribution of income (consumption) in Africa.

The papers for Zimbabwe on the impacts of the distributive land reform on women (Mujeyi, et al., 2018) and children's nutritional outcomes (Pindiriri, 2018); the adoption of soil water conservation in Ethiopia's degraded areas (Haile, 2019); women's response to market-oriented production in Uganda (Serunkuuma, et al., 2018); farm production diversity and micro-enterprise diversification in Malawi (Edriss, et al., 2018); and agricultural and trade policy in Ghana and Tanzania (Yan, et al., 2018), all use different impact pathways from interventions impacts to nutritional outcomes in rural households in Africa.

Zimbabwe

The impact of Zimbabwe's redistributive land reform policy on women's nutritional status, with particular focus on the MDD-W in rural smallholder farming households has been the focus of (Mujeyi, et al., 2018)'s analyses. The analyses are premised on the hypothesis that improving access to adequate and better-quality agricultural land enhances the diversity and increases the availability of food, which in turn ensures better

nutritional outcomes for the household. They allude to the fact that land redistributive policies aim to achieve equitable access to resources for agricultural production (Appendini, et al., 1994), and where off-farm employment is low, agriculture plays a leading role as a source of food and employment (Muraoka, et al., 2017).

Whilst several important determinants of household nutritional status exist, they posit that agricultural land is the single most important factor in determining the nutritional status of households. This is because access to agricultural land at the household level has both a direct and an indirect influence on its nutritional status, implying that not only the availability of food is affected but also the diversity of food consumed.

The Fast Track Land Reform Program (FTLRP) acquired, sub-divided and transferred over 10 million hectares of prime agricultural land to over 145,000 smallholder farm families and also created over 20,000 medium-scale farms, occupying about 2.7 million hectares under a resettlement scheme, an unprecedented shift in terms of the country's agrarian structure and land tenure system. Remarkably, this was a paradigm shift away from a dualistic system to a multi-modal tenure system dominated by state control of land resources.

The study uses the 2018 Zimbabwe Vulnerability Assessment Committee (ZimVAC) Rural Livelihoods Assessment, but the sample size was restricted to smallholder farming households in the land reform resettlement and communal area subsectors. They employed the endogenous switching regression (ESR) approach. They find no statistically significant difference between the beneficiaries and non-beneficiaries of the land reform in terms of the MDD-W. They advocate the need for the empowerment of female members of the household, with relevant nutritional education to equip them with adequate knowledge and information on the importance of diversified diets at the household level, and to enhance the delivery of critical support services such as agricultural extension, credit and social protection to women of reproductive age in land reform areas.

Conversely, (Pindiriri, 2018) finds that land reform improves child nutrition in rural areas. By buttressing the importance of the link between agricultural policies on nutrition, (Pindiriri, 2018) examines the impact of the land reform policy-induced access to land on nutritional outcomes of children, a crucial consumptive service of the household in Zimbabwe. The author provides a theory of change (the specific impact paths of access to land on nutrition), which holds that land reform policy improves access to agricultural land and directly influences agricultural production which, in turn, affects nutritional outcomes via increased incomes and consumption.

The study utilized Multiple Indicator Cluster Survey (MICS) 2014 data that sampled 17,047 households, which held data relevant for their study. The study applied agricultural household modelling in demonstrating the theoretical relationship between land access and nutritional outcomes. The results reveal that increasing land holding for households

owning agricultural land and increasing the production of domesticated birds, goats and pigs improve nutritional outcomes, reducing the number of underweight children in rural areas. Resource access policies such as land reform improves child nutrition in agricultural or rural areas. Hence, in general, the study recommends policies increasing access to land and livestock.

Ethiopia

(Haile, 2019) provides a description of the extent of land degradation in the Ethiopian highlands, where 85% of the population lives in rural areas with 90% of these rural populations depending on agriculture as the main means of livelihood. More than 2 million hectares of Ethiopia's highlands have been degraded, hence making it difficult to mitigate soil erosion (World Bank) and conserve soil-water.

In promoting soil and water conservation (SWC) practices, the central government and development partners have invested substantially in the sustainable use of natural resources with the aim of increasing agricultural production and reducing food insecurity and vulnerability. (Haile, 2019) assesses farm households' vulnerability to food insecurity among SWC adopters and non-adopters using vulnerability as the expected poverty approach. The study was carried out in three districts in Eastern Ethiopia using cross-sectional data of 408 farmers (200 from adopters and 208 from non-adopters). Following an endogenous switching regression and propensity score matching approach, the results indicate that the adoption of soil and water conservation practices not only positively impacts the per capita food consumption expenditure and net crop value, but also significantly reduces the probability of farmers being food insecure or being vulnerable to food insecurity, as well as being transient and chronically food insecure. (Haile, 2019) recommends efforts in addressing land degradation using SWC structures by strengthening the human and institutional capacity (enhancing farmers' education and continuous training and creation of awareness) on the effects of land degradation, as well as the importance of adopting appropriate SWC to control soil degradation and enhance farm productivity.

Uganda

(Serunkuuma, et al., 2018) try to answer the key question of how best to empower women in agriculture and bring them to the forefront of the fight against poverty and malnutrition in Uganda through targeted interventions given their unique role as primary food producers and custodians of household food security.

Since the late 1990s, the Government of Uganda (GoU) has pursued agricultural commercialization as the linchpin of its strategy to alleviate poverty and ensure sustainable and rapid economic growth. The GoU's support for market-oriented production was based on the prospect of enabling households to generate a higher income (thereby reducing poverty) and to ensure better access to food through the market rather than through self-sufficiency. (Serunkuuma, et al., 2018) examined the impact of maize and beans sales on household income and food intake, with a particular

focus on women. Their study examines the determinants of women's participation in markets that sell pro-women commodities on household income and food intake to determine the effectiveness of market-oriented production rather than self-sufficiency as a means of ensuring food and nutrition security in Uganda.

They raise the logic of Uganda's market-oriented production policy and the common perception about markets: that markets raise incomes and purchasing power which, in turn, create demand for consumer goods. The increase in demand for consumer goods enhances welfare which, in turn, creates demand for production inputs and investment goods. Markets also promote economic growth by facilitating the accumulation of assets and by providing opportunities for improving nutrition. Another study (Von Braun, et al., 1994) provides two main pathways through which the income-mediated effect of commercialization on nutrition and health operates. The first is where increased incomes are used to purchase either a different mix of goods and services or more of the current market basket, such as more access to healthcare or better housing, which leads to improved health. The second is through income-food consumption linkages, where increased income leads to improved energy or other nutrient intake by individual household members, which leads to improved nutritional status and, thus, improved health. They also provide differing views on the effect of market-oriented production on household food consumption: that market-oriented production negatively affects household food consumption due to reduced food availability when resources are diverted away from staples to the production of non-edible cash crops (Von Braun, et al., 1994) or when a big portion of produce is sold. (Serunkuuma, et al., 2018) use household survey data from the LSMS for Uganda for two waves (2009/10 and 2013/14). This allows for a sufficiently large gap (five years) to capture changes in household welfare, consisting of a sample of about 3,200 households, whose selection follows the 2005/2006 Uganda National Household Survey (UNHS).

They find that the proportion of female-headed households selling beans averaged 34%–38% over the two seasons compared to that of male-headed households at 38%–41%. Similar proportions are reported for maize (35%–38% for females and 44%–50% for males). There was growth in total household income between the two surveys, but the magnitude of income growth was higher among female-headed households than male-headed households. However, male-headed households had significantly higher total household income than their female-headed cohorts in both surveys. They report that having a female household head is associated with higher household dietary diversity (HDD), and income from maize and beans sales is significantly and positively associated with HDDS.

Malawi

(Edriss, et al., 2018) posit that micro-enterprising is crucial for improving rural households' nutrition status in a subsistence agrarian economy through monthly income receipts from the businesses that mostly lead to high food expenditure in households, and relying on various own farm products and increasing farm production diversity

increase household dietary diversity on nutritional food diversity in the rural household. The authors analyzed the effects of farm and non-farm micro-enterprise diversities as well as farm production diversity on household dietary diversity (or household nutritional outcomes, including children).

Their data were collected from 1,827 households, with 779 households engaged in farm and non-farm micro-enterprises in six districts with a high concentration of micro-businesses and high population densities. Both parametric and non-parametric descriptive statistics, and Poisson and negative binomial regressions were used for estimations.

(Edriss, et al., 2018) find several factors associated with household nutritional outcomes: farm and non-farm enterprise diversity, farm production diversity, and expenditure on food items all play major roles in influencing the nutritional status of the household including children. Increasing farm and non-farm micro-enterprise diversity by one micro-business group is associated with the possibility of the household consuming all 12 food groups. Similarly, increasing farm production diversity increases household dietary diversity by 33% (i.e., 4 food groups out of 12 could be consumed or added to the daily consumption, given five-food-group consumption on average) on nutritional food diversity in the rural household. Venturing into micro-businesses related to tubers and roots, legumes and pulses and horticulture positively and significantly affect household nutritional outcomes in the districts. The authors recommend the need to promote nutrition education and farm production diversity and micro-enterprise diversification as complementary and supplementary interventions for improving household members' nutrition.

Ghana and Tanzania

(Yan, et al., 2018) compare the impacts of alternative agricultural development strategies (increased agricultural productivity and trade) on the affordability of nutritious diets in Ghana and Tanzania. Policy outcomes are measured by the cost of the most affordable basket of food at each market every month that meets an average adult woman's estimated average requirements for 17 essential nutrients, based on policy-induced changes in the distribution of prices for 42 different foods in Ghana and 46 in Tanzania, observed monthly over five years at local markets in 10 regions of Ghana and 21 regions of Tanzania.

(Yan, et al., 2018)'s approach is based on the classic definition of food security (FAO, 1996): "…when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." By comparing market prices across regions and over time, they capture variation in physical and economic access for a range of people, using a whole-of-diet approach that adds up the cost of foods needed to meet all essential nutrient requirements.

They argue that policies and programmes can improve nutrition through systemic change, always making healthier diets more affordable and in all places. (Yan, et al., 2018) compare two kinds of intervention: increased agricultural productivity to lower prices, and better marketing enhancements that lower transport and storage costs across four categories of food: starchy staples, leguminous grains, fruits and vegetables, and animal foods. Using linear programming techniques, they estimate the monthly Cost of Nutrient Adequacy (CoNA) using these food groups and trace impacts of the policy interventions on the overall cost of meeting estimated average requirements for essential nutrients.

Interventions targeting food production are simulated, such as Ghana's Planting for Food and Jobs (PFJ) programme. The programme mainly aims to raise harvest quantities and primarily serves to alter the average price level for each food group and efforts to improve transport and storage, such as market infrastructure for Tanzania's National Trade Policy altering relative prices between locations and time periods.

The authors' simulations suggest that for Ghana, for increasing agricultural productivity in their PFJ the overall cost of nutritious diets is most sensitive to improvements in fruit and vegetable prices, whereas for Tanzania sensitivity is greatest for the level of leguminous grain prices as well as variation in fruit and vegetable prices. Results point to opportunities for more investment targeting, but diet costs remain sensitive to the prices of starchy staples and animal products. Measuring impacts on the overall cost of meeting all nutrient needs shows the importance of a balanced approach, targeting low and stable prices for all major food groups.

Effect of fertilizer subsidy on diet quality in African households

Fertilizer subsidies have been a major agricultural policy tool for poverty reduction in Africa recently. Included in the so-called "smart subsidies" (Morris, et al., 2007), fertilizer subsidies in Africa have arisen on the backdrop of relatively low food production growth as a result of the low use of inorganic fertilizers. It has therefore been argued that it is necessary to subsidize fertilizer costs for rural households to enhance crop yields, to increase incomes and food availability, and to reduce poverty (Wiggins, et al., 2010); (Dorward, et al., 2014).

Providing the possible different impact pathways of fertilizer subsidies on poverty reduction, several recent empirical studies on fertilizer subsidy impacts on household nutritional outcomes have emerged for countries in Africa, for example, Zambia (Kuntashula, et al., 2018) (Kiwanuka, et al., 2019); Malawi (Katengeza, et al., 2019); Uganda (Chumo, et al., 2019); and Mali (Smale, et al., 2018). These studies point to impacts (sometimes none) of subsidizing fertilizer for increased crop productivity in Africa on nutritional outcomes.

Zambia

(Kuntashula, et al., 2018) test whether any association exists between agricultural production and household dietary diversity following the implementation of the

Fertilizer Input Support Programme (FISP) and the Association of Agricultural Production Diversity and Dietary Diversity in Zambia programme, which has run over a decade, from 2009–2010. The main pathway that this study follows is whether the provision of inputs (mainly inorganic fertilizer subsidies) has had an impact on agricultural and income diversification as well as dietary diversity at household level. The authors used data from a cross-section survey of a nationally representative randomly selected sample of 7,934 farm households in Zambia. These households participated in the 2015 Rural Agricultural Livelihoods Survey (RALS15) conducted by Zambia's Central Statistical Office (CSO) and the Indaba Agricultural Policy Research Institute (IAPRI). The data were analyzed using matching and Poisson regression modelling to estimate the effects of the FISP policy on agricultural production and dietary diversities, and the effect of production diversity on dietary diversity.

FISP policy has promoted crop diversity, agricultural income diversity and general household income diversity among small scale farmers. However, the effect of FISP on crop diversity when area of crop production is taken into consideration appears to fade. These results seem to suggest that it is the value of agricultural and other farm enterprises that the policy has the greatest effect on, and not necessarily increasing areas under different crops. The pathway to increased diversity has been through increased fertilizer being accessed by farmers. The results also show that FISP has a direct influence on household dietary outcomes. The policy increased household dietary diversity.

(Kiwanuka, et al., 2019) also studied the effect of gendered participation in Zambia's FISP on HDD. They indicate there are various pathways to improving food and nutrition security in rural agrarian communities. These include: (i) increasing agricultural production, productivity and diversification that lead to an increase in food availability and diversity, and a reduction in food prices; (ii) increasing incomes and therefore people's purchasing power; and (iii) empowering women (World Bank).

The pathway of agricultural input subsidy programmes such as FISP is directly through enhancing agricultural productivity and diversification. Increased agricultural productivity and diversification implies that farmers can access diversified on-farm foods (consume what they produce), while the excess is sold to generate income which is then used to purchase other foods that are not available on the farm. Besides, subsidized inputs drive production costs and food prices down, which subsequently increase rural households' purchasing power of diversified foods.

The study used one wave of nationally representative data from the Rural Agricultural Livelihoods Survey (RALS) data on small and medium-scale farming households in Zambia. These were collected in 2015 using data on 7,924 households drawn from the 2015 RALS. They used the ordered probit in their estimation of effects.

Their results show that the majority of both participants and non-participants in FISP

have low diversified diets. Participation in FISP is skewed against households with female decision makers in crop production, constituting the majority of households with a high HDDS compared to households with no female decision makers. Although not significant, having a female decision maker is positively associated with high HDDS, while participation in FISP has the opposite effect. Among the key factors associated with the probability of having a high HDDS are the household head's education level, fertilizer quantity used, access to extension services, increased off-farm income and number of productive assets owned. Their findings suggest that reducing the gender gap in women's participation in FISP coupled with efforts aimed at promoting agricultural diversification through input subsidy programmes are critical steps to enhancing household food and nutrition security.

Malawi

(Katengeza, et al., 2019) argue on the premise that, potentially, farm input subsidy policies and integrated soil fertility management (ISFM) technologies enhance nutrition security through food and cash crop production because empirical evidence suggests that such policies result in higher crop production and incomes, which lead to improved household nutrition security. They examined the impact of integrating the farm input subsidy policy and ISFM technologies on nutrition outcome variables in Malawi focusing on anthropometry indicators of height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ), and related stunting, underweight and wasting as nutrition outcome variables for children under the age of five.

This potential linking of FISP and ISFM technologies with nutrition through increased agricultural production was at the centre of their research. Their argued theory of change suggests that FISP and ISFM technologies increase agricultural production which, in turn, improves own consumption and agricultural incomes. An increase in own consumption and agricultural incomes increase household nutrition status.

They used two nationally representative Integrated Household Survey (IHS) data sets: household panel survey data covering six districts in Central and Southern Malawi in four rounds for the years 2006, 2009, 2012, 2015; and LSMS-IHS data for 2010, 2013 and 2016.

Their results show that whilst fertilizer subsidy and individual ISFM technologies have inconsistent impacts on nutrition security when implemented separately, there is robust evidence of the positive impact of fertilizer subsidy on nutrition security when integrated with ISFM technologies. They found an increase in WHZ and a decline in underweight and wasting among children under five due to the integration of the fertilizer subsidy and organic and inorganic fertilizer, suggesting that integration of farm input subsidy policies and ISFM technologies has the potential to improve nutrition security. Thus, the promotion of farm input subsidy policies should be integrated with ISFM technologies to achieve sustainable nutrition security.

Uganda

(Chumo, et al., 2019) provide several pathway linkages of agriculture to nutrition. However, they follow the agricultural policy-relative food price effects on food affordability linkages to nutrition status through the extension participation (service delivery) approach of diversifying production impact on nutritional outcomes. Given the objective of the extension programme (increasing income through the adoption of profitable agricultural enterprises and improved technologies and practices, agricultural productivity and marketed output) this study is premised on increased productivity through diversification of production and increased marketing of the output. This could have an impact on relative prices and the consequences for the affordability of food and the nutritional status of children under five. Using propensity score matching techniques and data from the 2013/14 nationally representative household survey, they find that participation in the National Agriculture Advisory Services (NAADS) significantly influences a reduction in stunting among children under five, but not underweight or wasting children, at least demonstrating that participation positively impacts on child nutritional status. They advocate several governmental interventions, including the development and implementation of agricultural programmes that incorporate nutritional outreach behaviour change.

Mali

Acknowledging several pathways that link agricultural policies on diets of rural households, (Smale, et al., 2018) link the fertilizer (input) subsidy and its nutritional implications (focussing on the amount of subsidy linkages to the diet quality, MDD-W/WDDS) of women of reproductive age (WRA) who manage plots within male-headed households in Mali. They use this agricultural policy (fertilizer subsidy programme) to test the association of the subsidy with the diet quality of farm women.

Their theory of change is that boosting agricultural productivity could potentially lead to higher shares of the harvest sold and thereby raising income, with the diet influenced by either change in the crop grown and farm production, or by changes in food purchases. They used survey data for the crop year 2017–18 that included 2,400 households, and within these households 5,900 WRA were interviewed regarding their consumption in the preceding 24 hours (measured as either MDD-W or WDDS). They tested per/kg impacts of fertilizer received as a subsidized price on the diet quality of WRA who manage plots of crops targeted by the subsidy programme. They find less than half (43%) of the WRA who meet the minimum adequate score of consuming foods from at least five key foods in the day preceding the survey. The study finds that if other factors are held constant, women managing plots who planted crops targeted by the subsidy were more likely to consume sources of food rich in iron, but also to consume more snacks or meals purchased outside the home, which are sources of sugar, than other women of reproductive age in the households surveyed. They found that the overall effect of the fertilizer subsidy on women's dietary diversity through fertilizer applied to plots they managed was likely to be quite small, although statistically significant—a kg/ha was associated with a change in score that is 2.5% of a point (food group).

In a comparative review, (Smale, et al., 2018) identified the potential impacts of fertilizer impacts on nutrition in Tanzania on dietary diversity among, but not within, households (Gine, et al., 2015) and a positive but not significant impact of fertilizer subsidy on household food security or dietary diversity in Malawi (Snapp, et al., 2015).

Effect of policy profiling/targeting on the potential of improving nutrition outcomes

Zimbabwe

(Oostendorp, et al., 2019) use a strongly disaggregated approach to impact evaluation, in that first, profiles of households are identified, signalling in which types of households (characterized by socioeconomic, agro-ecological and climate conditions) children suffer most from stunting. Using these profiles, the next step in the paper is assessing whether policies that would be aimed at improving dietary diversity, and hence reduce stunting, should be aimed at the households most in need, or whether they should rather focus on "most value by the dollar". Their analysis combines geo-referenced DHS data with map data on soil quality, length of growing period, climate, and farming systems. In the paper, non-parametric estimation techniques (polling) are applied in the characterization of households with stunted children, and a parametric impact evaluation is performed in the second part. As the DHS is an observational dataset, the authors rely on propensity score matching to identify treated and non-treated populations. In addition, they also correct for a possible seasonal bias in data collection, as the DHS survey had been conducted over a period of several months. Their main conclusion is that targeting profiles with a high share of households that have children suffering from inadequate diet diversity will be relatively efficient as they also tend to have a high impact coverage. However, the correlation is not perfect, and the impact of improving diet diversity is actually decreasing as the likelihood of suffering from inadequate diet diversity increases.

Although the paper studies Zimbabwe, the main contribution of the paper should be viewed in the methodological area, pointing out the possible errors that can be made when focusing on average treatment effects rather than taking a more disaggregated approach. It is clear that alternative profiles of households would be relevant for different countries and contexts, but that the approach is universally applicable, specifically when more specific interventions need to be planned and/or evaluated.

Ethiopia

For Ethiopia, (Haji, 2018) focused on the impact of smallholder agricultural commercialization on child underweight and wasting. The idea is that increased income from commercialization translates into food purchases of higher quality and greater diversity, thereby improving the nutritional status of all household members, including children. Similar to (Smale, et al., 2020), this study uses LSMS data as the point of departure, but relies on three waves: 2011/2012, 2013/2014 and 2015/2016, constructing a panel of 1,911 households. Child malnutrition is then measured by anthropometric indicators (weight-for-age, weight-for-height and height-for-age), while commercialization is measured by the household crop

commercialization Index (CCI), which is the ratio of gross value of crop sales divided by the gross value of production, times 100.

Methodologically, "treated" and "non-treated" populations first needed to be defined in the paper, as the LSMS is an observational data set, not one that results from an experimental set-up. Hence, a variant of the propensity score used in (Oostendorp, et al., 2019) is applied, as well as controls for pre-treatment variables that seem to be correlated with commercialization. Again, as in (Oostendorp, et al., 2019), a check is run on the covariate balancing property and accepts 1,853 households for further analysis as they are in the common support region.

The authors conclude that the impact of commercialization on stunting is insignificant and inhibits a non-linear pattern. For underweight, the results are more complex: moderate commercialization has a negative effect on underweight, but more intense commercialization has a positive impact. However, overall, the marginal effects of commercialization are positive and significant. The same pattern and conclusion is found for wasting. Overall, the paper concludes that commercialization has a positive impact on child nutrition.

Zambia

For Zambia, (Marinda, et al., 2018) concentrate on the impact of a policy for agricultural diversification on stunting, under the assumption that monocultures in production are associated with one-sided consumption, leading to micro-nutrient deficiencies. The study relies on the DHS for 2006/07 and 2013/14 to assess the relation between stunting and dietary diversity, as (Oostendorp, et al., 2019) did for Zimbabwe, but this time using a parametric (linear) regression method. The actual policies under investigation include investment in rural infrastructure, crop improvement, establishment of secure rights to land and water, development and liberalization of credit markets, creation of cooperatives and encouragement of the private sector to play an active role in the development of smallholder outgrower schemes.

The paper concludes that the overall low dietary diversity in 2007 and in 2014 was a contributing factor to the high stunting levels in Zambia, although the levels dropped slightly from 48.2% in 2007 to 42.2% in 2014. The paper finds a positive relation between diet diversity and stunting for young children (between 6 and 23 months), but no significant relation for older children (24–59 months).

The paper has two major weaknesses: the relation between the policies mentioned and production diversification is not shown, and diet diversity is taken to represent production diversity. The latter assumption is particularly problematic as other studies, e.g. (Smale, et al., 2020), have shown that even in rural areas, the share of own production in consumption is relatively modest. Hence, the paper actually studies whether diet diversity has a relation with stunting, and no policy conclusion can be drawn on the effectiveness of agricultural production diversification.

Kenya

For Kenya, (Ateka, et al., 2018) take up the well-known fact that empowered mothers have a lower likelihood of having malnourished children. Using DHS data for 2003, 2008/2009 and 2014, the paper assesses: (i) whether empowerment indicators for women have shown trends in the period under study; (ii) whether household dietary diversity and children's anthropometric indicators have changed in the same period, and (iii) what dimensions of women's empowerment have had an impact on the nutritional status of children. Methodologically, to assess trends in empowerment, a probit model is used, with empowerment on the left-hand side and a number of explanatory variables on the right-hand side, under the assumption that the residuals of the model are normally distributed, while the full vector of indicators of empowerment is used, along with other household characteristics, to explain the household nutrition diversity. To account for possible endogeneity (factors impacting on empowerment also affecting nutritional indicators), additional test are carried out, leading to a modified model used in the analysis.

The main conclusion on the relation between empowerment and nutritional outcomes are: (i) agency, that is the ability to co-decide on the use of household income, which has a positive impact; (ii) having control over large purchases, which has a negative impact, presumably because food purchases do not fall into this category and large purchases may actually crowd out food; (iii) access to news and communication channels, which has had a positive impact; (iv) reducing time spent to fetch water and firewood, which has a positive impact; (v) land ownership, which has a positive impact; (vi) access to cold storage, which has a positive impact; (vii) education, which has a positive impact; (viii) having health insurance, which has a positive impact; (ix) a higher social status, which has a positive impact; and (x) having sex at a younger age and age difference with partner, which have a positive impact, which runs counter to the other results as, usually, a larger age difference is associated with more inequality between the partners.

In general, the study confirms the idea that there is a positive relation between women's empowerment and child nutritional status and offers, through detailed analysis, good indicators of where to focus attention.

Conclusions/implications

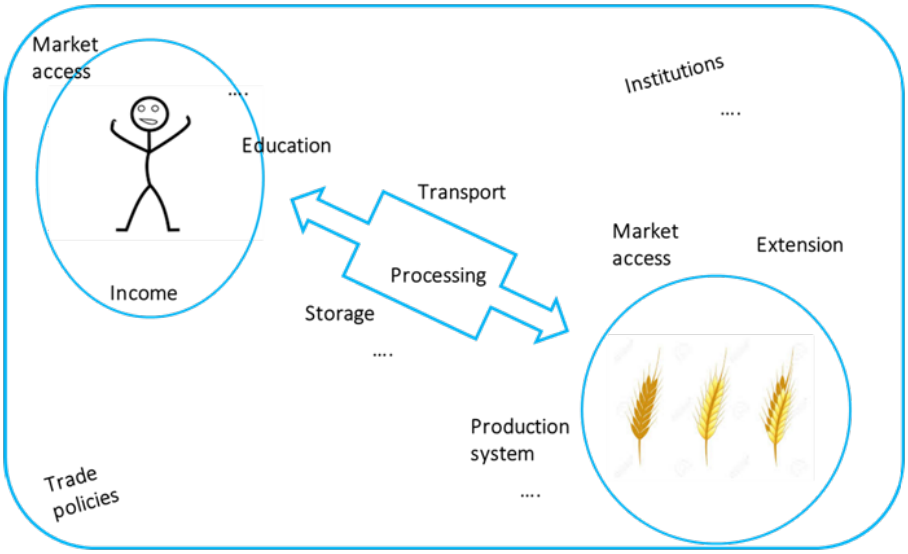
This paper synthesizes empirical evidence on several related questions: What empirical evidence exists on whether diets in SSA are shifting toward more highly processed foods, with greater shares of food purchased away from home, containing more sugars and/or being potentially obesogenic foods? How do agricultural production and market policies affect the affordability of nutritious diets? Who lacks and benefits from dietary diversity?

Using a broad conceptual livelihoods framework, we can identify several linkages and areas that are under-researched in the context of the AERC while, on the other hand, there seems to be a (too) strong emphasis on agricultural policies. An important missing

link is from dietary changes to productivity and employment; both through direct effects on the farmers, who, if better nourished, can be more productive, and indirect effects of changing diets in urban areas on rural hinterlands, including new options for employment in horticulture, livestock and processing.

To highlight where research could be positioned along the full chain from consumer back to producer, Figure 7 provides an overview of possible points of entry.

Figure 7: Food system and entries for research



Starting in the upper-left corner, policies and interventions aimed directly at consumption can be studied, which could include topics such as the impact of food aid in kind, fortification of food, and generic or group-specific interventions. Interventions aimed at the consumer include poverty alleviation, food education and ensuring consumers' physical access to (good) food. Conversely, in the lower-left corner, studies could be conducted on policies aimed directly at production, including improved seeds, bio-fortification, and possibly the impact of genetically modified organisms (GMOs). Policies aiming at producers would include improving knowledge (extension), adaptation of production systems to climate change, and policies that would incentivize producers to use fertilizers. Third, research can focus on the link between producers and consumers, viz. cold storage and transport, smart packaging, processing and marketing. Finally, research could also focus on the environment of the food chain; the system/economy as a whole. This could include studying (changes in) institutions – for example rules for and regulations on land ownership, environmental protection, credit accessibility and contract enforcement – and on relations with the external world, such as trade policies and policies guiding foreign investment.

Looking at the overall trends and conclusions, the studies synthesized in this paper (including studies not commissioned by the AERC) suggest that the dietary transition in Africa and specifically in SSA is still in the early stages, with relatively modest increases of consumption of meat and processed foods. However, it is also clear that large differences already exist between rural and urban areas, and that there are many countries that suffer from the triple burden of undernutrition, overnutrition and micronutrient deficiencies, particularly in lean seasons. On the question of how to improve nutritional outcomes, the empirical evidence is country-specific and sometimes even conflicts within countries when different data sets and methods are applied. This particularly holds true for the widespread policy of fertilizer subsidies that have had positive effects on nutritional outcomes in some countries, but little to none in others. Targeted interventions that are broader than agricultural ones alone seem to be effective, but the effectiveness of interventions does not always align with a desire to reach the neediest households. Finally, we conclude that many questions have remained unanswered, and more targeted research, particularly on the relation between diet transformation and (agricultural) productivity and employment, is needed.

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