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Making Agriculture Pro-Nutrition

Opportunities in Tanzania

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ABSTRACT

Extreme poverty and chronic malnutrition are widespread in rural Tanzania, where smallholder agriculture dominates the economy. Given the sector's role as the main source of food and livelihood for many malnourished people, agriculture has substantial potential to reduce poverty and hunger. Unfortunately, to date, the agricultural sector has not yet reached this potential, and agricultural growth has not translated to significant improvements in nutrition outcomes at large. In this study, we explore the links between agriculture and nutrition in Tanzania and review the evidence on how these links can be strengthened for improved nutrition. We further quantitatively evaluate the potential nutrition outcome of agricultural growth through productivity-enhancing investments over the next five years.

Tanzania has witnessed 3.3 percent gross domestic product (GDP) per capita annual growth in the past 11 years (1999–2010), whereas the prevalence of chronic undernutrition in children fell modestly, from 48.3 percent in 1999 to 42.0 percent in 2010. With 0.6 percentage point of annual reduction in undernutrition prevalence, Tanzania's nutrition outcome is comparable to most other Sub-Saharan African countries. However, in some Sub-Saharan African countries, such as Ethiopia, Uganda, and Zambia, child undernutrition prevalence has been reduced by more than 1 percentage point per year in the past decade, suggesting that there is room for Tanzania to improve its nutrition outcome. Within Tanzania, there is significant regional heterogeneity in both the levels of undernutrition prevalence and the reduction of undernutrition over time. Regional heterogeneity is also mirrored in the types of nutrition programs. In most cases, the nutrition programs implemented by government and nongovernmental organizations are fragmented and lack coordination among different actors. At the regional level, significant improvements in coordination among the government, development partners, and civil society only began in 2005; such coordination will be critical to maximize the future impact of nutrition interventions in Tanzania. The recently developed National Nutrition Strategy sets the stage for deliberate action and harmonization of investments and programs in this matter.

Through increasing smallholder incomes, agricultural productivity can also contribute to reducing undernutrition. This study combines an econometric estimation with results of an economywide model simulation to show that successful implementation of the Tanzania Agriculture and Food Security Investment Plan can accelerate agricultural growth, adding an additional 1.6 percentage points to annual GDP per capita growth in 2011–2015. With such growth, the prevalence of child stunting would be reduced by an additional 0.3 percentage point per annum in 2011–2015, and an additional 130,000 children would avoid becoming stunted by 2015.

However, to substantially reduce other aspects of malnutrition, other interventions targeted especially to women and children will likely be needed, in addition to programs designed to increase agricultural growth. Particularly important are nutrition education and child feeding programs, which have been shown to be highly effective in Tanzania and other developing countries. Some nutrient supplementation programs have been successfully put in place as well; however, fortification of main staple foods has been done only on a very limited scale, and agriculture-related interventions, particularly biofortification, have been largely underexplored. These deserve greater attention, and the emphasis of staple food fortification in the National Nutrition Strategy is promising.

Keywords: agriculture, nutrition, food security, development strategy, intervention, Tanzania, Sub-Saharan Africa

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ABBREVIATIONS AND ACRONYMS

AIDS	acquired immune deficiency syndrome
AMREF	African Medical and Research Foundation
AVRDC	World Vegetable Center
BCC	behavioral change communication
BFHI	baby Friendly Hospital Initiative
BMZ	Federal Ministry for Economic Cooperation and Development (Germany)
CAADP	Comprehensive Africa Agriculture Development Program
CARE	Cooperative for Assistance and Relief Everywhere
CDC	Centers for Disease Control and Prevention
CGIAR	Consultative Group of International Agricultural Research
CIP	International Potato Center
COUNSENUTH	Center for Counseling, Nutrition, and Health Care
CRS	Catholic Relief Services
DALY	disability-adjusted life years
DCGE	dynamic computable general equilibrium
DFID	Department for International Development (UK)
DHS	Demographic and Health Survey
DPG	Development Partner Group
FAO	Food and Agriculture Organization of the United Nations
ENHANCE	Expanding Nutrition and Health Achievements through Necessary Commodities and Education
FtF	Feed the Future
GDCGM	Global Database on Child Growth and Malnutrition
GDP	gross domestic Product
HAZ	height-for-age z-score
HIV	human immunodeficiency virus
IFPRI	International Food Policy Research Institute
IMCI	Integrated Management of Childhood Illness
ITNs	Insecticide Treated Mosquito Nets
IV	instrumental variable
IYCF	infant and young children feeding
JAST	Joint Assistance Strategy for Tanzania
JICA	Japan International Cooperation Agency
LMIC	low- and middle-income country
lowess	locally weighted scatter plot smoothening
MAFSC	Ministry of Agriculture, Food Security, and Cooperative
MAMM	Primary Health Services Development Program
MKUKUTA	National Strategy for Growth and Reduction of Poverty
MOCDGC	Ministry of Community Development, Gender, and Children
MOFEA	Ministry of Finance and Economic Affairs
MOHSW	Ministry of Health and Social Welfare
MOEVT	Ministry of Education and Vocational Training
NBS	National Bureau of Statistics
NFFA	National Food Fortification Alliance
NCCIDD	National Council for Control of Iodine Deficiency Disorders
NGO	nongovernmental organization
NNS	National Nutrition Strategy
OFSP	orange-fleshed sweet potatoes

OLS	ordinary least squares
PEEED	Poverty Eradication and Economic Empowerment Department
Partage	Association de parriange d'enfant du monde
PMO-RALG	Prime Minister's Office Regional Administration and Local Government
PPP	purchasing power parity
REPOA	Research on Poverty Alleviation
RR	relative risk
RUFs	ready-to-use foods
SDC	Swiss Development Cooperation
SSA	Sub-Saharan Africa
SUA	Sokoine University of Agriculture
T-MARC	Tanzania Marketing and Communications
TAFSIP	Tanzania Agriculture and Food Security Investment Plan
TAHEA	Tanzania Home Economics Association
TASPA	Tanzania Salt Producers Association
TFNC	Tanzania Food Nutrition Center
TIE	Tanzania Institute of Education
TWG	Technical Working Group
TZS	Tanzanian Shillings
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations' Children Fund
USAID	United States Agency for International Development
WAZ	weight-for-age z-score
WDI	World Development Indicators
WHO	World Health Organization
WHZ	weight-for-height z-score

1. INTRODUCTION

Persistent poverty and chronic malnutrition[1] are predominantly rural phenomena that characterize the developing world. Yet agricultural growth, which is also rural in nature, has been shown to be a major driver of poverty reduction, especially in countries with large agricultural sectors and large rural populations engaged in agriculture, as is the case in most Sub-Saharan African countries (Delgado, Hopkins, and Kelly 1998; Diao, Hazell, and Thurlow 2010; World Bank 2007). Income growth among the poor has also been shown to significantly improve the consumption of calories (for example, Abdulai and Aubert 2004a; Strauss 1984) and micronutrients per capita (for example, Abdulai and Aubert 2004b; Ecker and Qaim 2011; Ecker, Weinberger, and Qaim 2010). However, the nutritional status of individuals, particularly children, has been much less responsive to income growth (for example, Alderman, Hoogeveen, and Rossi 2006; Ecker, Breisinger, and Pauw 2011; Haddad et al. 2003).

Large-scale agricultural investments and accelerated agricultural growth have significant potential to improve nutritional outcomes in poor households, given agriculture's pro-poor growth potential and the increased consumption of food and health services as the incomes in those households rise. Agricultural growth can be particularly important to subsistence farmers, among whom undernutrition is particularly widespread, because it raises their incomes and can increase the supply of readily available food. This suggests that agriculture can be both pro-poor and pro-nutrition and that there are potential synergies between agricultural interventions and other interventions in nutrition-governing sectors, such as health and education. Regrettably, relatively little is known about the potential of agriculture in reducing malnutrition and about how to design agriculture interventions to be more effective in improving nutrition outcomes.

Research that systematically links agriculture, nutrition, and health and quantifies the nutritional effects of agriculture is still in its infancy, as is the realization of comprehensive, multisector interventions for reducing malnutrition in practice. The 2011 international conference on Leveraging Agriculture for Improving Nutrition and Health, facilitated by the International Food Policy Research Institute (IFPRI), has created a major initial push in this direction of research, and large global development assistance initiatives, such as Feed the Future (FtF) of the United States Agency for International Development (USAID), are beginning to integrate nutritional goals into agricultural development strategies.

This study analyzes the nutrition situation in Tanzania, explores the links between agriculture and nutrition, and estimates the nutritional effects of large-scale agricultural productivity-enhancing investments. Tanzania is a focus country of USAID's FtF initiative for 2011–2015, and the Tanzanian government has launched the national Tanzania Agriculture and Food Security Investment Plan (TAFSIP), which should implement the Comprehensive Africa Agriculture Development Program (CAADP), aiming at reducing hunger and food insecurity by raising smallholder productivity. Thus, the commitment of the government and the engagement of large development partners like USAID and others in agriculture and other nutrition-relevant sectors, including health and education, offer great opportunities to leverage agriculture interventions for reducing malnutrition at a large scale. The study provides analytical support to this progress.

The study is structured as follows: Section 2 conceptualizes the nutrition system and explains the pathways through which agriculture can contribute to improved nutrition outcomes. Section 3 reviews the literature on the rationality and effectiveness of agricultural and nonagricultural interventions to improve nutrition. Section 4 analyzes the nutrition situation in Tanzania and the country's nutrition strategy and programs implemented over the past decade. Section 5 predicts the nutritional effects of agricultural productivity-led growth on chronic child undernutrition for 2011–2015, and Section 6 concludes.

[1] Malnutrition includes both under- and overnutrition. In this paper, we focus on undernutrition in terms of both macronutrients (carbohydrates, proteins, and fat providing calories) and essential micronutrients (minerals and vitamins). We frequently use the term *malnutrition* to emphasize that micronutrient deficiencies are an integral part.

2. CONCEPTUAL FRAMEWORK

The Nutrition System

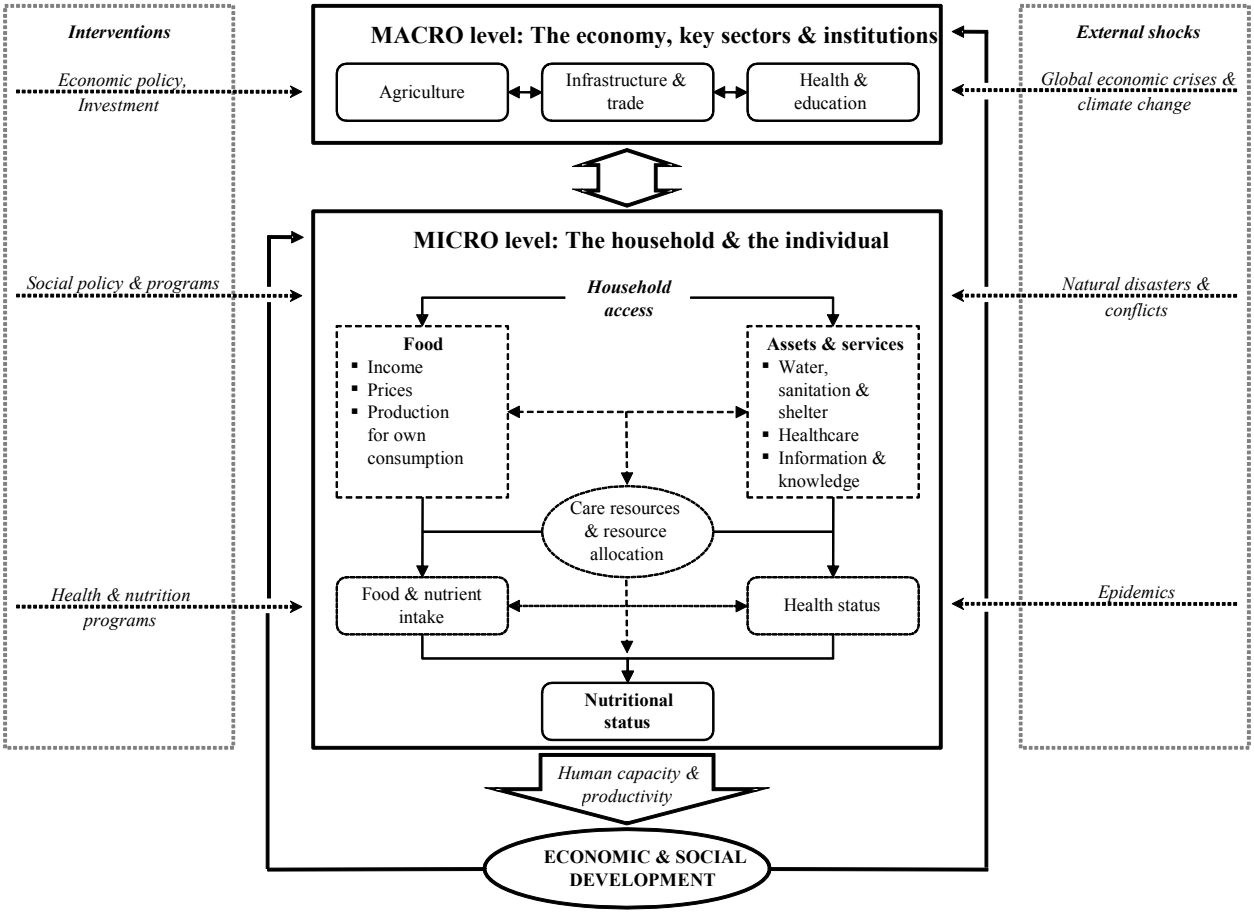
At the 1996 World Food Summit, the heads of state and government defined food security as a situation "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996, para. 1), whereby "the nutritional dimension is integral to the concept of food security" (FAO 2009, fn. 1). Achieving this situation requires concerted action across sectors and intervention at the individual, household, national, regional, and global levels (FAO 1996). Although this food security definition lays a foundation for our understanding of the nutrition system, nutrition goes far beyond food consumption and is subject to health, education, and other factors.

The ultimate goal of public policy and international development assistance is to improve societal and individual welfare. Since nutrition is a fundamental human need with important long-term development implications (World Bank 2006), the success of national policies or international engagement can be assessed in terms of their effects on people's nutritional status. This notion drives the development of our conceptual framework. Our framework is particularly designed for analyzing country-level development strategies and specific intervention options in the form of policies and programs to reduce malnutrition, but it also allows for assessing the nutritional impact of external shocks, such as global economic crises, climate-related and natural disasters, and epidemics. At the household and individual levels, our framework draws on the United Nations Children Fund (UNICEF)'s framework of the causes of child malnutrition and death (UNICEF 1990), which has served as the basis of most nutrition-related frameworks. Given the focus of this analysis on pro-nutrition investments and targeted programs in Tanzania, we limit our conceptual explanation to the nutritional impact of interventions.

Figure 2.1 outlines the channels through which interventions (and external shocks) at different levels and in different sectors translate into nutrition outcomes and the key factors determining these outcomes. For analytical purposes, the framework differentiates between factors at the national and regional (subnational) level—the macro level—and at the household and individual level—the micro level. Thus, an individual's nutritional status is considered a direct outcome of various micro-level factors and an indirect outcome of various macro-level factors, whereby the factors at each level are horizontally and vertically interconnected through different linkages, of which the key linkages are discussed below.

At the macro level, economic growth and the structure of growth across and within the economic sectors—which determines the distribution of the growth benefits across the population—are the core factors of people's well-being. The distribution of benefits is regulated through institutions. The macro level is linked to the micro level through supply and demand of goods and services and via the factor market, where households earn incomes for the provision of factors of production. The key sectors for human nutrition are agriculture, trade and infrastructure, health, and education. Joining their forces and utilizing synergies is critical for improving nutrition outcomes.

Figure 2.1—A conceptual framework of the nutrition system



Source: Authors' representation.

Agriculture is the most important sector for achieving food security in the early stages of economic development and plays an important role in the development process in many ways; however, the sector's relevance for food security changes during the process of structural transformation (Mellor 1966). Depending on a country's stage of development, agriculture's primary role in contributing to nutrition can be through supplying food, employment, and/or income (Haddad 2000). Thus, agricultural growth has strong linkage effects that drive overall growth and often reduce food prices, which especially benefits net food consumers with a high share of spending on food. Agriculture also has the potential to cushion rising income inequalities that are often observed during structural transformation; this, in turn, often leads to high adjustment costs and can be a binding constraint for development (Diao, Hazell, and Thurlow 2010). In addition, agricultural exports provide substantial earnings in most developing countries, thus generating revenues for investment (World Bank 2007). The pathways through which agricultural investment can improve nutrition directly and indirectly are outlined in the next subsection.

In the course of progressing national and international market integration, an efficient trading system, functioning market institutions, and physical infrastructure become increasingly important to establish food supply chains that quickly move food through the market, from domestic and foreign producers to consumers, at declining transaction costs. Transportation infrastructure also enables people to access health and education facilities and make use of services that are critical for good nutrition (Fay et al. 2005).

At the micro level, the nutritional status of all household members is subject to the household's economic (and physical) access to food and to basic household assets and (public) services that can

promote individuals' good health and nutrition. Most cases of limited access are due to limited financial resources, thus perpetuating the vicious cycle of poverty, malnutrition, and illness. Hence, the most important factor affecting food access is household income and, in subsistence farm households, the assets to produce food for consumption. Not only does income poverty limit access to food of sufficient quantity, quality, and diversity—with quality referring to sufficient macro- and micronutrients and types of food (including breast milk for infants)—but it also increases vulnerability to food price spikes and other shocks, leading to volatility in nutrient supply. High food prices force the poor to adjust their dietary choice and budget allocation to other basic goods and services that might translate into a deterioration of the nutritional status of the most vulnerable individuals—mostly, young children.

Furthermore, individual food access and adequate food intake are contingent upon intrahousehold food distribution and the care given to meet individual dietary needs, both of which, in turn, depend on the education and nutritional knowledge of the household decisionmaker and the person responsible for meal preparation, gender equality in decisionmaking, and cultural customs and social habits (Christiaensen and Alderman 2004; Hoddinott and Haddad 1995; Menon and Ruel 2003). Children's nutritional status is also directly determined by the mother's nutritional and health status through the physiological and social mother–child relationship. In addition, the nutritional knowledge, the physical capability, and women's availability to provide care are usually most critical for the nutritional status of all family members, because mothers are typically entrusted to feed their children and prepare the meals for the household (Smith et al. 2003).

Finally, an individual's nutritional status is determined by his or her health status (and vice versa), which influences the physiological nutrient requirements and interacts with the utilization of nutrients from food. For example, parasitic diseases such as malaria, schistosomiasis, and diarrhea cause nutrient losses through blood and stool; they also reduce nutrient absorption, necessitating higher nutrient intake and thus more food to cover the losses, if such compensation is possible. At the same time, poor nutrition weakens the human immune system and therewith increases the risk of disease and illness (Black, Morris, and Bryce 2003; Walker et al. 2007). Thus, access to clean drinking water, hygienic sanitation, proper shelter, basic healthcare for disease and illness prevention and treatment, and related information and knowledge all affect people's nutritional status indirectly through the link with health (Frongillo, de Onis, and Hanson 1997; Smith, Ruel, and Ndiaye 2005; Wolfe and Behrman 1982).

Good nutrition is fundamental for individuals to realize both their maximum physical and intellectual potential. It is the basis for the well-being of individuals and for human capital formation, and, as such, it is key to economic development and the formation of societies. Conversely, poor nutrition has serious, long-lasting economic consequences at the micro and the macro level. Malnutrition reduces a household's income-earning ability, perpetuates poverty, and slows economic growth through three routes: (1) direct losses in productivity from poor physical and mental performance or death, (2) indirect losses from reduced working and cognitive capacity and related deficits in schooling, and (3) losses in resources due to increased healthcare costs (World Bank 2006). Even temporary malnutrition can cause irreversible health impairments, particularly in children, limiting the development potential of future generations.

Hence, the relationship between income and nutrition is bidirectional, whereas the returns to improved nutrition—especially of children—might materialize later in life. It is important to remember that the time lag between an intervention and its (monetary) impact may be large; therefore, it is difficult to quantify exactly the returns to the investment of the intervention a priori. For example, improved nutrition among children allows them to perform better in school (in the short–medium term), which may later pay off when they enter the labor market; however, attributing this monetary benefit to better nutrition during childhood alone is erroneous. The same holds true at the macro level, in that increases in national school enrollment and achievement rates may result from improved nutrition, which in turn may lead to gains later in national gross domestic product (GDP). However, these gains would not be solely attributable to nutrition interventions. Nonetheless, there is strong scientific evidence that malnutrition is associated with large economic losses at the individual and national level. As an example, UNICEF and the Micronutrient Initiative (2004) postulates that iron deficiency lowers the intelligence quotient in

schoolchildren by 5 to 7 points on average, and Horton and Ross (2003) estimated that for 10 developing countries, the median productivity losses from physical and cognitive impairments due to iron deficiency exceed 4 percent of GDP annually, or about US$17 per capita.

The nutrition system can be compromised by external shocks, such as global economic crises, climate change, natural disasters, conflicts, and epidemics, at various points in time at the macro and micro levels. Although it is often difficult or even impossible to prevent such external shocks, appropriate risk management strategies are important for mitigating these effects on people's nutrition during and after the crises. Given that wealthy households possess more means to respond to external shocks and that higher-income countries can better cope with crises, policies that support shared growth in themselves can function as preventive risk management and improve the nutrition situation of malnourished populations.

Agriculture-Nutrition Pathways

Investments in agriculture and along the food value chain can contribute to improved nutrition through at least six interlinked pathways:

Income Growth and Food Price Reduction

Most agricultural investments aim at increasing agricultural productivity and marketable output that might contribute to higher incomes of farm households, reduced food prices, or both. The additional income can be used to purchase more food, food of better quality, and a more diversified diet or be spent on better healthcare, education, clothing, shelter, and sanitation, which all affect nutrition directly or indirectly. At the macro level, investments might generate economic growth and government revenues that can be redirected into social safety nets or invested into the health and education sectors, for example.

Agricultural Technologies

One promising strategy for reducing specific micronutrient deficiencies is biofortification—a breeding technique that increases the stable amount of bioavailable micronutrients, such as iron, zinc, and vitamin A, in the plant organs consumed in staple cereals and root and tuber crops (Nestel et al. 2006). Using biofortification has several critical strengths for reducing micronutrient malnutrition among the poor: it targets the poor, who eat large amounts of food staples daily; it is self-targeted toward rural areas and inclusive to remote areas where poverty and malnutrition are particularly widespread and persistent; and it is sustainable in that it relies on the foods that people are already used to eating (Bouis, Graham, and Welch 1999; Bouis 2002; Timmer 2003; Bouis et al. 2011). Other agricultural technologies with the potential to reduce hunger and malnutrition include drought-resistant crops and irrigation schemes that reduce volatility in nutrient supply. In addition, technologies that save labor or reduce agrochemical usage can affect the nutritional status of workers or their family members through changing allocation of time (especially among women caring for their infants), resources, and lower health risks from exposure.

Direct Access to Quality Food

A modification of the agricultural production system can improve people's nutrition at the local level. Most farming households in the developing world primarily produce food for subsistence. Where investments lead to diversification of agricultural food production, they might also lead to modification and diversification of the household diet toward a diet rich in foods with a high bioavailable content of essential proteins and micronutrients, such as fish, meat, vegetables, and fruits. Examples include initiatives to promote home, school, and community gardens and small-scale livestock husbandry and aquaculture. In addition, a more diversified agricultural production can lead to a better supply of nutrient-rich foods in the local market, making these foods more available to buyers.

Value Chain Innovations

Processing of foods offers a good opportunity to add nutrients to food products and condiments—a process known as *fortification*. To reach a large share of the population and provide a continuous supply through the market, regularly consumed foods are targeted. The best-known form of mass fortification is the iodization of salt, which has proven to be a successful tool for reducing iodine deficiency disorders (Mason, Rivers, and Helwig 2005). Other fortified products include flours enriched with iron or zinc and oils and fats with retinol (vitamin A) and fat-soluble B vitamins. Furthermore, innovations and investments that improve market coordination and quality assurance among processors or that lead to reduction in postharvest losses and shorter supply chains for perishable foods are important components for improving nutrition, especially in urban areas. Similarly, providing behavioral change communication via product packaging (for example, nutrition information and recipes), as well as labeling of the nutritional value of products, can constitute important value chain innovations that reach masses and complement other forms of nutritional mass communication.

Allocation of Household Resources

Both technological and system-oriented investments change agricultural production patterns and the profitability of particular production activities. For example, if an activity is predominantly controlled by women, and women can make greater income earnings from it, agricultural investment can affect the ways in which households spend money, how food is allocated among individual household members, and the type of (nutrition-beneficial) assets that are accumulated (Hoddinott 2011). However, the incentives are not necessarily pro-nutrition. For example, where the returns on time spent on agricultural work increase, households may devote more of their labor to agricultural production. If this time does not come from reduced leisure time or from labor inputs from outside the household, household members could reduce time spent for other income-generating activities, for care and feeding time for children, or for meal preparation and eating (Hoddinott 2011).

Behavioral Changes

Creating demand for healthy nutrition is fundamental for eradicating malnutrition. Investments in formal education and nutrition information campaigns, as well as in women empowerment, are critical in this context. Moreover, better knowledge of breastfeeding and complementary feeding among mothers is universally needed in malnourished populations. The agricultural extension service system may also provide a communication platform to deliver nutrition-superior knowledge to men, who usually control household resources but share less responsibility for the nutritional and health well-being of children.

The importance of each pathway is context-specific; comprehensive investments that utilize the synergies of these pathways might be most beneficial, given the multidimensionality of the malnutrition problem.

3. RATIONALITY AND EFFECTIVENESS OF NUTRITION INTERVENTIONS

Nutrition interventions can be differentiated into food-based strategies, nutrition education, and supplementation. Food-based strategies include dietary diversification, biofortification, and food fortification. Food-based strategies are the focus of the following review of the rationality and effectiveness of nutrition interventions, because they are rooted in or closely related to the agricultural sector and aim at tackling the causes of malnutrition and providing sustainable solutions. Given that some food-based approaches require behavioral change among consumers to be effective, there is a high likelihood for synergies between agricultural and educational interventions to improve nutrition; therefore, we carefully review the effectiveness of nutrition education programs. For the sake of completeness and comparability, we also review the effectiveness of delivering high-dosed nutrient supplements—a short-term measure to reduce severe malnutrition—and of disease treatments affecting nutrition. It is important to remember that when evaluating the different strategies, pure unit-based cost-effectiveness is only one criterion, and the adequacy of the particular strategy to target the population in most need for help is also important.

Dietary Diversification

Most farming households in the developing world primarily consume foods that they produce; therefore, interventions that increase food production quantity and the diversity of the production have high potential to directly influence the nutritional status of the farm household members. Although many interventions aiming at enhancing dietary diversity through food production diversification, such as small-scale horticulture or livestock-based approaches, have shown positive effects on consumers' diet, evidence quantifying the nutritional impact of such interventions is limited. For instance, Ruel (2001) found that home gardening programs indeed increase the intake of vitamin A and iron-rich vegetables among the children of beneficiary households, but significant improvements in their nutritional status (measured by anthropometric indicators) could not been detected due to insufficient scientific rigor of the available, analyzed studies. Nonetheless, Ruel (2001) showed that projects combining agricultural interventions with nutrition education components were more successful in improving diets than were agricultural interventions alone.

The relevance of including a nutrition education component in agricultural interventions in order to improve nutrition outcomes, particularly to reduce vitamin deficiencies in young children, was also demonstrated by Faber, Venter, and Benadé (2002) and Faber, Jogessar, and Benadé (2001). In a rural South African village, mothers were introduced to gardening skills but also educated about the importance of micronutrients in child development and the role of vegetables and fruits in providing those micronutrients. Children of mothers who participated in the project showed significantly higher dietary intakes of vitamin A, riboflavin (vitamin B2), vitamin B6, and ascorbic acid (vitamin C) compared with other children. Moreover, due to the spreading of nutrition information throughout the village as a result of the intervention, the demand for beta-carotene-rich squash increased and led to an improved vitamin A status (measured by the serum retinol concentration in the blood) of children of both the intervention and the control group.

Berti, Krasevec, and FitzGerald (2004) conducted a systematic review of various agricultural interventions to assess their nutritional impact and largely confirmed and generalized the findings from the previous studies. They reviewed 25 intervention projects, including home gardening, livestock, mixed garden and livestock, cash cropping, and irrigation, in terms of their effects on nutrition indicators such as anthropometrics, biochemical and clinical indicators, and morbidity. Most interventions increased food production output but did not necessarily improve the nutritional status of the members of the participating households. Of all 25 projects, 20 had a positive effect on diets; however, these changes did not necessarily coincide with changes in anthropometric, biochemical/clinical, or morbidity indicators. Nineteen projects had a positive effect on nutrition, while nutrition was improved in 11 of 13 home gardening projects, identifying the latter as among the most nutrition-effective agricultural intervention strategies. In general, projects were more likely to have a significant nutrition effect if they invested more

broadly in different types of *capital* (differentiated into physical, natural, financial, human, and social capital), in addition to the agricultural intervention. Of the 19 projects that had a positive effect on nutrition, 14 invested in four or five types of capital. Those projects that invested in human capital—especially through nutrition education and consideration of gender issues—tend to be more effective at causing a measurable, positive nutritional change; but such investments are neither always necessary nor sufficient to trigger a positive change (Berti, Krasevec, and FitzGerald 2004).[2]

Interventions that involve higher intakes of proteins, minerals, and vitamins from animal-source foods have a high potential for improving nutrition, because of the high bioavailable concentration of nutrients in these foods. However, few studies have assessed the nutritional impact of animal production interventions, and their validity in terms of nutrition effectiveness is limited because of the study design and evaluation method. Leroy and Frongillo (2007) reviewed 14 studies that generally reported a positive effect on dietary intake, but only four studies evaluated the impact on nutritional status and hence could demonstrate a positive effect. However, the studies failed to attribute the change in dietary intake and nutritional status as a direct outcome of increased animal production or an indirect outcome of income growth. Nonetheless, Leroy and Frongillo (2007) found that the interventions that had a clear positive effect on diets and nutrition were limited to those that had a nutrition education component or in which women played a key role. Thus, taking the findings for (largely) horticulture-based interventions from Berti, Krasevec, and FitzGerald (2004) and for livestock-based interventions from the Leroy and Frongillo (2007) meta-analyses together, we can conclude that, independent of the type of agricultural intervention, the effectiveness of any agricultural intervention can be increased by complementing it with interventions that improve human and social capital.

Yet studies assessing the cost-effectiveness of dietary diversification interventions have been sparse. A well-known, long-term program focusing on homestead food production in Bangladesh—established by Helen Keller International (HKI) in 1988—provides strong evidence that home gardening and livestock holding sustainably improve beneficiaries' access to vitamin- and mineral-rich vegetables and livestock products, including eggs and meat (Bushamuka et al. 2005; Iannotti, Cunningham, and Ruel 2009). The program also contributed to strengthening women's status in the household through greater control of income generated by the intervention. Still, in more than 20 years of existence and expansion throughout South and Southeast Asia, programming costs for this intervention have not been reviewed with regards to their cost-effectiveness (Iannotti, Cunningham, and Ruel 2009).

Biofortification

Although ensuring the consumption of a diversified and well-balanced diet is certainly the most sustainable strategy to address the problem of malnutrition, for many it is not an immediately achievable solution, given that the poor often lack (economic) access to afford an adequate diet and that farmers are unable or unwilling to partly replace staple food production with horticulture on their land (Meenakshi et al. 2010). The regular consumption of staple foods enriched with key micronutrients such as iron, zinc, and vitamin A can considerably reduce the shortage of these micronutrients in staple-dominated diets. The recent success of HarvestPlus Challenge Program of the Consultative Group for International Agricultural Research provides convincing evidence that biofortification can be an important strategy to reduce micronutrient malnutrition at a large scale, and several recent studies (for example, Stein et al. 2005; Stein et al. 2007) have revealed a high effectiveness of biofortification programs.

In an experimental study in rural Mozambique designed to assess the effectiveness of introduction of orange-fleshed sweet potatoes (OFSP) in an integrated agriculture and nutrition intervention, Low et al. (2007) showed that the serum retinol concentration in young children significantly increased through the consumption of OFSP compared with the children of the control group (whose levels did not change significantly), and vitamin A deficiency dropped. Through this integrated approach, nutrition knowledge was increased among both women and men, demand for OFSP rose, the OFSP production area was expanded by a factor of more than 10, and OFSP emerged as the cheapest

[2] The effectiveness of specific nutrition education programs is separately reviewed below.

source of vitamin A in the intervention area. Similar results were found in a comparable study carried out in rural South Africa (Jaarsveld et al. 2005).

In an ex ante, cross-country assessment, Meenakshi et al. (2010) postulated that biofortification can be a highly cost-effective tool for combating micronutrient deficiencies in the developing world at large, although the impact may significantly differ by crop, micronutrient, and country. Even under pessimistic scenarios that assume low reductions in the overall burden of micronutrient deficiencies, the cost-effectiveness of biofortification programs at the individual level remains quite high. To quantify the cost-effectiveness of interventions in terms of their health and nutritional outcomes, the disability-adjusted life years (DALY) approach—introduced by Murray and Lopez (1997) as a measure of the magnitude of ill health from global diseases—has been increasingly used in the context of biofortification, such as by Meenakshi et al. (2010) and previous studies (for example, Zimmerman and Qaim 2004; Stein et al. 2007). The DALY approach considers both morbidity and mortality outcomes in a single index; DALYs lost are the sum of years lived with disability due to preventable disease or circumstances and the years of life lost due to preventable death. Accordingly, the impact of an intervention is measured by the extent of the reduction of DALYs lost (referred to as DALYs saved).

Table 3.1 shows the percentage reduction in DALY burden of micronutrient deficiencies through biofortification of different staple crops with different micronutrients, as estimated by Meenakshi et al. (2010). The table also reports the costs of the intervention, including research and development costs, adaptive breeding costs, dissemination costs, and maintenance breeding costs. Meenakshi et al. (2010) estimated the benefits and costs of developing and introducing biofortified staple crops for both a pessimistic and an optimistic scenario. The pessimistic scenario assumes that the coverage rates of adoption are half those of the optimistic scenario, due to lower customer acceptance and the quality of seed systems. Likewise, micronutrient content of biofortified staples can vary; thus, under the pessimistic scenario, biofortified foods produce less of the micronutrient. In addition, the variation in the effectiveness of different crops at reducing the burden of a particular micronutrient deficiency results from different food processing (drying, milling, and so on) and preparation methods, which can be associated with large nutrient losses before human consumption; therefore, under a pessimistic scenario, these losses are 20–50 percent higher than under the optimistic assumptions. Under both scenarios, the range in the percentage reduction of DALYs lost and the costs per DALY saved, given in the table, are subject to the country of intervention. Consumption patterns vary greatly across countries and regions, as does the share of the staple food in the local daily diet. Nonetheless, considering the benchmark costs of a highly cost-effective intervention as suggested by the 1993 World Development Report (World Bank 1993), amounting to $196 per DALY saved in 2004 dollars at today's value (Meenakshi et al. 2010), biofortification of all main staple foods—including beans—is highly cost-effective at reducing vitamin A, iron, and zinc deficiency universally under the optimistic scenario; under a pessimistic scenario, it remains very cost-effective for the major staple crops in the country of intervention. The cost estimates of Meenakshi et al. (2010) show that biofortification can be an even more or at least similarly cost-effective strategy for combating micronutrient deficiencies as compared with food fortification and nutrient supplementation. For the dissemination of iron- and zinc-dense rice and wheat, Behrman, Alderman, and Hoddinott (2004) gave a general range of the benefit–costs ratio of about 12:1 to 19:1, and for the dissemination of vitamin A–dense rice (Golden Rice) of about 9:1 to 19:1.

Table 3.1—Benefits and costs of biofortifying staple crops by nutrient under pessimistic and optimistic scenarios

	Percent Reduction in DALYs Lost		Costs (US$) per DALY Saved	
	Pessimistic	Optimistic	Pessimistic	Optimistic
Vitamin A				
Cassava	3–4	19–32	124–1,006	8–27
Maize	1–8	17–32	113–289	11–18
Sweet potato	38	64	30	9
Iron				
Beans	4–9	16–36	134–439	20–66
Rice	4–8	11–21	17–234	3–55
Wheat	6–7	28–39	10–13	1–3
Zinc				
Beans	3–5	15–20	1,494–5,940	153–576
Rice	13–20	33–56	7–55	2–12
Wheat	5–9	33–48	11–18	1–2

Source: Adopted from Meenakshi et al. (2010).

Fortification

In many countries, fortification has been established as a standard food-based strategy for directly delivering micronutrients added to commonly consumed foods and condiments—the *vehicles*—to a large share of consumers, most successfully in the case of salt iodization. The advantages and drawbacks of food fortification have been discussed in several studies (for example, Allen et al. 2006; Fiedler, Sanghvi, and Saunders 2008; Dary and Mora 2002). The main advantages include the cost-effectiveness of the intervention and its neutrality toward consumption patterns and program participation, whereas the requirements of centralized processing and adequate market-based supply channels limit the potential of fortification to reduce micronutrient deficiencies in rural, subsistence-dominated systems.

Fortification costs are generally low and mainly concentrated on initial investments. Baltussen, Knai, and Sharan (2004) found that in the African context, the costs of iron fortification are as low as US$27 per DALY saved to provide access to fortified foods to 50 percent of the target population (considering a 10-year time horizon). Expanding the coverage to 95 percent of the target population, the costs per DALY saved decrease to as low as US$20 per DALY, due to economies of scale. Of the total costs, about 75 percent accounts for the costs of the electrolytic iron fortificant, with the remaining costs dedicated to equipment, staff, and monitoring and evaluation (Allen et al. 2006).

Fiedler and Macdonald (2009) examined the cost-effectiveness of fortification programs in 48 countries by looking at the fortification of sugar and vegetable oil with vitamin A and maize and wheat flour with a package of micronutrients consisting of iron, zinc, vitamin A, and several B vitamins. Assuming a 30 percent reduction in the micronutrient deficiencies of the persons consuming the fortified product and accounting for consumption patterns and various accumulating costs of producing and sustainably establishing fortified products, Fiedler and Macdonald (2009) estimated the costs per DALY saved, as shown in Table 3.2 for selected African countries. Fortifying wheat flour, though often less consumed than maize flour in the African countries considered, is particularly cost-effective, partly due to the concentration of wheat milling and distribution among a small number of large manufacturers driving down prices, as well as shifting consumption patterns toward wheat-based, ready-made products, such as bread and noodles. Horton (2006) and Horton and Ross (2003) estimated the benefit–cost ratio for fortifying staple foods with iron at 8:1, in general.

Table 3.2—Costs of food fortification relative to health benefits in selected African countries

	Costs (US$) per DALY Saved			
	Sugar	Vegetable Oil	Maize Flour	Wheat Flour
Tanzania	227	106	201	5.61
Ethiopia	—	43	—	12.68
Ghana	—	251	491	5.88
Kenya	262	161	1,252	7.53
Malawi	223	**105**	120	10.81
Mali	146	2,696	—	4.68
Mozambique	1,545	301	—	22.38
Rwanda	225	68	—	—
Uganda	56	—	197	—
Zambia	218	—	659	12.1

Source: Fiedler and Macdonald (2009).

Nutrition Education and Child Feeding Counseling

Information campaigns and education programs are critical in all nutrition interventions both for the uptake of the intervention and for boosting its impact, given that behavioral changes are necessary for successful and sustainable implementation in most cases. However, nutrition education is not only an important complementary intervention for increasing the effectiveness of the core intervention; it is also a malnutrition-reduction strategy itself. Given widespread poor nutrition knowledge, informing and educating people—especially adolescent girls and women about breastfeeding and appropriate complementary feeding of young children, for example—can significantly contribute to a reduction in child undernutrition. Similarly, a behavioral change regarding dietary patterns and food preparation methods might significantly reduce micronutrient malnutrition, particularly among non-poor households (Horton et al. 2010).

Analyzing community health and nutrition programs from several countries, Mason et al. (2006) found that among the different factors of child growth considered, targeted nutrition education is particularly effective at changing child feeding and care practices and ensuring long-term behavioral change. For a community nutrition program in Zimbabwe in the 1980s, Mason et al. (2006) attributed a decline in child stunting within six years by 1.1 percentage points per annum to a supplementary feeding intervention in concert with nutrition education, child monitoring, and programs for increasing farm income. Likewise, in a similar program in Tanzania's Iringa region, the prevalence of children underweight dropped from 50 percent in 1984 to 35 percent in 1988—or a decrease of about 3.8 percentage points per annum—thanks to growth monitoring combined with education campaigns and supplementary feeding at the community level. In general, preventative nutrition education instituted as early as possible in children's lives is more effective than a recuperative approach that targets those already assessed to be malnourished (Ruel et al. 2008; Alderman 2007). Ruel et al. (2008) found that the prevalence of child undernutrition is 4–6 percent (depending on the anthropometric indicator considered) lower in communities that received regular preventative nutrition information than in the recuperative communities that were targeted because of their mild and moderate underweight prevalence. These findings clearly support the general notion that the age of children matters for the impact of interventions tackling child undernutrition and underscores the importance of targeting the 1,000-day period, which includes pregnancy and the first two life years and is known as the *window of opportunity*. Growth retardation manifesting in early ages is hardly compensated for in later life and accumulates in the development process under chronic undernutrition (UNICEF 2009; Black et al. 2008).

Inappropriate breastfeeding practices are one of the main causes of increased mortality and morbidity among young children (Black et al. 2008); thus, breastfeeding promotion programs can have high nutrition impact. For example, Bhutta et al. (2008) showed that individual and group counseling significantly increase the odds of exclusive breastfeeding during the first half-year of life. Hernandez, Marquez, and Parlato (1995) found that mass media campaigns were able to notably improve

breastfeeding practices. They attributed a 20–40 percent increase in exclusive breastfeeding during the first half-year of the child's life (depending on the period of months considered); yet the study could not demonstrate significant changes in the length or weight of the children.

After the first six months, complementary feeding (in addition to breastfeeding) becomes increasingly important, and its inappropriateness (or absence) substantially increases the risk of permanent growth failure. Likewise, programs promoting adequate complementary feeding practices have shown to be effective tools for improving children's nutritional status in several studies (for example, Penny et al. 2005; Santos et al. 2001). Guldan et al. (2000) found that an education intervention in China that is targeted at improving child feeding practices improved the mean height-for-age z-score (from –1.93 to –1.17) and the mean weight-for-age z-score (from –1.96 to –1.32) of one-year-old children. In addition, the prevalence rate of anemia among the children of the intervention dropped by 10 percentage points below the rate of the control group. Thus, Guldan et al. (2000) demonstrated that targeted nutrition education interventions can reduce child undernutrition and dietary iron deficiency in a measurable and statistically significant manner. However, a household's food security situation is an important factor of the effectiveness of education programs in reducing child malnutrition. Bhutta et al. (2008) found that among the food secure, education programs alone are effective at raising children's height-for-age z-scores and thus reducing underweight; however, only in combination with nutrient supplements delivery did nutrition education programs have a statistically significant and positive effect among the food insecure.

There is general consensus that breastfeeding promotion saves infants' lives and that targeted programs are often cost-effective too (Darmstadt et al. 2005). The benefit–cost ratio for breastfeeding promotion programs in hospitals ranges from 6 to 67; for integrated child care programs including a nutrition component, it ranges from 9 to 16, depending on the program's design (Behrman, Alderman, and Hoddinott 2004). However, there is less agreement that community-based nutrition education programs can reduce child undernutrition effectively (Bhutta et al. 2008). The cost-effectiveness of the main service offered (that is, nutrition education) is generally quite high—estimated at US$53–153 per DALY saved (Ho 1985; Waters et al. 2006, in Horton et al. 2010). The ability of a large-scale program to deliver counseling effectively is controversial (Linnemayr and Alderman 2011). Analyzing a program aiming at reducing child undernutrition through improving nutritional knowledge of mothers in Senegal, Linnemayr and Alderman (2011) detected only a weak program impact on children's weight-for-age measure, which was statistically significant only for the youngest children and fell short of the planned outcome.

More generally, even investments in formal education can have high potential to improve nutrition outcomes. Glewwe (1999) differentiated three pathways through which formal education can improve child nutrition: First, education can generally raise awareness and the level of understanding and therewith improve people's ability to diagnose and understand health problems. Second, students can obtain health knowledge in schooling that can be directly applied during child rearing later in life. Third, education can expose people to new technologies and experiences and thus make them more susceptible to modern medicines, treatments, and knowledge-influencing decisionmaking. The importance of parental education—and especially of mothers' education—in reducing child undernutrition has been demonstrated in many studies (for example, Christiaensen and Alderman 2004; Semba et al. 2008; Smith and Haddad 2000).

Supplementation and Disease Treatment

In contrast to the previous strategies that tackle the underlying causes of malnutrition, nutrient supplementation treats the symptoms of undernutrition in a short-term, programmatic manner. Delivery of pharmacological nutrient preparations and treatment of diseases that cause and aggravate nutrient deficiencies are immediate and effective interventions that address acute, adverse nutritional and health conditions. However, they clearly provide no sustainable solutions to the malnutrition problem. Implementing nutrient supplement programs usually requires established delivery channels, such as through the health system, and regular treatment and monitoring of patients, especially for nutrient

supplements that have to be taken weekly, such as iron and zinc supplements, or that are toxic in high quantities, such as vitamin A supplements (WHO and FAO 2004). Logistic issues are also of concern and often constrain implementation of nutrient supplement programs in remote areas (Allen et al. 2006). Although supplementation does not require significant behavioral change in terms of food consumption patterns and feeding practices, patient compliance is inevitable and necessary (Latham 1997).

Nutrient supplement programs are generally highly cost-effective in reducing micronutrient deficiencies. For example, the effectiveness of iron supplements to reduce anemia in pregnant mothers was shown by Sloan, Jordan, and Winikoff (1992), as well as by Beaton and McCabe (1999). Baltussen, Knai, and Sharan (2004) estimated the costs at US$66–115 per DALY saved, and Behrman, Alderman, and Hoddinott (2004) reported a benefit–cost ratio of 6:1 to 14:1 for treatment of pregnant women and 176:1 to 200:1 per capita in populationwide programs. There is also strong evidence that iron supplementation of anemic schoolchildren improves school performance and psychomotor skills (Draper 1997), albeit the returns to investment have not yet been quantified in this respect. In terms of vitamin A deficiency, numerous studies have demonstrated the efficacy of vitamin A supplement programs in preventing and treating eyesight impairments, such as night blindness and xerophthalmia. For example, Djunaedi et al. (1988) and Katz et al. (1995) found that treatment with vitamin A supplements can reduce the prevalence rate of night blindness and xerophthalmia among affected individuals by 60 percent or more. In addition, the cost-effectiveness of vitamin A supplement programs is generally high. The program costs were estimated at US$3–16 per DALY saved (Ching et al. 2000; Fiedler 2000; Horton and Ross 2003 in Horton et al. 2010), and the benefit–cost ratio for treatments of preschool children was from 4:1 to 43:1 (Behrman, Alderman, and Hoddinott 2004). Moreover, a recent meta-analysis by West, Klemm, and Sommer (2010) suggests that vitamin A supplementation can significantly reduce under-five child mortality by an impressive 23–34 percent, confirming previous findings by Beaton, Martorell, and Aronson (1993).

Since nutrient deficiencies are also caused by major infectious diseases (for example, schistosomiasis, malaria)—known as secondary malnutrition (as opposed to dietary nutrient deficiencies, which are referred to as primary malnutrition) (Mayer 1976)—disease treatment and vaccination, as well as improved drinking water, sanitation, and general hygiene, all contribute to linear growth of children and to reduced malnutrition (Scrimshaw et al. 1968; Black et al. 2008,). For example, a meta-analysis by Curtis and Cairncross (2003) suggests that hygiene education interventions and the promotion of hand washing can reduce the risk of diarrhea by 38 to 45 percent in affected populations. Diarrhea, which is mostly caused by intestinal parasites, is a leading cause of morbidity and mortality among children (Prüss et al. 2002; Assis et al. 2005). Accordingly, disease control through improved sanitation and drinking water sources improves the height-for-age z-scores of affected children and reduces child stunting prevalence rates (Esrey 1996). Using the relative risk approach,[3] a meta-analysis by Fewtrell et al. (2005) suggests that water, sanitation, and hygiene interventions reduce the relative risk of diarrheal disease to 0.63–0.75. In addition, Horton et al. (2010) estimated the benefit–cost ratio of deworming campaigns at 6:1 in general. Furthermore, malaria alone was responsible for 1.21 million deaths in 2001 and accounts for nearly 40 million DALYs, primarily in low- and middle-income countries (Lopez et al. 2006). The disease causes low weight and height gain in children (Rowland, Cole, and Whitehead 1977) and leads to low birth weight and mortality among children born by infected mothers (Luxemburger et al. 2001). Both preventative medicines, such as sulfadoxine-pyrimethamine (Kuile, Eijk, and Filler 2007), and insecticide-treated bed nets (Gamble, Ekwaru, and Kuile 2006) have been proven to mitigate child mortality and morbidity, as reflected in the prevalence rate of stunted children.[4]

[3] The relative risk (RR) is the probability that a member of an exposed group will develop a disease relative to the probability that a member of an unexposed group will develop that same disease. RR less than 1 indicates decreased risk of disease among those who have been exposed to the treatment (or intervention).

[4] Ceteris paribus, a lower under-five mortality rate tends to increase the prevalence of stunted children, while a lower morbidity reduces the prevalence rate.

4. THE NUTRITION SITUATION IN TANZANIA AND PAST INTERVENTIONS

In this section, we first analyze the nutrition situation in Tanzania at the national and subnational levels over the past decade. We then examine the spatial distribution of undernutrition across Tanzania's administrative regions and identify common patterns among undernutrition, food insecurity, and agricultural potential. This comparison can provide important first-cut evidence about the potentials of poverty alleviation and agricultural interventions for reducing malnutrition. We explore different dimensions of undernutrition and food insecurity, including the prevalence of child stunting and underweight, undernourishment (measured in per capita calorie consumption), and food poverty; yet our focus is on chronic undernutrition among children as measured by the prevalence rate of child stunting.[5] Finally, we review Tanzania's nutrition strategies and intervention programs implemented between 2000 and 2010. The purpose is to identify cause-and-effect pathways at the subnational levels by linking the implemented nutrition programs to the nutrition outcomes observed over time, which might help explain the variation in the nutrition situation across regions. Moreover, previous studies have documented heterogeneity in malnutrition levels at the regional and subregional levels, duly warranting careful analysis of nutrition at the subnational level in Tanzania (Simler 2006).

Trends of Undernutrition in Tanzania

As Table 4.1 shows, Tanzania achieved a reduction in chronic child undernutrition, as measured by the child stunting prevalence rate, from 48.3 percent in 1999 to 42.0 percent in 2010. This change corresponds to an average reduction by 0.6 percentage point, or 1.3 percent, per annum over 11 years. Tanzania's reduction in child stunting is similar to the average reduction across low- and middle-income countries (LMICs) and the world average. Yet child stunting is still more prevalent in Tanzania than the LMIC group average. Tanzania's current prevalence rate is similar to the Sub-Saharan African (SSA) average but has declined more rapidly over the past decade, implying that the country has been more successful in bringing down chronic child undernutrition in recent years as compared with the subcontinent as a whole. SSA countries that have been more successful in reducing child stunting at rates of 2.5 percent per annum or more within the past decade include Zambia, Uganda, and Ethiopia, whereas less successful SSA countries, with reduction rates of less than 2 percent, include Kenya, Ghana, and Malawi (Table 4.1). Some SSA countries such as Nigeria, the Democratic Republic of Congo, and

[5] Child undernutrition is generally measured by three anthropometric indicators, relative to a healthy, international reference population. The indicators are height-for-age, weight-for-height, and weight-for-age. Children are considered as moderately and severely underweight, stunted, or wasted if their weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ), or weight-for-height z-scores (WHZ) are below certain critical values. Z-scores are calculated as the deviation of an individual's value from the median value of the respective reference population, divided by the standard deviation of the reference population. For defining moderate and severe forms, these critical values are commonly set at –2 and –3 standard deviations of HAZ, WHZ, and WAZ in the respective healthy, international reference population of the same sex and age. Accordingly, the prevalence rate of moderate and severe child stunting/wasting/underweight is determined as the percentage of children who are below the respective cut-off levels. In this paper, we focus on moderate (including severe) child stunting. Stunting is typically more prevalent than wasting and underweight.

The three anthropometric indicators have different implications for child nutrition and cannot be used interchangeably (WHO 1995). Low height-for-age indicates stunting, which is equivalent to gaining insufficient height relative to age; it reflects a process of failing to reach linear growth potential as a result of suboptimal nutritional conditions or health conditions or both. Thus, stunting describes chronic undernutrition, but it does not differentiate between a deficit associated with a past event and one associated with a continuing process (WHO 1995). Low weight-for-height indicates wasting, which is gaining insufficient weight relative to height or losing weight and which is usually a consequence of acute starvation or severe disease or both. Whereas height-for-age provides information about a child's nutrition and health history beginning with birth weight (which is subject to the health and nutritional status of the mother during pregnancy) and including morbidity and consumption deficiency episodes throughout childhood, weight-for-height is a short-term nutrition indicator and is responsive to recent shocks or seasonality effects, which might not have permanent nutrition impacts. Low weight-for-age indicates underweight, which is gaining insufficient weight relative to age or losing weight. Low weight-for-age is influenced by the child's height (height-for-age) as well as his or her weight (weight-for-height) and therefore is a result of stunting or wasting or both. The composite nature of this indicator makes interpretation complex (WHO 1995).

Rwanda have even experienced an increase in the prevalence of child stunting within the past decade. This situation is particularly alarming in countries such as Ghana, Nigeria, and Rwanda, which experienced high per capita GDP growth rates of above 5 percent on average (measured in current international dollars at purchasing power parity [PPP]) during 2000–2009, similar to Ethiopia's and Zambia's growth rates. Yet the SSA countries with the highest reduction rates in child stunting on the subcontinent are still much less successful in bringing down child undernutrition than are some countries in Latin America, such as Nicaragua and Mexico, and in South and Southeast Asia, such as Bangladesh and Vietnam (Table 4.1).

Table 4.1—International comparison of changes in child stunting prevalence within the past decade

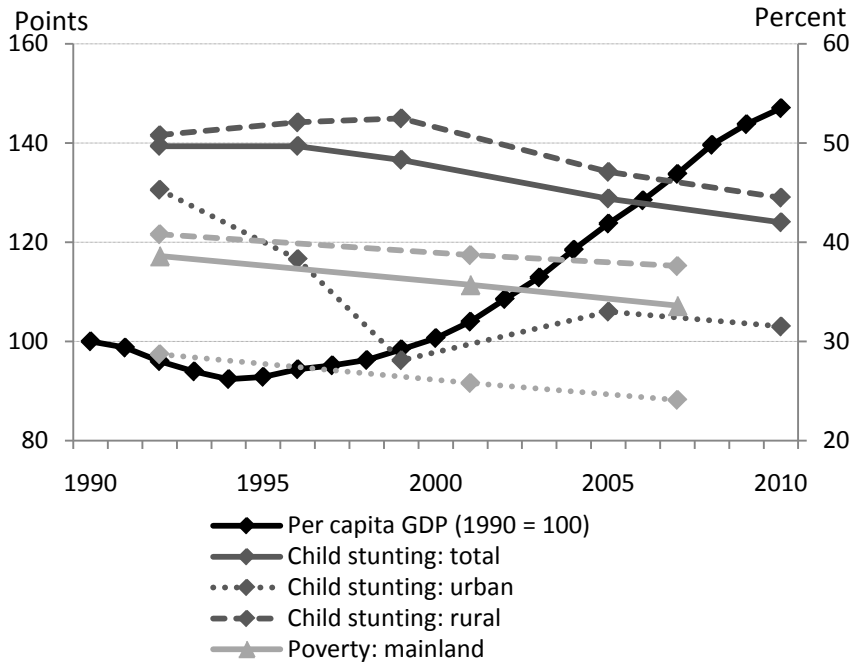
	Beginning of the century		Latest observation		Average annual change	
	Percentage	Year	Percentage	Year	Percentage points	Percentage
Tanzania	*48.3*	*1999*	*42.0*	*2010*	–0.6	–1.3
More successful countries outside SSA						
Nicaragua	25.3	2001	18.8	2005	–1.6	–7.2
Mexico	21.7	1999	15.5	2006	–0.9	–4.7
Bangladesh	57.2	2000	43.2	2007	–2.0	–3.9
Vietnam	43.4	2000	35.8	2006	–1.3	–3.2
More successful SSA countries						
Zambia	57.9	1999	45.8	2007	–1.5	–2.9
Uganda	44.8	2001	38.7	2006	–1.2	–2.9
Ethiopia	57.4	2000	50.7	2005	–1.3	–2.5
Less successful SSA countries						
Kenya	41.0	2000	35.2	2009	–0.6	–1.7
Ghana	31.3	1999	28.1	2006	–0.5	–1.5
Malawi	54.6	2000	52.5	2005	–0.4	–0.8
Nigeria	39.7	1999	41.0	2008	0.1	0.4
DR Congo	44.4	2001	45.8	2007	0.2	0.5
Rwanda	48.3	2000	51.7	2005	0.7	1.4
Regional averages*						
LMICs	37.5	2000	33.3	2009	–0.5	–1.3
SSA	43.6	2000	42.0	2009	–0.2	–0.4
World	36.1	2000	31.7	2009	–0.5	–1.4

Source: Based on WDI database (2011) and NBS and ICF Macro (2011).
Notes: We classify a country as more successful if it achieved an annual reduction in the prevalence of child stunting of more than 2 percent.
* Estimates from WDI database (2011).
SSA = Sub-Saharan Africa; LMIC = low- and middle-income countries.

Tanzania's real GDP per capita grew at an annual rate of almost 4 percent between 2001 and 2010 on average, compared with negative growth in the first half of the previous decade and less than 2 percent growth in the second half. As Figure 4.1 shows, the country's national economic growth was associated with a moderate reduction of poverty and chronic child undernutrition in both urban and rural areas. The decline in the poverty rate measured according to the national poverty line was linear; however, considering a time lag of some months to years, the prevalence of child stunting appears to be more responsive to economic growth, especially as economic growth began to accelerate toward the end of the 1990s. As expected, both poverty and chronic child stunting have been significantly more widespread in rural than urban areas. The rates of reduction in the prevalence of poverty and child stunting in rural and urban areas are similar to the reduction rates at the national level, whereas the drop in

the urban child stunting rate in 1999 and the increase in the subsequent years is difficult to explain (Figure 4.1). Furthermore, a higher rate of child underweight in urban areas than in rural areas, as reported for 2010 (NBS and ICF Macro 2011), is rather atypical and difficult to explain—especially against the background that it reverses the national trend of declining undernutrition rates.[6] Most probable is that several factors are at play that explain these statistics, possibly including a significant decrease in the time spent by mothers breastfeeding and caring for their children in urban areas as the mothers necessarily have to return to work after maternity and a reduced provision of free medical services for women and children in the urban areas as compared with rural areas (Maletnlema 2002; Ruel, Haddad, and Garrett 1999). However, further empirical investigation would be necessary to establish the causes of this atypical result in Tanzania.

Figure 4.1—Trends of economic growth and poverty and child undernutrition reduction in Tanzania



Source: Based on WDI database (2011) and NBS and ICF Macro (2011).

At the regional level, chronic child undernutrition is most prevalent in Dodoma, Iringa, Lindi, and Rukwa, where more than half of all children under five were stunted in 2010, as Table 4.2 shows. Child stunting is least widespread in Dar es Salaam region and Town West in Zanzibar, which are dominated by urban populations, and in Kilimanjaro and Zanzibar South, which had prevalence rates of below 30 percent in 2010, according to NBS and ICF Macro (2011). Except in Rukwa and Arusha, child stunting declined in all rural regions from 1999 to 2010, as well as in most regions during 2005–2010. Mtwara and Iringa were most successful in reducing child stunting, with an annual average decline of 1.8 percentage points or higher between 1999 and 2010.[7]

[6] At present, we do not have access to the raw data of the 2010 Tanzania Demographic and Health Survey (DHS) and therefore are not able to cross-check the estimates reported in NBS and ICF Macro (2011). We emphasize that NBS and ICF Macro (2011) is a preliminary report, and the questionable estimate of child underweight in urban areas might be a typographical error.

[7] Tables A.1, A.2, A.3, A.4, and A.5 in the Appendix show the prevalence of severe and moderate child stunting, underweight, and wasting in Tanzanian children under five in 2010, 2005, 1999, 1996, and 1992, respectively. Table A.6 shows the number of stunted children in 1999, 2005, and 2010 and the changes over time.

Table 4.2—Prevalence of stunting and underweight in children (under five years) by region in percentage and annual average change in percentage points

	Stunting					Underweight				
	2010	2005	1999	Annual change 2005-2010	Annual change 1999-2010	2010	2005	1999	Annual change 2005-2010	Annual change 1999-2010
Total	42.0	44.4	48.3	-0.5	-0.6	15.8	16.7	25.3	-0.2	-0.9
Mainland	42.3	44.8	48.5	-0.5	-0.6	15.7	16.8	25.3	-0.2	-0.9
Residence										
Urban	31.5	33.0	28.1	-0.3	0.3	17.3	12.3	15.5	1.0	0.2
Rural	44.5	47.1	52.5	-0.5	-0.7	14.4	17.8	27.3	-0.7	-1.2
Region										
Arusha	43.9	33.2	*35.5*	2.1		28.2	16.2	*29.9*	2.4	
Dar es Salaam	18.8	22.1	28.7	-0.7	-0.9	11.8	10.9	17.5	0.2	-0.5
Dodoma	56.0	50.1	61.0	1.2	-0.5	26.8	24.4	32.6	0.5	-0.5
Iringa	51.9	62.2	71.9	-2.1	-1.8	18.2	17.9	31.8	0.1	-1.2
Kagera	43.6	43.4	51.8	0.0	-0.7	17.1	18.3	24.3	-0.2	-0.7
Kigoma	48.2	59.7	57.8	-2.3	-0.9	15.4	28.4	31.5	-2.6	-1.5
Kilimanjaro	27.6	28.1	45.2	-0.1	-1.6	11.0	14.4	34.8	-0.7	-2.2
Lindi	53.5	58.6	63.6	-1.0	-0.9	24.3	18.4	31.9	1.2	-0.7
Manyara	45.8	48.1		-0.5		24.2	21.9		0.5	
Mara	31.0	46.6	32.2	-3.1	-0.1	11.9	13.1	12.9	-0.2	-0.1
Mbeya	49.8	44.7	56.5	1.0	-0.6	9.7	9.4	20.4	0.1	-1.0
Morogoro	44.4	43.0	60.5	0.3	-1.5	16.0	13.5	25.5	0.5	-0.9
Mtwara	43.5	58.6	66.5	-3.0	-2.1	18.9	19.6	32.2	-0.1	-1.2
Mwanza	38.7	34.8	43.8	0.8	-0.5	11.4	11.0	23.5	0.1	-1.1
Pwani (Coast)	31.7	42.6	48.2	-2.2	-1.5	11.3	22.0	11.6	-2.1	0.0
Rukwa	50.4	53.4	47.1	-0.6	0.3	13.5	18.5	20.2	-1.0	-0.6
Ruvuma	46.2	59.7	57.9	-2.7	-1.1	15.8	16.7	27.9	-0.2	-1.1
Shinyanga	43.3	44.3	44.1	-0.2	-0.1	10.1	14.0	18.6	-0.8	-0.8
Singida	39.0	44.8	56.4	-1.2	-1.6	18.9	23.8	25.3	-1.0	-0.6
Tabora	33.6	42.0	44.3	-1.7	-1.0	11.6	15.4	16.1	-0.8	-0.4
Tanga	49.4	49.6	61.2	0.0	-1.1	24.1	26.4	45.9	-0.5	-2.0
Zanzibar North	40.6	22.1		3.7		27.1	16.2		2.2	
Zanzibar South	29.1	34.5	33.6	-1.1		17.1	19.5	14.2	-0.5	
Town West	19.6	20.6		-0.2		15.5	11.5		0.8	
Pemba North	39.3	39.6	51.3	-0.1		23.9	17.0	32.3	1.4	
Pemba South	31.3	31.1		0.0		18.6	16.0		0.5	

Sources: Based on GDCGM (2011) and NBS and ICF Macro (2011).

Although the direction and magnitude of changes are similar for child stunting and child underweight for most regions, significant differences between the two indicators do exist for some regions. For example, in 2010, 10 percent of all children in Shinyanga and Mbeya were underweight, but more than 40 percent were stunted, ranking the two regions at the top of low child underweight prevalence and only in the middle third of low stunting prevalence in the case of Shinyanga and even in the last third of low stunting prevalence in the case of Mbeya (see also Table 4.3). Both the differences in the undernutrition levels and the changes over time appearing between child stunting and underweight are partly due to the different implications of the height-for-age and weight-for-age measures. The stunting indicator reflects cumulative effects of chronic undernutrition (and illness) over a long period that starts during pregnancy, whereas the underweight indicator captures the effects of recent events but fails to differentiate between short- and long-run manifestations of undernutrition.

Spatial Pattern of Undernutrition, Food Insecurity, and Agriculture

Child stunting is predominant in rural areas, where almost five times more stunted children live (2.7 million) than in urban areas (0.6 million); this corresponds to 45 percent of the rural population of under-five children (compared with 32 percent in urban areas), as Table 4.3 shows. Because poverty is more widespread in rural areas and health conditions are considerably worse (NBS 2007), agriculture may be positioned as a potential lever for improving nutrition and a convenient entry point or vehicle for a variety of nutrition interventions. Moreover, self-sufficient farming is the main source of food in rural Tanzania, and most of the poor and food insecure engage in agriculture for their livelihoods (NBS 2007). The food poverty rate—measured as the percentage of people living in extreme poverty with an income level insufficient to meet basic food needs—is more than five times higher in rural than urban areas (Table 4.3), stressing that extreme poverty and child undernutrition coexist and that intervention strategies need to include synergies that address both problems simultaneously.

Table 4.3—Spatial patterns of child undernutrition, household food insecurity, and agricultural potential (latest estimates)

	Demographics (2010)				Child undernutrition (2010)				Household food insecurity (2007)				Agricultural potential (2007)			
	Population		Proportion of rural population		Prevalence of child stunting		Prevalence of child underweight		Prevalence of undernourishment*,**		Food poverty rate*		Maize yields*		Rice yields*	
	Millions	*Rank*	Percentage	*Rank*	Percentage	*Rank*	Percentage	*Rank*	Percentage	*Rank*	Percentage	*Rank*	mt/ha	Rank	mt/ha	Rank
Total	43.19		73.7		42.0		15.8									
Mainland	41.91		74.2		42.3		15.7		23		29.8		0.9		2.0	
Residence																
Urban	11.38				31.5		17.3		23		5.7					
Rural	31.81				44.5		14.4		23		31.4					
Region																
Arusha	1.06	20	68.7	20	43.9	11	28.2	21	33	17	30.6	9	1.3	6	3.1	1
Dar es Salaam	1.81	11	4.0	21	18.8	1	11.8	7	21	7	4.5	2				
Dodoma	1.66	13	81.0	7	56.0	21	26.8	20	30	13	39.4	16	0.8	11		
Iringa	1.82	10	78.7	10	51.9	19	18.2	14	10	2	18.2	7	2.3	2		
Kagera	1.50	15	90.3	1	43.6	10	17.1	13	32	15	37.5	13	0.6	14	1.8	3
Kigoma	0.25	23	77.1	13	48.2	15	15.4	10	30	12	34.8	11	1.4	5	1.3	5
Kilimanjaro	3.12	3	75.8	16	27.6	2	11.0	3	12	5	16.2	6	0.8	10	3.0	2
Lindi	1.64	14	75.3	18	53.5	20	24.3	19	31	14	39.1	15				
Manyara	1.37	18	85.6	3	45.8	13	24.2	18	33	17	30.6	9	1.3	6	3.1	1
Mara	3.84	1	76.5	14	31.0	3	11.9	8	47	20	36.0	12	1.1	7	0.9	9
Mbeya	2.66	4	78.3	12	49.8	17	9.7	1	11	4	6.8	4	1.7	4		
Morogoro	1.74	12	69.6	19	44.4	12	16.0	12	10	3	28.9	8	0.5	16	0.9	8
Mtwara	0.92	21	76.1	15	43.5	9	18.9	16	33	16	6.5	3	0.3	17		
Mwanza	1.38	17	78.4	11	38.7	6	11.4	5	33	18	50.8	18	1.0	8	1.1	6
Pwani (Coast)	2.56	5	75.6	17	31.7	4	11.3	4	29	10	34.2	10	0.6	12	0.1	11
Rukwa	3.57	2	80.5	8	50.4	18	13.5	9	36	19	52.2	20	2.3	1		
Ruvuma	1.39	16	82.9	4	46.2	14	15.8	11	29	11	37.8	14	2.2	3	1.0	7
Shinyanga	0.25	24	89.3	2	43.3	8	10.1	2	14	6	39.8	17	0.9	9	1.4	4
Singida	2.12	7	81.3	5	39.0	7	18.9	15	26	9	51.8	19	0.6	15		
Tabora	1.32	19	78.9	9	33.6	5	11.6	6	25	8	4.4	1				
Tanga	2.11	8	81.1	6	49.4	16	24.1	17	10	1	11.0	5	0.6	13	0.6	10

Sources: Compiled from NBS (2011), NBS and ICF Macro (2011), NBS (2007), MOFEA (2010), and Pauw and Thurlow (2010).
Notes: Rank increases with the level of undernutrition, undernourishment, and food poverty and decreases with the agricultural potential. The color scale classifies the regions into three groups of better-off, medium, and worse-off regions. Estimates of undernourishment, food poverty, and yields were not available, so we limited the ranking of regions to those of the Tanzanian mainland.
* Available for Mainland Tanzania only. Arusha and Manyara are combined. ** Urban areas excluding Dar es Salaam City.

Agricultural growth plays an important role in both rural economic growth and poverty and hunger reduction in Tanzania (Pauw and Thurlow 2010). However, this alone might not be enough to significantly reduce chronic child undernutrition (Ecker, Breisinger, and Pauw 2011). Exploiting the regional patterns of undernutrition, food insecurity, and agricultural potential is paramount to develop effective strategies for both leveraging agricultural growth for improved nutrition through agricultural investments and utilizing agriculture's links to nutrition as channels for targeted interventions. Against this background, Table 4.3 ranks Tanzania's regions according to their (1) prevalence of child stunting and underweight, (2) prevalence of undernourishment (which is measured on a per capita calorie consumption basis and is sometimes referred to as hunger rate), (3) food poverty rate, and (4) yields of maize and rice—the main staple crop and one of the main cash crops, respectively. Given that the actual maize and rice yields are far below their agronomic potential, we use actual yields as indicators of profitability for producing these crops from both a self-sufficient and an income-earning perspective. The rankings in Table 4.3 show significant heterogeneity among indicators of child undernutrition, household food insecurity, and agricultural productivity at the regional level, underscoring that eliminating child undernutrition requires careful attention to region-specific nuances and involves more than just broad-based hunger and poverty strategies.[8] Yet there are also important common patterns, from which essential lessons can be drawn to improve nutrition and make agricultural productivity-enhancing investments pro-nutrition. For example, hunger and nutrition are highest in Dodoma, where maize yields are relatively low (0.8 tons per hectare), classifying the region as one of the worse-off regions according to all three indicators. Thus, investments such as USAID's FtF, which is geared at increasing maize yields among the farming poor in Dodoma, have great potential to reduce hunger—a major constraint of improving child nutrition. If designed accordingly to complement nutrition interventions, these investments could also yield synergies that amplify the impact on nutrition.

The importance of nutrition-specific interventions cannot be overstated, as demonstrated in Rukwa, where maize yields are highest—though far from their agronomic potentials—and yet more than half of the children are stunted and cannot afford basic food needs. In addition, in this region, more than one-third of the population is hungry. The fact that few nutrition-specific interventions were found in Rukwa, as shown in Table 4.4, suggests that even though productivity in maize was relatively high, there was limited impact on nutrition. If we also take Mtwara and analyze its nutrition levels and productivity, we find that although nutrition outcomes in that region were relatively better than in the other regions, agricultural potential is relatively lower. Thus, combinations of agricultural- and nutrition-specific investments are essential, and increasing agricultural productivity alone may fail to improve nutrition.

Other regions where increasing maize yields can be expected to contribute to reducing hunger and child undernutrition include Arusha, Manyara, and Ruvuma. On the contrary, in regions with high maize production potential and widespread child undernutrition but a low prevalence of undernourishment and extreme poverty, such as in Iringa and Mbeya, the nutritional impact of investing in maize production may be limited at scale. Similarly, investments in rice production may have greater potential for reducing hunger and undernutrition at large scale in Arusha, Manyara, and Kagera, and less potential in Kilimanjaro. Productivity-enhancing investments in staple food production in regions with a high prevalence of undernutrition but a relatively high level of household food security and low yield potential, such as Tanga and Morogoro, may be less effective in improving nutrition outcomes. In these regions, other agricultural interventions, such as promotion of home gardening for dietary diversification, and nonagricultural interventions, such as nutrition education programs, may have higher nutritional impacts. Although this analysis of common patterns of undernutrition, food insecurity, and agricultural potential

[8] Although the rankings of regions by prevalence of undernourishment and food poverty are relatively similar in most cases, readers might expect an even higher consistency, given that hungry people are typically living in extreme poverty and tend to spend additional income on calorie-rich staple foods. Differences in the percentage of undernourished people and extreme poor people may be largely due to different estimation methods. For example, differences may occur from different consumption patterns and different per-calorie costs of the same staple food across regions that are not accounted for in the food poverty rate, which is based on a universal minimum expenditure level throughout the country estimated for purchasing an average consumption basket.

can provide a good first-cut picture at regional level, more research is certainly needed at the household and community levels to understand how to better leverage agricultural investments for improved nutrition.

Nutrition Strategy and Implementation

Before 2011, no clear national strategy or coordination was in place to improve nutrition in Tanzania. While policy at the national level may have had the implicit goal of improving nutrition, the reality was that no deliberate national policy or strategy had been developed, and most nutrition programs in Tanzania were localized, with implementation differing significantly by region. Likewise, as the analysis in the previous subsection shows, the levels of malnutrition have differed by region, at the present and in the past, as did the baseline levels at the starting points of different interventions. The analysis also reveals significant regional differences in the changes of malnutrition over time; these differences may partly be explained by the existence and effectiveness of past and ongoing nutrition programs in the regions. In this section, we show that there are significant regional differences in terms of the engagement of development partners, nongovernmental organizations (NGOs), and community-participatory programs fighting malnutrition on the ground. Furthermore, we note essential differences in the kinds of programs implemented by each actor; the targeted population; and the design, scale, duration, and timing of the interventions. All are important factors to consider, and they likely affect the final nutritional outcomes in each region.

To assess what was actually done at the regional level in the more recent past, we conducted a comprehensive literature review and searched for nutrition strategies and programs between 2000 and 2010. Government publications were retrieved from various ministries, and reports from development partners and NGOs were obtained. We also pulled together information on nutrition interventions from a variety of websites, including the Tanzania Food Nutrition Center (TFNC), the Ministry of Health and Social Welfare (MOHSW), HKI, the Cooperative for Assistance and Relief Everywhere (CARE) International, World Vision International, Save the Children—United Kingdom, the World Bank, and the websites of various United Nations (UN) organizations. Other websites searched include local public and private organizations and firms such as Tanzania Marketing and Communications (T-MARC) Company Limited, Research on Poverty Alleviation, and Power Foods. Furthermore, we searched websites of international organizations, firms, and academic institutions that we found to have nutrition projects in Tanzania, including Land O'Lakes Inc., General Mills Inc., Procter and Gamble, Cornell University's International Nutrition Program, Cornell Weill Center for Global Health, the Jhpiego of Johns Hopkins University, the Harvard School of Public Health, and Tufts University Nutrition Center.

Beyond that, an important source of information was personal communications, with relevant key informants at the TFNC, Sokoine University of Agriculture, UNICEF, WHO, HKI, World Vision, Catholic Relief Services (CRS), Edesia Global Nutrition Solutions, and USAID. These personal communications were critical in validating the data we obtained from the other sources, as well as in providing additional information. Thus the personal communication with key informants served as a useful triangulation method and corroborated our findings.

We focus on 2000–2010 because interventions implemented over the past decade are likely to be more pertinent in terms of understanding recent trends in nutrition and informing future efforts to improve nutrition in Tanzania. So far, there has been no other systematic review of nutrition interventions after 2000. Nutrition interventions in prior periods were assessed by Dolan and Levinson (2000), Utz (2008), and Leach and Kilama (2009).

Given this study's topic, we are particularly interested in the potential of food-based strategies rooted in agriculture, which have been largely neglected in the literature. The agriculture–nutrition nexus in Tanzania and other countries is hardly understood and is under-researched, and yet most households experiencing severe malnutrition are located in rural areas and directly depend on agriculture for food and income. Also, recent studies suggest that there may be significant potential to improve nutrition among rural populations through agriculture given the potential existence of synergies among agriculture,

poverty reduction, and nutrition and health interventions (see above). Interventions using the links among agriculture, nutrition, and health materialize in the medium and long run rather than in the short run, while a combination of interventions is necessary to combat malnutrition in rural areas effectively, sustainably, and in a broad-based manner (Haddad et al. 2003; Utz 2008). Against this background, we first discuss the institutional coordination and the recent institutional strategy reform in the area of nutrition, before reviewing specific nutrition programs implemented over the past decade.

Institutional Coordination and Strategy Reform

Table 4.4 shows that several government agencies, development partners, and civil society and nongovernmental organizations were extensively engaged in reducing malnutrition in Tanzania, to the extent that this study can only highlight the main strategies and programs while also documenting a few unique actors and interventions.

Table 4.4—Nutrition-related programs and projects by executing/implementing organization in Tanzania since 2000

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Government Ministries and Agencies			
Ministry of Health and Social Welfare (MOHSW): Tanzania Food Nutrition Center (TFNC)	Nutrition and health training; Integrated Management of Childhood Illness (IMCI); vitamin A supplementation, immunization, and deworming of children; infant and young child feeding (IYCF); food distribution for lactating mothers and elderly; distribution of insecticide treated mosquito nets (ITNs); legislating mandatory fortification of staple foods and iodations of salt (and standards); social marketing and behavioral change communication (BCC) for fortified foods	Nationwide	Continuously
Ministry of Agriculture, Food Security, and Cooperative (MAFSC)	Promotion of micronutrient-rich food consumption by extension service and dietary diversification through farm-level production and home gardens (especially fruits, pulses, livestock)	Nationwide	Continuously
Ministry of Education and Vocational Training (MOEVT): Tanzania Institute of Education (TIE)	Training of schoolteachers for health and nutrition curriculum application (in collaboration with HKI); review and update school curricula to incorporate nutrition	Nationwide	Continuously
Ministry of Community Development, Gender, and Children (MOCDGC)	Training of community development workers on nutrition	Nationwide	Continuously
Ministry of Finance and Economic Affairs (MOFEA)	Financial budget planning and allocation of funds to health and agriculture	Nationwide	Continuously
MOFEA: National Bureau of Statistics (NBS)	Conducting surveys and reporting statistics and information on nutrition to inform policy	Nationwide	Continuously
MOFEA: Poverty Eradication and Economic Empowerment Department (PEEED)	Development and implementation of poverty reduction and economic empowerment strategies and programs	Nationwide	Continuously
Prime Minister's Office Regional Administration and Local Government (PMO-RALG)	Policy oversight and implementation of the Public Service Reform Program (PSRP), incl. health and nutrition sector reform	Nationwide	Continuously

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Development Partners			
United States Agency for International Development (USAID)	A2Z Project (micronutrient supplementation); National malaria prevention program, agriculture programs (especially maize, horticulture and dairy products);	Nationwide	Since 2004
United Nations Children's Fund (UNICEF)	Immunization; vitamin A supplementation and deworming of children; maternal and child health promotion; community IMCI; salt iodization; treatment and management of severe acute malnutrition in 10 model hospitals; malaria prevention and control (incl. distribution of ITNs); strengthening institutional arrangements for nutrition; advocacy and BCC on nutrition	Nationwide	Continuously
	Child survival and development (integrating health and nutrition)	11 regions (56 districts; incl. regions below)	Until 2006
	Essential nutrition actions: IYCF; early childhood development	Kilimanjaro (Hai and Siha), Pwani (Bagamoyo), Iringa (Makete), Mtwara (Mtwara Rural), Kagera (Kagera and Ngara), Kigoma (Kigoma and Kasulu), Dar es Salaam (Temeke), Zanzibar	Since 2007
	Fortification of maize flour at hammer mill level	Iringa (Kilolo)	2001–2004
	Partnership and coordination for nutrition (incl. Development Partners Group on Nutrition, multisectoral Technical Working Group on Nutrition, and civil society-led partnerships for nutrition); promotion of standards and guidelines to support delivery of essential nutrition services; support for emergency preparedness and response on nutrition	Nationwide	Continuously
Swedish International Development Agency (SEDA)	Financial support to TFNC	Nationwide	Continuously
Department for International Development (DFID, UK)	Animal Health Program: helminth control in goats	Nationwide	Until 2006
World Bank	Financial support for food fortification (US$2 million, under Tanzania Health Sector Development Project);	Nationwide	Until 2006
	Scaling up Nutrition Initiative	Nationwide	Since 2008

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Development Partners (continued)			
Embassy of Japan	Japan Social Development Fund: Financial support for rural food fortification (US$2.69 million)	Nationwide	Continuously
Japan International Cooperation Agency (JICA)	New Rice for Africa (NERICA) program: Irrigated rice production	Kilimanjaro (Moshi Rural)	2007–2012
World Health Organization (WHO)	Treatment and management of severe acute malnutrition; support for healthy child growth; promotion of IYCF; Baby Friendly Hospital Initiative (BFHI); support to nutrition strategy and policy development; promotion of food safety policies, food-borne diseases surveillance, food hygiene	Nationwide	Continuously
World Food Programme (WFP)	School feeding program (for 640,000 primary school children); purchase for Progress initiative (connecting farmers to markets); Food for Assets activities (building village-level irrigation schemes); supplementary feeding for orphans and vulnerable groups; advocacy for national food fortification and establishment of a national school feeding program	Dodoma, Singida, Arusha, Manyara, Kigoma, Kagera	Since 2007
United Nations Population Fund (UNFPA)	Funding of reproductive and child health programs of MOHSW; training of service providers for Family Life Education in schools	Nationwide	Until 2011
United Nations High Commissioner for Refugees (UNHRC)	Refugee operations (for about 357,000 refugees), incl. food basket rations, feeding, distribution of ITNs, deworming and vaccination of children, micronutrient supplementation for children and pregnant women; assistance in nutrition survey administration	Kigoma, Kagera	2003–2007
	Support for transition from humanitarian assistance to sustainable development	Kigoma, Kagera	Since 2008
UN organizations	ONE UN Joint Program: Food security oversight, technical guidance, and coordination		Since 2008
Irish Aid	Community nutrition support	Morogoro (Kilosa)	Until 2007
	National budget support to health and agriculture	Nationwide	Since 2007
	Support to civil society organizations engaged in pastoralism, land rights, and conflict resolution	Mwanza, Dodoma, Zanzibar	Since 2007
International Fund for Agricultural Development (IFAD) and Swiss Development Cooperation (SDC)	The First Mile Project: Orange and tomato value chain improvement for smallhodler income generation and dietary diversification	Tanga (Muheza), Kilimanjaro (Hai)	2005–2012

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Civil Society and Nongovernmental Organizations			
Helen Keller International (HKI)	Vitamin A supplementation and deworming of children	Nationwide	Since 2001
	Training of community health workers and education and communication of women on maternal anemia control and nutrition	Nationwide	Since 2009
	Training of school teachers and education and communication of government officials and coordinators to apply school health and nutrition curriculum	Dodoma, Singida, Mtwara, Lindi, Pwani, Ruvuma	Until 2013
	Promotion of orange-fleshed sweet potatoes (OFSPs)	Mwanza, Mara	2009–2012
	Promotion for diarrhea treatment with zinc	Nationwide	
	Promotion of large-scale fortification of oil and wheat flour	Mwanza	2011–2014
	Promotion of homestead food production	Mwanza	2011–2013
World Vision Canada/Tanzania	Micronutrient and Health (MICAH) program:		
	Maize flour fortification with iron	Tanga (Korogwe)	2000–2005
	Sukumaland Food Security Project for Rural Households: Nutrition education of mothers; promotion of good IYCF practices; promotion of food processing, preservation, and preparation; promotion of home gardens	Shinyanga (Bariadi)	2000–2004
	No Hungry Children Program: Nutrition education of mothers; promotion of good IYCF practices; promotion of food processing, preservation, and preparation; management of malnutrition and treatment of severe cases	Dodoma	2003–2007
	Matomondo Food Security Project: Vaccination and deworming of children; promotion of IYCF practices; nutrition education of mothers; management of malnutrition; distribution of ITNs	Dodoma (Korogwe)	2004–2009
	Essential Nutrition Package Project (for children under five)	Singida (Singida Rural, Iramba)	Since 2009

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Civil Society and Nongovernmental Organizations (continued)			
World Vision International	The 7-11 Jump-start Initiative: nutrition and health interventions for pregnant women and 0-24 month-old children (supplementation with iron/folate, vitamin A, zinc oral rehydration therapy, malaria prevention and intermittent preventive treatment, deworming, antenatal care and skilled birth attendance; training on appropriate breast-feeding practices, essential newborn care, hand-washing, appropriate complementary feeding of 6-24 month-old infants)	Kagera, Kigoma, Shinyanga, Tabora, Singida, Dodoma, Arusha, Manyara, Kilimanjaro, Tanga, Morogoro	Since 2009
	Expanding Nutrition and Health Achievements through Necessary Commodities and Education (ENHANCE) project: Improvement of child health and nutrition by managing common childhood illnesses through IMCI	Tanga (Korogwe, Handeni, Kilindi and Muheza), Morogoro (Mvomero, and Morogoro), Dar es Salaam (Kinondoni)	2007–2010
	School feeding programs in 106 primary schools	Tanga, Morogoro and Shinyanga	Since 2008
	Support of presidential malaria initiative: Training of reproductive and child health staff to provide and implement infant ITNs	Mainland Tanzania (and Mafia Island)	Since 2009
	Upgrading of ITN voucher system and free ITNs distribution for children under five (funded by Global Fund)	Nationwide	Since 2009
Tanzania Home Economics Association (TAHEA)	Training on nutrition and OFSP preparation and promotion of OFSP production through agricultural extension services	Mwanza	Continuously
Catholic Relief Services (CRS) (in partnership with local Catholic church dioceses and mission hospitals)	Orphans and vulnerable children nutrition programs and feeding schemes; Training of community volunteers and care takers on parenting and social skills, incl. child nutrition; specialized nutritional support to HIV positive children	Arusha, Tanga, Iringa, Ruvuma, Manyara	Since 2004
	Integrated agriculture, health, and nutrition programs: IYCF; training in essential life skills, behavior change for prevention, and ways to live positively with HIV; community-based microfinance; development of agricultural markets for local crops through integrating agro-enterprise development and HIV-related projects; provision of disease-tolerant cassava plants and increasing yields of cassava (Great Lakes Cassava Initiative)	Mwanza, Tanga, Arusha, Manyara, Dodoma	Since 2004
	Therapeutic feeding and nutritional counseling, short-term food supplementation	Dodoma, Arusha, Tanga, Iringa, Ruvuma, Manyara	2009-2010

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Civil Society and Nongovernmental Organizations (continued)			
Cooperative for Assistance and Relief Everywhere (CARE) International	Refugee humanitarian support; maternal health and neonatal care; microfinance for women and girl education	Kagera, Kigoma	Continuously
Heifer International (in partnership with the Evangelical Lutheran Church of Tanzania)	Promotion of livestock production and BCC on consumption of animal products	Mara (Tarime), Pwani	Continuously
Center for Counseling, Nutrition, and Health Care (COUNSENUTH)	Nutrition counseling	Nationwide	Continuously
Association de parriange d'enfant du monde (Partage) Tanzania	Victoria Program: Orphan feeding in 22 villages	Kagera	Continuously
Touch Foundation and Bugando University College of Health Sciences	Training community health workers and medical practitioners	Mwanza, Mara, Kagera, Shinyanga, Kigoma, Tabora	Since 2002
White Ribbon Alliance for Safe Motherhood in Tanzania	Maternal antenatal and neonatal care campaign	Nationwide	Continuously
Tanzania Marketing and Communications (T-MARC) Company Ltd.	BCC and social marketing for use of low osmolarity oral rehydration salts and pediatric zinc for diarrhea treatment; promotion of national malaria control program	Nationwide	Since 2009
Plan Vivo—Vi Agroforestry under the Lake Victoria Regional Environmental and Sustainable Agricultural Productivity Programme	Planting of mangoes, lemons, avocado, and jackfruit to improve dietary diversity	Kagera	Since 2010
Save the Children UK	Healthcare for children under five (for about 45,000 children)	Lindi (Ruangwa, Kilwa)	2001–2010
	Cash transfer program for improved nutrition (60 households)	Lindi (Lindi)	Since 2007
	Malaria and pneumonia diagnosis training for clinical officers in 55 rural dispensaries; maternal health care support	Lindi (Ruangwa, Kilwa)	Since 2007
African Medical and Research Foundation (AMREF)	Provision of water and sanitation facilities; education and promotion of good hygiene, water, and sanitation practices	Mara (Serengeti), Pwani Mkuranga)	Continuously
	Training of community health workers for malaria prevention	Mtwara	Continuously

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Academic Research and Training Institutions			
Sokoine University of Agriculture (SUA)	Development of dietary guidelines	Morogoro, Iringa	2001–2004
	Development of nutrition interventions for improved health and productivity	Morogoro, Iringa	2006–2009
	Integration of food security, adequate care, and environmental quality: Development of econutrition guidelines for community action in the context of climate change	Morogoro	2010–2014
	Research: Enhancing child nutrition and livelihood of rural households through postharvest value chain technology improvement in groundnuts	Nationwide	2009–2012
	Research: High nutritive diet for children infected or affected by HIV using OFSPs	Morogoro	2004–2006
	Research: Dietary strategies to improve feeding practices, dietary adequacy, and growth of infants and young children in rural areas	Dodoma (Mpwapwa)	2009–2012
	Research: Ready-to-feed extruded cereal-bean-soybean composite supplementary food for rehabilitation of undernourished children and nutrition support for HIV-infected children	Morogoro, Dodoma	Since 2006
	Research: High micronutrient density soybean-based supplementary food for pregnant women	Morogoro, Kilimanjaro	Since 2011
Muhimbili University of Health and Allied Sciences	Education, training, and research on nutrition and health	Nationwide	Continuously
Cornell University—Cornell Program in International Nutrition	Cornell Program in International Nutrition: Education, training, and research on nutrition and health	Nationwide	Continuously
Research on Poverty Alleviation (REPOA)	Food and nutrition policy research	Nationwide	Continuously
Uwazi	Food and nutrition policy research	Nationwide	Continuously
Sikika	Food and nutrition policy research	Nationwide	Continuously
Policy Forum	Food and nutrition policy information dissemination, advocacy, and networking	Nationwide	Continuously

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Academic Research and Training Institutions (continued)			
Ifakara Health Research and Development Center (in collaboration with Save the Children)	Food and nutrition policy research	Lindi (Ruangwa, Kilwa), Pwani (Bagamoyo, Rufiji), Morogoro (Kilombero), Mtwara (Mtwara), Dar es Salaam	Continuously
Harvard School of Public Health	Education, training, and research on nutrition and health	Nationwide	Continuously
Johns Hopkins University	Research: Focused antenatal care as a platform for reducing maternal and neonatal deaths and improving the health of mothers and newborns	Nationwide	Continuously
	Research: Malaria prevention and control (funded by US Centers for Disease Control and Prevention [CDC]); Mothers and Infants, Safe, Healthy, Alive Program (funded by USAID);Communication and Malaria Initiative (funded by USAID); BCC (Tanzania Capacity and Communication Project)	Nationwide	Since 2005
World Vegetable Center (AVRDC)	Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa Project (funded by Federal Ministry for Economic Cooperation and Development [BMZ])	Arusha	Until 2009

Table 4.4—Continued

Executing/Implementing Organization	Programs/Projects	Program/Project Site: Region (District)	Program/ Project Period
Private-Sector Firms and Organizations			
Millers (as part of National Food Fortification Alliance [NFFA])	Flour and vegetable oil fortification (iron, zinc, vitamin A)	Nationwide	Since 2011
Tanzania Salt Producers Association (TASPA)	Salt iodization	Nationwide	Continuously
Power Foods Industries Ltd.	Production of ready-to-use, nutrient-rich food products for malnourished children	Nationwide (mainly Dar es Salaam)	Continuously
Land O'Lakes Inc. (in collaboration with World Wide Wires and funded by USAID)	Tanzania Dairy Enterprise Initiative: dairy marketing/ promotion to improve nutrition; dairy policy reform and advocacy; production and handling of dairy		2003-2006
	Tanzania Dairy Development Program for milk production (US$8 million; 17,000 farmers): Training and technical assistance; supply of dairy inputs; development of market linkages to improve the dairy cold chain; consumer awareness campaign on dairy and nutrition	Tanga, Kilimanjaro, Arusha, Mara	2011–2013
General Mills (in collaboration with US African Development Foundation [ADF])	Nyirefami Grain Processing project	Arusha	Since 2008
	Fortification of maize flour in mills; blending of maize flour with milled cassava, sorghum, and millet	Dar es Salaam, Morogoro	2012–2015
Procter and Gamble (in collaboration with Water and Sanitation Rotarian Group, H20 for life and Africare)	Water and sanitation program in schools; provision of PUR water purifier packets	Nationwide (mainly rural)	Continuously

Source: Various (partly unpublished) documents, websites of listed organizations, and personal communications.
Notes: This list, though comprehensive, only focuses on the major programs with greater scale of coverage and greater visibility in terms of publication via various media. Also, development partners' roles in terms of direct budget support and sector basket fund support to Tanzania is not reflected here.

The involvement of multiple organizations brought together significant resources and expertise to address the complex challenge of malnutrition. However, prior to 2005, limited coordination or sharing of responsibilities and information occurred among the actors, which curtailed the level of nutritional impact. Only recently have coordination, sharing of information, and responsibilities improved as part of an institutional strategy reform that has streamlined the way development partners and civil-society organizations collaborate with the Tanzanian government in the field of nutrition.

One major change was the development and implementation of a new policy and legal framework, the Joint Assistance Strategy for Tanzania (JAST), which delineates how the Tanzanian government engages with development partners and provides mechanisms for development partners to allocate funding and implement development activities in the country. The JAST was approved by the Cabinet in 2006 and has since led to a shift by development partners from providing individual project financial support to providing national budget support[9] through general budget support and *basket funds*.[10] For example, Irish Aid ended its long-standing area-based support in Kilosa district in Morogoro region in 2007 and increased its contribution to the national agriculture basket through the Agricultural Sector Development Program, which is part of the JAST. Similarly, the Department for International Development (DFID) of the United Kingdom significantly increased its direct budget support to Tanzania's health basket starting in 2003 and allocated nearly 80 percent of its funding through general budget support by 2009 (Thornton et al. 2010). However, DFID's funding allocation to agriculture declined as DFID chose to focus on education interventions and general budget support. Taken together, the reallocation of both development partners can be perceived as coordinated sharing of responsibilities, with Irish Aid focusing on health and agriculture support and DFID focusing more on education and general budget support. Other development partners also increased their funding of the agriculture and health baskets, including the Danish Agency for International Development, the Norwegian Agency for Development Cooperation, the Swiss Agency for Development and Cooperation, the Embassy of the Netherlands, Canadian International Development Agency, the Japanese International Cooperation Agency, the European Union, KfW Bankengruppe, UN organizations, and the World Bank.

The shifts in the structure of development partners' financial support has had implications for nutrition in that the government's decisions on budget allocation now play a greater role compared with the past, when most nutrition interventions were directly funded by the development partners. Therefore, the manner in which the government allocates funds across regions and councils has greater influence on the delivery of health services and nutrition programs in each region and sub-region. Unfortunately, precise information on the actual amounts spent on nutrition under local governments' Comprehensive Council Health Plans was not available, which has limited our ability to link changes in nutrition outcomes at the regional level to the institutional strategy reform. Remedially, it stresses the need for traceability and detailed auditing of government spending on nutrition.

Some of the recent reforms in coordination are a result of government-led efforts by the MOHSW and the TFNC, which led to the creation of a multisectoral Technical Working Group (TWG) on nutrition in 2008. Through the TWG, nutritionists were recently deployed at the regional secretariat levels of government, and a push to hire nutrition staff has been made. Several ministerial departments increased their engagement in nutrition policy dialogue and formulation, including the Ministry of Agriculture, Food Security, and Cooperative (MAFSC); the Ministry of Education and Vocational Training (MOEVT); the Ministry of Community Development, Gender, and Children (MOCDGC); and the

[9] In recent years, development partner financial support to Tanzania has been managed under the new framework of the JAST which legally requires funds to be allocated through three major channels: (1) general budget support, which has increased from 274.6 billion Tanzanian Shillings (TZS) in 2002/03 to TZS 934.9 billion in 2008/09; (2) basket funds, which have also increased; and (3) project funds, which have seen a reduction in funding.

[10] In the area of nutrition, most funding is under the *health basket*, while most agriculture-related programs are supported through the national *agriculture basket*. There may be a need for improved clarity and coordination between the allocation of finances from the health and agriculture baskets to nutrition and, hence, linking Tanzania Agriculture and Food Security Investment Plan (TAFSIP) and the Primary Health Services Development Program (MAMM) under the National Strategy for Growth and Reduction of Poverty (MKUKUTA) umbrella.

MOHSW. In addition, the Ministry of Finance was involved in financial planning and budgetary allocation for nutrition programs. The TWG offers a good opportunity to strengthen the links between the different ministries dealing with nutrition-related issues, as, at present, numerous opportunities for closer collaboration appear to be underutilized. A separate aspect of the institutional strategy reform within government was the increasing role of regional administration and local government authorities under the prime minister's office. For example, in the health sector, the MOHSW no longer provided direct services at the district and municipal levels, as this role was transferred to local government authorities. Thus, the capacity and ability of local governments to deliver health services and implement nutrition programs may have also contributed to the nutrition outcomes at the regional level in 2010. Areas with more institutional capacity, financial resources, and nutritional expertise are likely to have achieved more progressed in combating malnutrition. Further evaluation of the role of local governmental and civil society organizations on nutrition outcomes is certainly needed.

To increase the efficacy of nutrition interventions in the future, the collaboration between governmental organizations and development partners needs to go beyond the recent improvements in coordination and involve more information and responsibility sharing, particularly during financial planning and evaluation phases. As outlined in its strategic plan, the TFNC has become more proactive in this regard, bringing together and coordinating a variety of organizations, as well as outside the government. In 2009/10, for example, the TFNC led the consultative process of developing the National Nutrition Strategy (NNS). Development of the NNS was a joint initiative of the government, multiple development partners, and civil society entities under the auspices of the Development Partner Group on Nutrition,[11] in which UNICEF played a vital role. The NNS was approved in 2011 as the leading national nutrition policy document. Moreover, TFNC has played a pivotal role in the implementation of nutrition programs at the community level, in partnership with a wide variety of development civil society organizations, such as the USAID A2Z project and the HKI Integrated Nutrition Program.

Recently, the engagement of national ministries in community-based nutrition interventions has expanded beyond MOHSW, though the other ministries still engage to a lesser extent in terms of resources provided. For instance, MAFSC launched community nutrition education programs in conjunction with agricultural extension programs, coordinated by the ministry's Nutrition Unit. Some of these initiatives were implemented in partnership with the Tanzania Home Economics Association (TAHEA), which provided training on nutrition and food preparation of nutrient rich-foods (for example, OFSPs in Mwanza). In addition, the Food Security Unit of MAFSC began combining its continuing community-based programs on enhancing agricultural production and marketing with dietary diversification components. Through homestead vegetable and fruit production initiatives, the Food Security Unit also promoted dietary diversification at the household level. MOEVT, through the Tanzania Institute of Education and in collaboration with HKI and UNICEF, redesigned the school curricula to include nutrition education components and trained schoolteachers on health and nutrition. MOEVT has also offered school feeding programs that purchase food from local farmers, creating a demand for nutritious food. However, more certainly needs to be done to leverage agriculture for improved nutrition at a larger scale and to achieve higher (if not full) coverage of nutrition programs at the regional and national levels.

Small-Scale Agriculture for Improved Access to Nutritious Food

In general, very few agricultural programs in Tanzania have been purposely tied to nutrition improvement, and little has been done to deliberately promote healthy nutrition and diversified diets at the household and community level. Yet dietary diversification through homestead food production is

[11] In 2003, a generic Development Partner Group (DPG) was set up to improve coordination between the development partners and the Tanzanian government. This DPG started out in 1998 as an informal domestic version of the Development Assistance Committee. After 2003, sectorwide development partner groups under the DPG were instituted in line with the sectorwide approach that was adopted by the government of Tanzania. It is only recently that the Nutrition DPG has been instituted, in recognition of the need to improve coordination on nutrition program implementation.

arguably one of the most promising areas for improving nutrition sustainably. Although there have been few, a variety of notable small-scale agriculture interventions have been implemented, such as fruit orchard planting projects (for example, orange and mango farming in the Muheza district of Tanga region), wild fruit forestry projects in Arusha region, vegetable gardening in several regions across Tanzania, and livestock production strategies in the northwestern regions.

One example of a relatively large-scale project is Heifer International's livestock programs, which have been implemented in all 21 regions of mainland Tanzania but with a main concentration of activities in the northwestern regions near the Kenyan border. These programs have arguably improved the livelihoods of farming households and contributed to improved dietary quality in the intervention communities through their direct access to animal food products. Under Heifer International's projects, households in Tarime district in Mara region, for example, received dairy cattle in 2007; this program was targeted to increase milk consumption locally. The Read to Feed program in Bagamoyo district in Pwani region provided chicken and dairy goats to beneficiary households, while more recently the NGO started to include nontraditional livestock donations in their portfolio. In 2010, households in Longido district of Arusha region received camels after drought decimated the cattle population. Although the projects are designed to improve household-level food security through income generation and the ability of communities to cope with drought shocks, a more rigorous analysis is required for assessing their impacts.

Other livestock programs designed to increase dietary diversity were carried out by DFID since the 1990s but ended in 2006/07, as a consequence of DFID's development assistance modification (see above). The Animal Health Program in Morogoro, Iringa, and Tanga regions had a major research component and was tied to agricultural extension and outreach activities for animal production and consumption. The program mostly focused on small-scale dairy and cattle production and addressed a variety of zoonotic diseases, including tick-borne diseases, mastitis, and Newcastle disease in poultry. Other related DFID projects aimed at supporting smallholder maize and sesame production in Lindi and Mtwara regions, and these ran from the early 2000s to 2007 (DFID 2006; Thornton et al. 2010). Although not designed to purposively improve dietary diversity, initiatives administered by the Ministry of Livestock Development's Veterinary Investigation Centers to fight Newcastle and Bursal diseases in poultry in Morogoro, Tabora, Iringa, Mtwara-Mikindani, and Mvomero regions were considered important in preventing loss of access to protein and micronutrient foods. Yet most animal production initiatives were not coordinated or explicitly combined with other nutrition interventions, such as nutrition education campaigns.

Similarly, MAFSC's promotion of orange, tangerine, and pineapple production in Muheza district of Tanga region (in 2000–2010) was not intended to improve nutrition through home consumption but to generate farm incomes; most fruits were produced for domestic sale and export. Thus, there is large scope for explicitly incorporating nutrition goals in these agricultural interventions. A notable example is the Plan Vivo (*Emiti Nibwo Bulora*)—a program implemented in 2010 that promotes small-scale production of mangoes, lemons, avocadoes, and jackfruit in Kagera district. This multipurpose program is designed to contribute to cash-income generation among small-scale farmers and increased dietary diversity in the intervention area, while also improving the ecosystem through afforestation and agroforestry. Given the high potential of fruit production in a number of regions (Morogoro, Tanga, Iringa, Mbeya, Pwani, Dodoma, and Zanzibar) and the surprisingly low levels of fruit production and consumption, promoting fruit production and consumption may deserve greater attention as one component of a comprehensive nutrition strategy. The main obstacles of this strategy at present are the lack of capacity in fruit processing and rudimentary fruit value chains that have seen large volumes of postharvest losses. Hence, investments in fruit production, processing, and marketing, combined with nutrition education campaigns, may make a significant contribution to reducing micronutrient malnutrition at a large scale.

Biofortification: An Underdeveloped Opportunity

Biofortification is not widespread in Tanzania and is limited to OFSPs, the dissemination of which has largely been concentrated in Mwanza region. The International Potato Center (CIP) of the Consultative Group of International Agricultural Research (CGIAR) consortium introduced more than 20 high-dry-matter-content OFSP varieties in Zanzibar and the Eastern and Lake Zones in 2001 and tested adaptability and acceptability of the different varieties. In conjunction with TAHEA and CARE, CIP has organized multiplication systems for OFSP, and efforts are still ongoing to multiply seed production through on-farm seed growers. Biofortification is new and generally underdeveloped in Tanzania. The vitamin A status could be improved through OFSP in Mwanza region, where USAID and HKI have worked with smallholder farmers to increase production and consumption. Other areas in the country, including Kibaha district in Pwani region and Hombolo district in Dodoma region, have begun adopting OFSP production recently.

Scope for Expanding Mass Fortification of Staple Foods

So far, very few food products in Tanzania are fortified, and fortification of staple foods has only been undertaken at a very limited scale. Only in 1998 did food fortification efforts begin through the USAID-funded Opportunities for Micronutrient Interventions (OMNI) project. The OMNI baseline assessment revealed that there was virtually no fortified domestic food in the market prior to 1998, except for iodized salt. Salt iodization has been a success story in Tanzania, as in many other countries, though challenges in maintaining the iodine concentration in the salt and achieving full coverage remain.[12] The OMNI baseline assessment identified maize flour, wheat flour, vegetable oil, and sugar as food products and condiments suitable for fortification (for the benefits and costs of fortifying these products, see Section 3). Following the assessment, a few development partners began investing in food fortification programs. For example, in 2000, UNICEF initiated a project to fortify maize flour processed by small-scale millers in Kilolo district of Iringa region, and in 2002, World Vision Canada started a food fortification project in Korogwe district in Tanga region as part of its Micronutrient and Community Health program. These interventions were coupled with a number of studies to evaluate the availability, physical state, and management of locally operated small-scale mills. Although a nutritional impact on individuals has been expected, the interventions have been too small to reflect measurable improvements of the nutrition situation at the regional level. Currently, efforts are underway to scale up these fortification programs.

Major first steps in scaling up food fortification were the development of a National Action Plan for Enriching Staple Foods (NFFA 2009) and the establishment of the National Food Fortification Alliance (NFFA) in 2009. The goal of the NFFA is to build a private–public partnership to advance legislative efforts for mandatory fortification of processed staple foods—namely, maize and wheat flour (fortified with iron and zinc) and vegetable oils (fortified with vitamins A and D). The NFFA committed itself to assist in improving quality assurance of fortified foods by instituting quality assurance standards in conjunction with the Tanzania Food and Drug Authority. Currently, there are no clear standards for fortified products, and the monitoring and inspection of private-sector food processors to certify standards are lacking. The NFFA is also expected to implement capacity-building initiatives in the private sector to

[12] Thanks to salt iodization, iodine deficiency disorders significantly declined between 1999 and 2010 (NBS and ICF Macro 2011). Salt iodization was implemented in 1985 and has been coordinated by the National Council for Control of Iodine Deficiency Disorders (NCCIDD). At the time, Tanzania was implementing an iodine supplementation program to treat deficient persons from 27 of the most adversely affected districts with iodized oil capsules. The iodine supplementation program was gradually phased out with time, as iodized salt was universally available in 1996. NCCIDD—a public–private partnership—merged into the newly founded Tanzania Salt Producers Association (TASPA) as leading institution in 1994. Since then, TASPA has played a pivotal role of coordinating more than 6,500 salt producers (especially small-scale salt producers) that are dispersed throughout the country in efforts to attain universal salt iodization. Despite this success story, significant challenges still remain and need to be addressed. For instance, although the government of Tanzania has mandated universal iodization of salt since 1997, national coverage is estimated at 84 percent, and only 43 percent of salt contains an iodine concentration within the acceptable range (Assey et al. 2009; Assey et al. 2007). Moving forward, the main challenges will be to improve quality assurance among the small-scale salt producers, who predominantly supply salt consumed in rural areas.

train food processors on fortification methods, particularly for small-scale food processors, which are dominant in rural areas. In addition, community-based point-of-use and home-based fortification interventions are planned, including the distribution of nutrient powders to community-level millers and the marketing of nutrient *sprinkles*. Since high-dosed nutrient preparations can be added directly to food, the promotion of home-based fortification may be a promising strategy for reducing deficiencies of nutrients that are not harmful in overdosing.

Changing Behavior through Nutrition Education and Child Feeding Counseling

A few standalone nutrition education programs were implemented between 2000 and 2010. One such program is the Global Service Corps Tanzania HIV/AIDS and Nutrition Education program, which trained women's groups and people affected by HIV/AIDS in Arusha region. The community-based projects addressed life skills, stigma, and human rights issues surrounding HIV/AIDS and the importance of healthy living through good nutrition. Moreover, participants received training on food preparation and food preservation using techniques such as solar food drying and grain storage. Although the projects only reached small numbers of people, anecdotal evidence shows that the programs helped improve nutrition in the intervention community. Most nutrition education initiatives were tied to other programs that appeared to be most effective in delivering the services. However, no impact evaluation was carried out to measure the actual effect of these projects.

Despite being proven effective, behavior change communication and food and nutrition sensitization campaigns were sparse between 2000 and 2010. A notable exception is a social marketing program implemented by T-MARC—a local private company contracted by USAID. The project began in 2004 and has used a variety of media channels to sensitize the Tanzanian populace about the importance of nutrition. Yet, the project's outreach is likely to differ across regions and be especially weak in remote areas. Moreover, its nutritional impact is difficult to assess.

Promotion of immediate breastfeeding after birth and exclusive breastfeeding during the first half-year of life in health facilities has been an activity taken up primarily by MOHSW at the local government level. The extent of delivery of neonatal care services has been subject to the allocation of financial resources to district clinics and local health centers and to the quality of staff. Furthermore, a fundamental challenge is the limited use of the (public) healthcare system by mothers after giving birth, which is reflected by the low percentage of mothers seeking neonatal care (NBS and ICF Macro 2011). In addition to improving and expanding the quality of health services offered in the public health facilities, the delivery of healthcare services by community health workers and nutrition and health education specialists in the villages needs to be upgraded. Women's time available to seek healthcare (in far-distant health facilities) is often very limited, mainly due to their responsibility for childcare and engagement in agricultural production activities. Therefore, an opportunity to promote superior nutrition and health in rural areas may be to combine nutrition education and child feeding counseling with agricultural extension—a traditional activity conducted by MAFSC.

Supplementation and Disease Treatment—Examples for Successful Partnerships

Supplementation schemes with iron, zinc, vitamin A, and folic acid were in place in all regions of Tanzania throughout the past decade, primarily carried out by MOHSW and civil society (see Table 4.4). Trials of multi-micronutrient supplement programs were also conducted, and plans were put in place for scaling them up. However, the distribution and coverage were fragmented, with most remote areas receiving inconsistent coverage. Most remarkably, the coverage of vitamin A supplementation among children increased from 14 percent in 1999 to 85 percent in 2005 and reached 93 percent by 2010 (NBS and ICF Macro 2011). This increase only accounts for the delivery of a single capsule of vitamin A supplements per year; the coverage of the often-required second is only 43 percent. Nevertheless, this is one area where the Tanzanian government, in partnership with HKI, USAID, and other partners, can be attributed for improving vitamin A nutrition in the country.

Other integrated medical interventions, such as the distribution of treated mosquito nets, intermittent presumptive malaria treatments, and deworming and immunization of children, also showed a high coverage and notable progress. For example, the coverage of the integrated management of child illnesses programs increased from 19 percent of all districts in 2000 to 73 percent in 2010, and the number of pregnant women receiving iron supplements increased from 44–61 percent over the past decade (NBS and ORC Macro 2005; NBS and ICF Macro 2011). Similarly, oral rehydration therapy for diarrhea treatment in children increased from 57 percent to 70 percent of all children affected, and exclusive breastfeeding of infants less than 6 months increased from 32 percent to 41 percent, thanks to the joint effort of governmental organizations, local civil society organizations, and international development partners. This progress suggests that broad-based health interventions were improving, yet nutrition outcomes barely improved, stressing the need to couple integrated medical interventions with other strategies, such as food-based strategies, as well as with education and behavioral change interventions (Masanja et al. 2008). These examples of successful collaborations of different entities in the health sector also highlight that joining forces in tackling public health problems—including malnutrition—is inevitable to achieve changes and be effective.

5. PREDICTING NUTRITION OUTCOMES OF AGRICULTURE-LED GROWTH

The analysis in this section estimates the potential effects of agriculture-led growth (through productivity-enhancing investment) on chronic child undernutrition for 2011–2015. Expected growth in agriculture is from an economywide modeling analysis in which agriculture growth is assumed to be an outcome of productivity change resulting from agricultural investment. The prevalence of stunting in children less than five years of age is chosen as an indicator to measure the nutrition situation. There are five reasons to support this choice: First, young children's nutritional status tends to be most responsive to changes in living conditions and to be vulnerable to food insecurity and diseases, due to their high physiological nutrient requirements for growth, their special dietary needs, their often more-direct exposure to adverse health conditions, and their dependency on adults. Second, and closely related to the first, undernutrition and micronutrient malnutrition are usually most prevalent among young children. Third, anthropometric measures capture the nutrition outcomes of inadequate food intake in terms of macro- and micronutrients, adverse health conditions, and the interaction of both. Fourth, from the three common child anthropometric measures (that is, height-for-age, weight-for-age, weight-for-height), we choose height-for-age (identifying stunting), because it best reflects the cumulative effects of chronic undernutrition and is therefore a good overall nutrition indicator. Fifth, by focusing on young children, who are often the weakest individuals in the household, we capture aspects of unequal intrahousehold distribution of resources that are ignored when looking at household-level indicators.

Methodology

We adopt a two-step approach to estimate the nutrition outcome of agriculture-led growth. In the first step, we assess the magnitude of economywide growth led by accelerated agricultural growth as the outcome of increased investment in the agricultural sector. This exercise is done by applying a dynamic computable general equilibrium (DCGE) model in which investment is assumed to lead to total factor productivity growth at agricultural subsector levels. The economywide growth is measured as growth in per capita GDP both at the national and regional levels. In the second step, we link per capita GDP to the prevalence of child stunting. Using cross-country data for LMICs and SSA countries, we econometrically estimate the general relationship between child stunting prevalence and per capita GDP. We then apply the estimated coefficients on cross-region data for Tanzania to predict the prevalence rates of child stunting and the number of stunted children by region and year for 2011–2015.

The methodology applied in this study focuses on the direct and indirect nutritional effect of economic growth. However, it cannot account for the nutritional effects of changing dietary patterns, improved nutritional knowledge, or superior health conditions that might be caused by agricultural interventions. Thus, this methodology is inappropriate for simulating the nutrition outcomes of biofortification, interventions that aim at dietary diversification by promoting home gardening and livestock husbandry and nutrition education programs. Hence, our estimates may underestimate the potential nutritional impact of agricultural investment, particularly in the immediate future.

The DCGE model applied to derive the GDP growth between 2011 and 2015 was developed by Pauw and Thurlow (2010) for Tanzania. The model disaggregates the economy into 20 administrative regions of mainland Tanzania.[13] A scenario reflecting the TAFSIP was designed, in addition to a baseline scenario reflecting the business-as-usual situation. The growth results of the DCGE model for both scenarios are used in this study.[14] Thus, unlike most previous studies (for example, Alderman, Hoogeveen, and Rossi 2006; Christiaensen and Alderman 2004; Haddad et al. 2003), growth is not based

[13] Today's Arusha region and Manyara region, which were one administrative region (Arusha) until 2001, are aggregated.

[14] Due to a lack of data, Pauw and Thurlow (2010) were not able to disaggregate nonagricultural sectors by region. Therefore, we use agricultural GDP growth by region and nonagricultural GDP growth at the national level to calculate total GDP growth by region. We thus assume that growth in nonagricultural sectors is constant across regions.

on any arbitrary assumption. Instead, the growth rates applied in this study are consistent with the current growth patterns and the implementation of TAFSIP.

To estimate the response of children's nutritional status to changing income, most previous studies (for example, Alderman, Hoogeveen, and Rossi 2006; Christiaensen and Alderman 2006; Ecker, Breisinger, and Pauw 2011; Garrett and Ruel 1999; Haddad et al. 2003) used a reduced-form demand model with children's z-score as the dependent variable and household income (or total expenditure) and various individual, household, and community characteristics as independent variables. Reduced-form demand models are based on a utility maximization over goods and health subject to a health production function and budget constraints (Glewwe 1999). The model is typically estimated by parametric, ordinary least squares (OLS) or instrumental variable (IV) regression. An advantage of this approach is that the nutritional effects of different factors, such as household income and education, can be isolated, but the cumulative nutritional effect of income growth is not captured. Because we are particularly interested in the overall effect of growth on nutrition over time, we apply a different approach in this study.

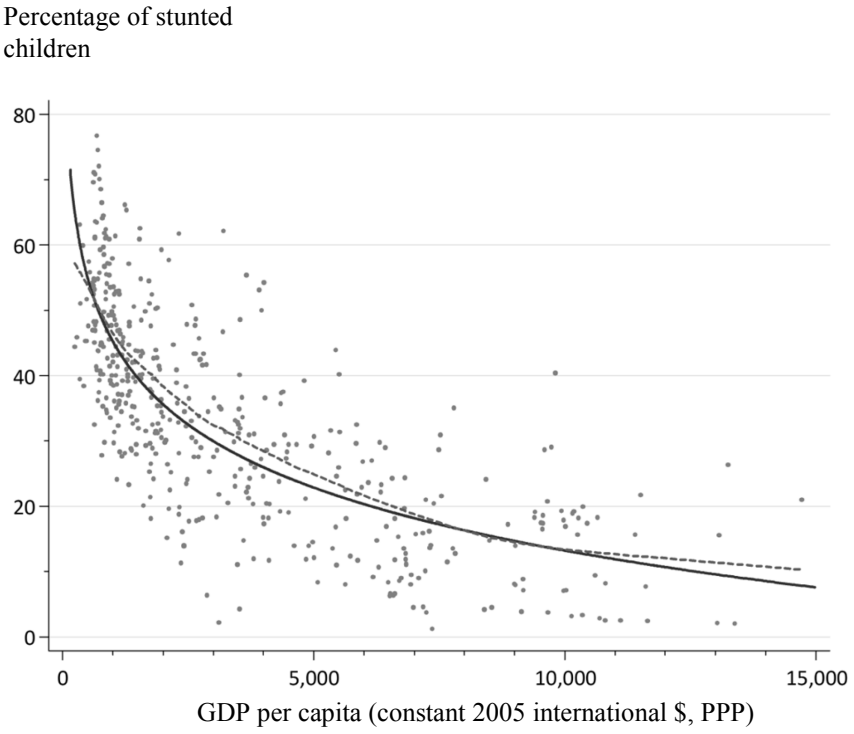
Similar to Haddad et al. (2003) and Headey (2011), we assume causality between child undernutrition and income and estimate the relationship between the prevalence of child stunting and per capita GDP level based on country-level, time-series data from the World Bank's World Development Indicators (WDI) database (2011). However, unlike Haddad et al. (2003) and Headey (2011), we do not assume a functional form in the first instance. Instead, we first use nonparametric regressions to explore the relationship between child stunting prevalence and GDP per capita levels, and then we choose a functional form that best reflects this relationship in the data. To do this, we apply a locally weighted (nonparametric) regression on data from LMICs, using STATA's locally weighted scatter plot smoothening (lowess) command. Given the shape of the curve, we apply a fractional polynomial regression of degree 1 on the data to determine the specific functional form and to obtain the parameter estimates. The estimation model in which per capita GDP is in logarithmic form has the best statistical fit of the data. This estimation model is defined as

$$Stunt = b_0 + b_1 * \left[ln\left(GDP_{pc}\right) + b_2\right] + \varepsilon, \quad (1)$$

where *Stunt* is the prevalence rate of child stunting in percentage; GDP_{pc}, the per capita GDP level; b_0, b_1, and b_3, the coefficients to be estimated; and ε, an error term. Per capita GDP is measured in constant 2005 international dollars at PPP normalized by 10,000.

Assuming there is a universal relationship between child stunting and GDP_{pc}, we also apply the same model on a subsample of the data, which contains data for all available LMICs in SSA. The LMIC sample contains observations from 123 countries for different years between 1980 and 2009, and the SSA sample observations are from 44 countries. Figure 5.1 shows the relationship between child stunting prevalence and per capita GDP in LMICs fitted by lowess and the fractional polynomial regression displayed in equation (1), while Table 5.1 reports the estimated results and measures of statistical fit of the model.

Figure 5.1—Relationship between child stunting prevalence and per capita GDP in LMICs, fitted by lowess (dashed line) and the fractional polynomial regression (solid line)



Source: Based on WDI database (2011).
Note: The chosen bandwidth of the lowess curve is 0.8 (that is STATA's standard bandwidth).

Table 5.1—Regression results

	b_0	b_1	b_2	Std. Err.	95% Conf. Int. for b_1		Obs.	F	R-sq.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LMICs	27.85	–13.90	1.052	0.528	–14.94	–12.86	472	692.18	0.596
SSA	38.40	–8.59	1.832	0.949	–10.49	–6.70	156	80.20	0.342

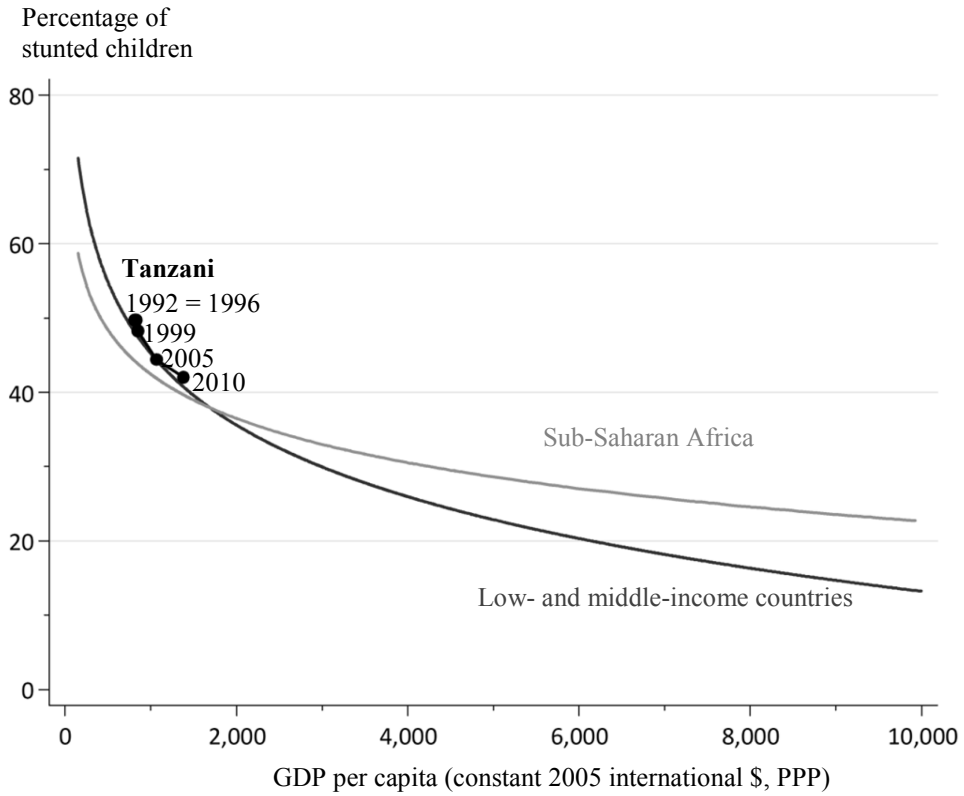
Source: Based on WDI database (2011).

The regression results indicate that if per capita GDP increases by 1 percent, the prevalence rate of child stunting in an average LMIC declines by 0.139 percentage point and by 0.0859 percentage point in an average SSA country (column (2) in Table 5.1). Taking Tanzania as an example, the stunting rate in 2010 was 42.0 percent; if the GDP per capita growth rate in 2011 were 1 percent, the country's stunting rate would fall to about 41.86 percent in 2011 according to the LMIC model and to about 41.91 percent according to the SSA model. In our discussion later, we will use the estimates at the lower and upper bounds of the 95 percent confidence intervals of the b_1 of the LMIC and SSA models; these estimates span ranges around the estimated percentage point reductions in child stunting (referred to as *confidence ranges,* hereafter) that we consider to be likely deviations from our exact predictions of the child stunting prevalence rates. For a 1 percent GDP per capita growth, our confidence range of the percentage point reduction in child stunting is –0.1494 to –0.1286 according to the LMIC model and –0.1049 to –0.067

according to the SSA model (see columns (5)–(6) in Table 5.1), which gives a total confidence range of –0.1494 to –0.067. The prediction result presented in the tables in the next subsection reports estimates at the lower bound and upper bound of the total confidence range.

Figure 5.2 plots the child stunting–growth relationship using the estimated coefficients reported in Table 5.1 and the actual per capita GDP level across countries reported in WDI database (2011). The curve for the LMIC model can be interpreted as the long-run child nutrition-growth path, which an average LMIC country tends to follow in the process of economic development. Analogously, the curve for the SSA model can be interpreted as the long-run child nutrition-growth path of an average SSA country. In Figure 5.2, we also highlight the nutrition-growth trend for Tanzania from 1992 to 2010.

Figure 5.2—Predicted relationship between the prevalence of child stunting and per capita GDP in LMIC and SSA countries



Source: Based on WDI database (2011); 2010 data for Tanzania is from NBS and ICF Macro (2011) and the DCGE model result.

Figure 5.2 shows that the prevalence of child stunting for SSA countries as a group is less responsive to economic growth than in the LMIC group. At the national level, Tanzania's nutrition-growth trend appears to be well predicted by the estimated LMIC and SSA nutrition-growth paths. The country's low per capita GDP level and high child stunting prevalence rate puts Tanzania at the left end of the nutrition-growth curves along the *x*-axis. The prevalence of child stunting stayed constant between 1992 and 1996 and began to slowly decline in the second half of the 1990s. With higher per capita GDP growth in the past 10 years, the prevalence of child stunting significantly dropped between 1999 and 2005. From 1992 to 2005, Tanzania's nutrition-growth trend followed the LMIC nutrition-growth path perfectly. Despite continuing growth, progress in reducing child stunting slowed after 2005, and Tanzania's nutrition-growth trend seemed to steer away from the LMIC path and to move along the SSA path. These observations underscore that in the case of Tanzania, the methodology of this study could provide a good alternative as compared with common approaches for predicting nutrition-growth trends.

To predict the prevalence rates of child stunting in Tanzania at the regional level for 2010–2015, we further combine the results from the DCGE model and the child stunting estimation models discussed previously. The benchmark prevalence rates of child stunting by region are taken from the 2010 Tanzania Demographic and Health Survey (NBS and ICF Macro 2011). Using as benchmarks regional and national GDP per capita growth rates solved from the DCGE model's baseline and TAFSIP scenarios and from available regional GDP per capita levels in 2010, annual per capita GDP is calculated at both regional and national levels between 2010 and 2015. The prevalence rates of child stunting at the regional and national levels are then predicted for each year between 2010 and 2015 under both baseline and TAFSIP scenarios. We perform this exercise using both LMIC and SSA estimation models to consider two alternative nutrition-growth paths. The estimation models also allow us to calculate annual changes in the prevalence of child stunting at given GDP per capita growth rates. Assuming that the child population growth rate is consistent with the population projection of NBS (2011), we finally calculate the numbers of stunted children using the prevalence of child stunting rate for each year between 2010 and 2015, as well as changes in the numbers of stunted children.

Results

Table 5.2 shows the actual prevalence rate of child stunting and per capita GDP growth rate in mainland Tanzania and its administrative regions in 1999, 2005, and 2010, and their changes in 2005–2010 and 1999–2010. Between 2005 and 2010, mainland Tanzania experienced 2.5 percent of annual growth in per capita GDP and 0.5 percentage point of annual reduction in the prevalence rate of child stunting, which corresponds to an arc elasticity of –0.425.[15] For the entire period of 1999–2010, both the annual per capita GDP growth rate (3.3 percent) and the annual reduction in child stunting (0.56 percentage point) are higher than the respective annual changes between 2005 and 2010. Yet, because the per capita GDP growth rate between 1999 and 2010 is relatively higher than the percent reduction in child stunting over this period, as compared with the period of 2005–2010, the value of the arc elasticity for the 11-year period is lower than the arc elasticity for the 5-year period.

[15] The child stunting arc elasticity is defined as the percentage change in the prevalence rate of child stunting between two years divided by the percentage change in the per capita GDP level over the same period.

Table 5.2—Changes in the prevalence of child stunting and per capita GDP and stunting-growth (arc) elasticity over the past decade by region

	Prevalence of child stunting (percentage)					GDP per capita (TSh, base year: 2007)					Arc elasticity	
	2010	2005	1999	Annual change (percentage points) 2005-2010	Annual change (percentage points) 1999-2010	2010	2005	1999	Annual growth (percent) 2005-2010	Annual growth (percent) 1999-2010	2005-2010	1999-2010
Mainland	42.3	44.8	48.5	-0.50	-0.56	572,442	506,027	401,289	2.5	3.3	*-0.425*	*-0.300*
Arusha*	43.9	33.2	35.5	2.14		650,208	581,563	471,753	2.3		2.730	
Dar es Salaam	18.8	22.1	28.7	-0.66	-0.90	1,255,092	982,528	1,022,135	5.0	1.9	-0.538	-1.514
Dodoma	56.0	50.1	61.0	1.18	-0.45	336,034	308,309	270,566	1.7	2.0	1.310	-0.339
Iringa	51.9	62.2	71.9	-2.06	-1.82	716,454	640,697	427,776	2.3	4.8	-1.400	-0.412
Kagera	43.6	43.4	51.8	0.04	-0.75	368,202	334,600	256,875	1.9	3.3	0.046	-0.365
Kigoma	48.2	59.7	57.8	-2.30	-0.87	404,745	308,786	265,401	5.6	3.9	-0.620	-0.316
Kilimanjaro	27.6	28.1	45.2	-0.10	-1.60	662,945	624,608	274,312	1.2	8.4	-0.290	-0.275
Lindi	53.5	58.6	63.6	-1.02	-0.92	445,060	442,140	341,009	0.1	2.5	-13.179	-0.520
Manyara	45.8	48.1		-0.46		596,612	538,640		2.1		-0.444	
Mara	31.0	46.6	32.2	-3.12	-0.11	522,330	503,783	319,064	0.7	4.6	-9.093	-0.058
Mbeya	49.8	44.7	56.5	1.02	-0.61	634,357	591,872	347,969	1.4	5.6	1.589	-0.144
Morogoro	44.4	43.0	60.5	0.28	-1.46	612,333	526,465	341,960	3.1	5.4	0.200	-0.337
Mtwara	43.5	58.6	66.5	-3.02	-2.09	426,105	389,831	469,454	1.8	-0.9	-2.769	3.746
Mwanza	38.7	34.8	43.8	0.78	-0.46	589,881	483,444	385,765	4.1	3.9	0.509	-0.220
Pwani (Coast)	31.7	42.6	48.2	-2.18	-1.50	415,117	377,100	334,682	1.9	2.0	-2.538	-1.424
Rukwa	50.4	53.4	47.1	-0.60	0.30	558,074	501,679	438,570	2.2	2.2	-0.500	0.257
Ruvuma	46.2	59.7	57.9	-2.70	-1.06	699,533	627,028	422,962	2.2	4.7	-1.956	-0.309
Shinyanga	43.3	44.3	44.1	-0.20	-0.07	398,007	341,214	372,387	3.1	0.6	-0.136	-0.264
Singida	39.0	44.8	56.4	-1.16	-1.58	321,512	291,995	358,438	1.9	-1.0	-1.281	2.995
Tabora	33.6	42.0	44.3	-1.68	-0.97	447,099	416,428	351,521	1.4	2.2	-2.715	-0.888
Tanga	49.4	49.6	61.2	-0.04	-1.07	657,744	616,355	306,600	1.3	7.2	-0.060	-0.168

Sources: Based on NBS and ICF Macro (2011) and DCGE model projection.
Note: *Arusha and Manyara regions were previously one administrative region (Arusha) until 2001. Therefore, the 1999 estimates of Arusha region cannot be compared with estimates after 2001.

In most regions, per capita GDP increased and the prevalence of child stunting declined during the past five years, as well as between 1999 and 2010 (Table 5.2). However, there are also notable exceptions: In some regions—for example, Mtwara and Singida—per capita GDP annual growth rate was negative in 1999–2010, although child stunting markedly declined in these regions during the same period. In other regions—for example, Rukwa—the prevalence rate of child stunting increased from 1999 to 2010, despite sizeable economic growth. Although the positive child stunting–growth arc elasticities are rather exceptional, they emphasize that regional specific factors other than the economic situation are important in explaining the nutrition situation of those regions. Furthermore, it can be noticed in Table 5.2 that for the shorter period (2005–2010), positive arc elasticities appear more frequently, and the variance in the arc elasticities across regions is much greater. This suggests that economic growth is more of a critical determinant of people's nutrition in the medium and long term than in the short term, and nutrition-growth elasticities should be interpreted accordingly. Thus, the arc elasticities for 1999–2010 in Table 5.2 would be a better reflection of the relationships between undernutrition reduction and economic growth than the arc elasticities for the rather short period of 2005–2010. Lastly, the results suggest that predictions based on observed arc elasticities of the past nutrition-growth trends are not a suitable procedure for estimating future child stunting rates by region, because they will provide misleading estimates, at least for some regions.

Taking a closer look at regional developments in the years between 2005 and 2010, some regions in Tanzania, including Arusha, Dodoma, Mbeya, and Mwanza, have experienced a deterioration of their nutrition situation, despite their economic growth (2.3 percent per annum in Arusha and 4.1 percent in Mwanza; Table 5.2). Rising or largely constant child stunting rates with positive economic growth indicate increasingly unequal distribution of the gains. On the contrary, there are also very promising examples: Dar es Salaam, Pwani, and Tabora were able to achieve percent reduction rates in the prevalence of child stunting (not reported) over the past decade that exceeded their GDP per capita growth rates, suggesting the success of these regions in leveraging economic growth for improved nutrition outcomes.

Nonetheless, trends in some regions' child stunting rate are influenced by factors other than economic growth, which makes it difficult to anticipate future trends responding to income growth. Implementation of nutrition intervention programs may explain the successful reduction in the child stunting rate in some regions, such as in Mtwara and Iringa (see Section 4); on the negative side, external shocks, including the influx of refugees from neighboring countries, may explain the rising prevalence of child stunting in some northern and western regions, such as Kagera, Kigoma, and Arusha (Baez 2011; Mbago 1994). Although it is important to fully understand such different historical trends across regions, it goes beyond the scope of this study. What we want to emphasize in this study is that the differential nutrition-growth trends across regions can only be partially characterized by the regional differences in economic growth, and that progress in reducing chronic child undernutrition cannot always be explained by economic growth. This should be kept in mind when we discuss the predicted results in the rest of this subsection.

Table 5.3 shows the predictions of the prevalence and numbers of stunted children, as well as their changes over time for the baseline scenario, and Table 5.4 shows these results for the TAFSIP scenario, which are reported as the change from the predictions under the baseline scenario.[16] Per capita GDP in mainland Tanzania is expected to grow at 2.1 percent per year between 2011 and 2015 under the baseline scenario and 3.6 percent under the TAFSIP scenario, where additional growth is led by accelerated growth in the agricultural sector. Corresponding to the GDP per capita annual growth rate of 2.1 percent in the baseline, the child stunting rate is expected to fall by 0.16 to 0.36 in mainland Tanzania (Table 5.3). Moving along the SSA nutrition-growth path, the prevalence of child stunting will decline from 42.3 percent in 2010 to about 41.3 percent in 2015, a total reduction of 1 percentage point in the next five years. If Tanzania follows the LMIC nutrition-growth path, the child stunting prevalence will decline to about 40.6 percent in 2015, a reduction of 1.7 percentage points in five years (Table 5.3).

[16] Table A.7 in the Appendix shows the estimation results for the TAFSIP scenario in absolute terms.

Under the TAFSIP scenario and along the LMIC path, an additional reduction of 1.3 percentage points in the five years is expected, indicating that the prevalence rate of child stunting in Tanzania will fall to 39.3 percent by 2015, with an additional 1.6 percent of per capita GDP annual growth between 2011 and 2015 (Table 5.4). At the regional level, the nutritional effects of growth under the TAFSIP scenario vary depending on the regional agricultural growth potential. For example, in Iringa and Rukwa regions, the TAFSIP investments are expected to lead to an additional annual reduction of child stunting of more than 0.5 percentage point compared to the baseline trend (Table 5.4), which adds up to an absolute reduction of 1 percentage point per annum. In other regions, such as Dar es Salaam, Kagera, Kilimanjaro, and Pwani, agricultural growth is modest under the TAFSIP scenario, which causes insignificant change in the prevalence of child stunting in these regions.

We further report the change in the number of stunted children. Due to Tanzania's high population growth, the number of stunted children is expected to increase by between 40,000 and 60,000 every year along the baseline (Table 5.3). Accelerated agricultural growth led by investment under TAFSIP helps an additional 30,000 children to avoid becoming stunted every year (Table 5.4). Although numbers of stunted children in 2015 will still be more than that in 2010, accelerated agricultural growth reduces the risk for an additional 130,000 children under 5 of becoming stunted in the next five years (between 2011 and 2015). Along the baseline, the absolute number of stunted children is expected to fall or not change in Arusha, Dar es Salaam, Dodoma, and Iringa regions by 2015. However, if agricultural investment of TAFSIP can be realized under the TAFSIP scenario, the number of stunted children is expected to fall in more regions, including Kilimanjaro, Morogoro, Mtwara, Mwanza, Singida, and Tanga.

Table 5.3—Prediction results under the baseline scenario

	Stunted children, 2010		Growth in per capita GDP, 2011–2015	Stunted children, 2015, acc. to SSA path		Stunted children, 2015, acc. to LMIC path		Annual change in stunting prevalence (percentage points), 2011–2015			
	Percentage	Thousand	Percentage	Percentage	Thousand	Percentage	Thousand	SSA path	LMIC path	Confidence range	
Mainland	42.3	3,167	2.07	41.3	3,427	40.6	3,373	–0.21	–0.34	–0.16	–0.36
Arusha	43.9	120	2.33	42.7	118	41.8	115	–0.25	–0.42	–0.19	–0.44
Dar es Salaam	18.8	91	3.76	17.8	82	16.8	78	–0.20	–0.40	–0.15	–0.43
Dodoma	56.0	210	1.96	54.9	198	54.2	196	–0.23	–0.35	–0.18	–0.37
Iringa	51.9	127	2.02	50.6	122	49.7	119	–0.26	–0.44	–0.20	–0.47
Kagera	43.6	236	1.43	42.9	279	42.6	276	–0.13	–0.21	–0.10	–0.22
Kigoma	48.2	194	1.88	47.2	229	46.7	226	–0.20	–0.31	–0.15	–0.32
Kilimanjaro	27.6	58	1.94	26.9	58	26.5	58	–0.13	–0.22	–0.10	–0.23
Lindi	53.5	70	1.11	52.8	72	52.5	72	–0.13	–0.21	–0.10	–0.22
Manyara	45.8	124	1.99	44.7	148	44.0	145	–0.21	–0.36	–0.17	–0.38
Mara	31.0	119	2.05	30.3	138	29.8	136	–0.15	–0.24	–0.11	–0.25
Mbeya	49.8	261	1.61	48.8	280	48.2	276	–0.19	–0.32	–0.15	–0.34
Morogoro	44.4	146	2.49	43.1	149	42.2	146	–0.26	–0.44	–0.20	–0.47
Mtwara	43.5	91	1.97	42.6	93	42.0	92	–0.19	–0.30	–0.15	–0.31
Mwanza	38.7	242	2.38	37.6	254	36.9	249	–0.22	–0.36	–0.17	–0.38
Pwani (Coast)	31.7	55	1.90	31.0	58	30.7	57	–0.13	–0.21	–0.10	–0.22
Rukwa	50.4	156	2.01	49.2	181	48.5	179	–0.24	–0.39	–0.18	–0.41
Ruvuma	46.2	106	2.02	45.1	116	44.2	114	–0.23	–0.39	–0.18	–0.42
Shinyanga	43.3	357	2.51	42.1	420	41.5	414	–0.23	–0.37	–0.18	–0.39
Singida	39.0	89	2.09	38.2	89	37.7	88	–0.17	–0.26	–0.13	–0.27
Tabora	33.6	170	2.73	32.6	195	32.0	192	–0.20	–0.32	–0.16	–0.34
Tanga	49.4	145	1.89	48.3	148	47.5	146	–0.23	–0.38	–0.17	–0.40

Source: See text.

Table 5.4—Prediction results under the TAFSIP scenarios, change from the baseline

	Additional change in GDP per capita growth, 2011–2015	Additional change in stunted children, 2015, acc. to SSA path		Additional change in stunted children, 2015, acc. to LMIC path		Additional, annual change in stunting prevalence (percentage points), 2011–2015				Additional, annual change in number of stunted children (thousand), 2011–2015			
	Percentage points	Percentage points	Thousand	Percentage points	Thousand	SSA path	LMIC path	Confidence range		SSA path	LMIC path	Confidence range	
Mainland	*1.55*	*–0.78*	*–77*	*–1.31*	*–126*	*–0.16*	*–0.26*	*–0.12*	*–0.28*	*–15*	*–25*	*–12*	*–27*
Arusha	1.81	–0.97	–3	–1.67	–5	–0.19	–0.33	–0.15	–0.35	–1	–1	0	–1
Dar es Salaam	0.17	–0.05	0	–0.10	0	–0.01	–0.02	–0.01	–0.02	0	0	0	0
Dodoma	2.10	–1.24	–4	–1.93	–7	–0.25	–0.39	–0.20	–0.40	–1	–1	–1	–1
Iringa	2.17	–1.42	–3	–2.47	–6	–0.28	–0.49	–0.22	–0.53	–1	–1	–1	–1
Kagera	1.42	–0.66	–4	–1.04	–7	–0.13	–0.21	–0.10	–0.22	–1	–1	–1	–1
Kigoma	1.46	–0.77	–4	–1.23	–6	–0.15	–0.25	–0.12	–0.26	–1	–1	–1	–1
Kilimanjaro	1.54	–0.52	–1	–0.90	–2	–0.10	–0.18	–0.08	–0.19	0	0	0	0
Lindi	1.00	–0.60	–1	–0.95	–1	–0.12	–0.19	–0.09	–0.20	0	0	0	0
Manyara	2.20	–1.21	–4	–2.04	–7	–0.24	–0.41	–0.19	–0.43	–1	–1	–1	–1
Mara	1.75	–0.63	–3	–1.04	–5	–0.13	–0.21	–0.10	–0.22	–1	–1	0	–1
Mbeya	1.45	–0.88	–5	–1.49	–9	–0.18	–0.30	–0.13	–0.32	–1	–2	–1	–2
Morogoro	1.69	–0.91	–3	–1.54	–5	–0.18	–0.31	–0.14	–0.33	–1	–1	0	–1
Mtwara	1.68	–0.81	–2	–1.30	–3	–0.16	–0.26	–0.13	–0.27	0	–1	0	–1
Mwanza	2.00	–0.93	–6	–1.57	–11	–0.19	–0.31	–0.14	–0.33	–1	–2	–1	–2
Pwani (Coast)	1.61	–0.56	–1	–0.90	–2	–0.11	–0.18	–0.09	–0.19	0	0	0	0
Rukwa	2.31	–1.38	–5	–2.30	–8	–0.28	–0.46	–0.21	–0.49	–1	–2	–1	–2
Ruvuma	2.02	–1.17	–3	–2.02	–5	–0.23	–0.40	–0.18	–0.43	–1	–1	0	–1
Shinyanga	2.61	–1.25	–12	–1.99	–20	–0.25	–0.40	–0.20	–0.42	–2	–4	–2	–4
Singida	2.39	–0.98	–2	–1.51	–4	–0.20	–0.30	–0.15	–0.32	0	–1	0	–1
Tabora	2.52	–0.96	–6	–1.55	–9	–0.19	–0.31	–0.15	–0.33	–1	–2	–1	–2
Tanga	1.68	–1.02	–3	–1.75	–5	–0.20	–0.35	–0.16	–0.37	–1	–1	0	–1

Source: See text.

To validate the prediction results discussed above, we synthesize findings drawn from the relevant literature (Table 5.5) and compare them with our own estimates. Based on panel data from Kagera region collected in the early 1990s, Alderman, Hoogeveen, and Rossi (2006) estimated that an annual household per capita income growth of 2.5 percent translates into an annual reduction in the child stunting prevalence by 0.21 percentage point, which is equal to an arc elasticity of –0.164 for 1993–2015. These estimates are very close to our estimates for Kagera region and fall into our confidence range. Under the baseline scenario with 2.1 percent of GDP per capita annual growth, the confidence range for the reduction in child stunting prevalence is 0.10–0.22 in Kagera region in our estimates. Our arc elasticity of the child stunting rate with respect to GDP per capita growth is –0.206 along the SSA path, which is only slightly higher than Alderman, Hoogeveen, and Rossi's (2006) estimate. Considering that Alderman, Hoogeveen, and Rossi (2006) used a reduced-form demand model and controlled for various nonincome factors in their estimation, including targeted nutrition intervention programs, this comparison increases our confidence in our results.

Moreover, Table 5.5 shows that the nutritional effects of economic growth can be amplified if they are combined with investments in formal education, particularly for girls and women, and direct nutrition interventions. For Ethiopia, Christiaensen and Alderman (2004) found an annual reduction in the prevalence of child stunting of 0.35 percentage point, resulting from income growth and improvement in formal education for females together, which is more than double the nutritional effect resulting from income growth alone (0.16). In addition, adding nutrition education campaigns to the package can reduce the prevalence of child stunting by an additional 0.16 percentage point. In their study on Kagera region, Alderman, Hoogeveen, and Rossi (2006) showed that the combined income growth and comprehensive nutrition interventions with full coverage in all communities can reduce the prevalence of child stunting in the region by 1.32 percentage points, which is more than six times the reduction associated with income growth alone.

Table 5.5—Long-run child stunting–growth effects from the literature

Population	Model / Data	Growth scenario	Projection period	Percentage of stunted children in base year	Annual average change (percentage points)	*Arc elasticity [range]*	Source
Kagera, Tanzania	Random-effects IV regression four-round panel, household survey	Per capita income growth of 2.5 percent	1993–2015	39	–0.21	–0.164	Alderman, Hoogeveen, and Rossi 2006
Kagera, Tanzania	Random-effects IV regression four-round panel, household survey	Per capita income growth of 2.5 percent plus nutrition interventions in all communities	1993–2015	39	–1.32	–1.026	Alderman, Hoogeveen, and Rossi 2006
Ethiopia	OLS regression cross-section, household survey	Per adult equivalent (AE) income growth of 2.5 percent	1998–2013	54	–0.16	–0.099	Christiaensen and Alderman 2004
Ethiopia	OLS regression cross-section, household survey	Per AE income growth of 2.5 percent plus formal schooling for females	1998–2013	54	–0.35	–0.219	Christiaensen and Alderman 2004
Ethiopia	OLS regression cross-section, household survey	Per AE income growth of 2.5 percent plus formal schooling for females and nutrition education campaigns	1998–2013	54	–0.51	–0.314	Christiaensen and Alderman 2004
Yemen*	OLS regression cross-section, household survey	National GDP of 4.0–6.8 percent (resulting in per capita income growth of 1.3–4.0 percent)	2009–2020	59.4	–0.14 –0.38	–0.049 (–0.175) –0.065 (–0.131)	Ecker, Breisinger, and Pauw 2011

Note: * GDP growth and per capita income growth rates are estimated from a DCGE model similar to the one underlying the GDP projections used in this study. The elasticity ranges are due to different sector growth rates, which result from different policy scenarios.

6. CONCLUSIONS

This study analyzes the nutrition situation in Tanzania and the links between agriculture and nutrition. The historical data show that Tanzania's per capita GDP grew at 3.3 percent annually between 1999 and 2010, while the prevalence of chronic undernutrition in children fell only modestly in this period, from 48.3 percent in 1999 to 42.0 percent in 2010. This decline corresponds to an annual reduction of 0.6 percentage point, which is comparable to many other Sub-Saharan African countries. However, in some Sub-Saharan African countries, such as Ethiopia, Uganda, and Zambia, child undernutrition prevalence has been reduced by more than 1 percentage point per year in the past decade, suggesting that there is room for Tanzania to improve its nutrition outcome.

Data at the regional level show that there is significant regional heterogeneity, both in the levels of undernutrition prevalence and the reduction of undernutrition over time. Such heterogeneity is also mirrored in the types of nutrition programs in the past decade. In most cases, the nutrition programs implemented by government and nongovernmental organizations were fragmented and lacked coordination among different actors. Some regions, such as Iringa and Kagera, had received more attention from various NGOs and development partners, while other regions, for example, Rukwa, Ruvuma, and Mbeya, were largely ignored. At the regional level, improved coordination among development partners, the civil society, and government will be critical to maximize any future impact of nutrition investments in Tanzania. Information sharing of activities carried out by different organizations and the government will also be helpful and is particularly important given limited resources and the multiple factors affecting nutrition outcomes in a region.

n addition to improved coordination at the regional levels, improved strategy at the national level will be vital. In this regard, the recent development of a National Nutrition Strategy (NNS) sets the stage for deliberate action and enhanced harmonization of investments to achieve greater impact on nutrition in the future. In so doing, multiple interventions of civil society and the government will need to be streamlined, and linking different types of investments across sectors will be important. For example, linking the agricultural investments under TAFSIP to nutrition and health interventions under MAMM can potentially yield synergies and amplify the nutritional impact of both agricultural and health investments. Given the current proposed budgets, it would seem that more efforts are needed to improve not only the budget allocation but also the coordination of programs between the health and agricultural ministries.

The Joint Assistance Strategy for Tanzania (JAST) has seen significant adjustments recently, with more aid going directly to national budget support and less to project-based support. Under this new institutional arrangement, more nutrition program design, planning, and implementation will be performed by governments, particularly local government authorities, per their Comprehensive Council Health Plans. This change calls for increased capacity building at the local government levels and enhancement of coordination among local government authorities and civil society at the regional levels to maximize the impact of nutrition programs.

At the regional level, results from our study show that although productivity of maize was higher in Rukwa region, this did not translate to high levels of nutrition in the region. Similarly, higher levels of rice productivity in Manyara did not appear to translate to a significant reduction in undernutrition. In addition, in Arusha, agricultural potential (as measured by the maize and rice yield gaps) was relatively high, yet undernutrition was at best average compared with the other regions. These results point to two things: First, paying attention to regional nuances will be important in designing any nutrition and agricultural investment plan or program in order to have more nutritional impact. Second, it is worthwhile to explore the possible integration of nutrition programs with agriculture, particularly in regions where agricultural productivity is high. For example, promoting complementary agricultural value chain innovations, such as fortification of maize, wheat, and rice products, may be worth considering in such regions. It is encouraging to see that the NNS includes fortification of maize and wheat flour, as well as oil, as part of a proposed fortification program. In fact, fortification efforts were already in place, albeit at

a smaller scale, in Iringa and Tanga; these two regions experienced improvements in nutrition in the past decade, indicating that such interventions (combined with the other interventions) indeed have an impact, and that scaling up such interventions is hence most likely to have a significant effect on nutrition at the national level. In the regions where the current agricultural productivity is low, the level of malnutrition is high, and there is high agricultural potential (for example, Manyara, Iringa, Arusha, and Dodoma), investments designed to increase agricultural productivity should incorporate nutrition objectives in order to achieve significant improvements in nutrition. Development partners' investments, such as the USAID's FtF initiative, rightly link agricultural investment with nutrition and are likely to take advantage of potential synergy and economies of scope if implemented at the proposed scale.

Biofortification is another nutrition-related agricultural intervention that could potentially complement nutrition interventions on the ground. Some organizations, such as HKI in partnership with USAID, are promoting consumption of OFSPs nationwide. The efforts to increase adoption and production of OFSP (under CIP and Tanzania Home Economics Association [TAHEA] programs) are limited to the Eastern and Lake regions of Tanzania, an indication of a lack of coordination between supply and demand for the same product. If interventions to promote adoption and production of OFSP under the CIP and TAHEA programs could be expanded to other areas of the country, it would significantly help improve vitamin A nutrition nationally. Moreover, such interventions could easily be combined with the current efforts of HKI and USAID to promote consumption of OFSP. The cost-effectiveness analysis documented in this study suggests that the unit cost of biofortification programs is relatively low and comparable to that of vitamin A supplementation, which has the greatest potential to reduce the burden of child morbidity and mortality (Bhutta et al. 2008). Since biofortification is a longer-term intervention, it is worthwhile to invest in biofortification in combination with behavioral change interventions that promote production, consumption, and marketing of OFSP.

Nutrition interventions need to be complemented by improvements in the underlying causes of undernutrition. Through increasing smallholder incomes, agricultural productivity-enhancing investments contribute to eliminating undernutrition. By combining an econometric estimation model with the result of an economywide model simulation, this study shows that the implementation of TAFSIP can accelerate agricultural growth, which would result in an additional 1.6 percent annual GDP per capita growth in 2011–2015. With such growth, the prevalence of child stunting will be reduced by an additional 0.3 percentage point per annum in 2011–2015, and an additional 130,000 children will avoid becoming stunted by 2015. Although our analysis only considers the next five years (until 2015), considering the long-term effects of the TAFSIP investments, the returns-to-investment in nutrition improvement due to TAFSIP will continue and possibly increase after 2015.

However, to substantially reduce other aspects of malnutrition, other interventions targeted especially to women and children will likely be needed, in addition to programs designed to increase agricultural growth. Particularly important are nutrition education and child feeding programs, which have been shown to be highly effective in Tanzania and other developing countries.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1—Child undernutrition in Tanzania by residence and region in 2010

	Undernutrition among children (under 5 years)					
	Stunting		Underweight		Wasting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Total	**42.0**	**16.5**	**15.8**	**3.8**	**4.8**	**1.2**
Mainland	42.3	16.6	15.7	3.8	4.6	1.1
Residence						
Urban	31.5	11.6	17.3	4.2	4.7	1.0
Rural	44.5	17.7	14.4	3.4	4.8	1.3
Region						
Dodoma	56.0	28.4	26.8	7.6	5.2	0.9
Arusha	43.9	17.7	28.2	7.6	9.5	2.5
Kilimanjaro	27.6	6.1	11.0	2.2	5.3	0.0
Tanga	49.4	21.9	24.1	6.2	5.5	1.6
Morogoro	44.4	18.8	16.0	3.1	5.3	2.3
Pwani (Coast)	31.7	10.5	11.3	1.9	4.2	0.4
Dar es Salaam	18.8	6.9	11.8	0.5	6.8	1.7
Lindi	53.5	20.5	24.3	6.0	4.1	0.9
Mtwara	43.5	16.4	18.9	4.1	2.6	0.4
Ruvuma	46.2	19.0	15.8	1.5	4.8	0.7
Iringa	51.9	22.3	18.2	2.4	3.5	0.8
Mbeya	49.8	19.2	9.7	1.8	1.2	0.0
Singida	39.0	15.2	18.9	5.2	9.2	2.5
Tabora	33.6	14.6	11.6	2.4	3.9	0.7
Rukwa	50.4	20.4	13.5	3.2	3.8	2.0
Kigoma	48.2	17.0	15.4	5.1	3.2	0.0
Shinyanga	43.3	11.9	10.1	2.5	2.5	0.6
Kagera	43.6	16.3	17.1	5.4	5.0	1.9
Mwanza	38.7	16.3	11.4	3.1	3.9	1.3
Mara	31.0	9.5	11.9	2.6	5.0	1.6
Manyara	45.8	25.4	24.2	7.3	7.4	1.8
Zanzibar North	40.6	15.3	27.1	5.3	16.4	5.0
Zanzibar South	29.1	9.2	17.1	4.7	10.6	3.6
Town West	19.6	8.7	15.5	2.4	11.5	5.1
Pemba North	39.3	15.3	23.9	7.7	12.7	5.8
Pemba South	31.3	13.5	18.6	3.6	8.9	2.0

Source: NBS and ICF Macro (2011).
Note: Estimates are preliminary. Prevalence rates of child undernutrition are estimated with reference to the WHO Child Growth Standards, adopted in 2006.

Table A.2—Child undernutrition in Tanzania by residence and region in 2005

	Undernutrition among children (under 5 years)					
	Stunting		Underweight		Wasting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Total	**44.4**	**17.7**	**16.7**	**4.1**	**3.5**	**1.0**
Mainland*	44.8	17.9	16.8	4.1	3.4	1.0
Residence						
Urban	33.0	10.7	12.3	1.9	3.2	1.0
Rural	47.1	19.3	17.8	4.6	3.6	1.0
Region						
Dodoma	50.1	21.1	24.4	6.8	4.5	0.6
Arusha	33.2	13.9	16.2	3.2	4.1	1.3
Kilimanjaro	28.1	8.0	14.4	2.5	6.1	1.7
Tanga	49.6	21.8	26.4	4.9	6.1	0.8
Morogoro	43.0	12.3	13.5	1.4	1.1	0.0
Pwani (Coast)	42.6	18.2	22.0	4.7	6.4	1.3
Dar es Salaam	22.1	4.4	10.9	0.8	3.3	0.6
Lindi	58.6	23.8	18.4	5.7	3.0	0.9
Mtwara	58.6	24.9	19.6	4.0	2.2	0.0
Ruvuma	59.7	23.7	16.7	1.3	0.4	0.0
Iringa	62.2	29.3	17.9	4.6	1.3	0.0
Mbeya	44.7	17.0	9.4	1.7	2.1	0.6
Singida	44.8	21.3	23.8	8.4	6.0	2.0
Tabora	42.0	16.0	15.4	4.4	3.2	1.3
Rukwa	53.4	22.3	18.5	5.6	2.5	0.8
Kigoma	59.7	26.0	28.4	8.6	4.8	1.5
Shinyanga	44.3	18.8	14.0	4.5	2.8	1.0
Kagera	43.4	18.3	18.3	4.3	4.6	2.3
Mwanza	34.8	10.6	11.0	2.8	2.8	0.9
Mara	46.6	21.1	13.1	4.3	3.1	1.1
Manyara	48.1	18.4	21.9	4.9	4.7	1.2
Zanzibar North	22.1	5.7	16.2	3.7	9.6	2.2
Zanzibar South	34.5	10.7	19.5	5.2	9.2	4.0
Town West	20.6	6.1	11.5	1.0	7.0	2.0
Pemba North	39.6	18.9	17.0	3.7	6.5	2.0
Pemba South	31.1	10.4	16.0	3.4	5.7	3.5

Source: GDCGM (2011).
Note: Prevalence rates of child undernutrition are estimated with reference to the WHO Child Growth Standards, adopted in 2006.

Table A.3—Child undernutrition in Tanzania by residence and region in 1999

	Undernutrition among children (under 5 years)					
	Stunting		Underweight		Wasting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Total	**48.3**	**22.4**	**25.3**	**7.8**	**5.6**	**2.0**
Mainland*	48.5	22.6	25.3	7.9	5.5	2.0
Residence						
Urban	28.1	10.8	15.5	4.8	6.2	2.0
Rural	52.5	24.8	27.3	8.5	5.5	2.0
Region						
Dodoma	61.0	29.2	32.6	9.8	2.7	2.7
Arusha (incl. Manyara area)	35.5	20.1	29.9	11.4	11.3	2.7
Kilimanjaro	45.2	23.3	34.8	11.1	7.6	5.7
Tanga	61.2	34.3	45.9	12.2	9.8	5.2
Morogoro	60.5	29.6	25.5	7.6	4.8	2.4
Pwani (Coast)	48.2	25.3	11.6	1.7	0.0	0.0
Dar es Salaam	28.7	19.2	17.5	7.6	7.4	0.8
Lindi	63.6	33.6	31.9	15.3	2.0	1.0
Mtwara	66.5	27.1	32.2	7.6	2.1	0.0
Ruvuma	57.9	19.9	27.9	4.2	4.4	3.0
Iringa	71.9	53.4	31.8	11.5	1.1	0.0
Mbeya	56.5	21.4	20.4	3.7	0.0	0.0
Singida	56.4	22.6	25.3	3.3	5.6	2.2
Tabora	44.3	18.2	16.1	4.1	4.2	2.9
Rukwa	47.1	11.7	20.2	5.3	7.3	3.7
Kigoma	57.8	24.5	31.5	10.0	5.3	0.0
Shinyanga	44.1	14.6	18.6	5.8	4.2	0.4
Kagera	51.8	22.3	24.3	10.7	7.4	3.0
Mwanza	43.8	20.1	23.5	7.0	3.9	1.4
Mara	32.2	9.7	12.9	3.5	5.6	2.8
Zanzibar North Zanzibar South Town West	33.6	10.6	14.2	2.5	3.6	0.2
Pemba North Pemba South	51.3	24.4	32.3	13.3	12.3	4.4

Source: GDCGM (2011).
Note: Prevalence rates of child undernutrition are estimated with reference to the WHO Child Growth Standards, adopted in 2006.

Table A.4—Child undernutrition in Tanzania by residence and region in 1996

	Undernutrition among children (under 5 years)					
	Stunting		Underweight		Wasting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Total	**49.7**	**23.5**	**26.9**	**9.0**	**8.5**	**3.0**
Mainland	49.9	23.6	26.8	8.9	8.4	3.0
Residence						
Urban	38.3	16.0	16.1	5.2	8.1	2.1
Rural	52.1	25.1	29.2	9.9	8.6	3.1
Region						
Dodoma	53.8	28.6	28.4	8.2	8.6	3.0
Arusha (incl. Manyara area)	49.9	23.1	32.8	11.6	8.4	2.9
Kilimanjaro	38.8	19.6	19.1	5.4	7.1	2.7
Tanga	61.6	30.2	29.5	8.0	6.6	1.6
Morogoro	62.7	30.7	21.9	9.0	5.2	1.7
Pwani (Coast)	59.2	27.9	29.2	9.1	10.7	2.7
Dar es Salaam	37.9	15.6	18.3	6.4	9.5	2.6
Lindi	64.6	38.0	35.4	14.0	8.1	5.6
Mtwara	65.8	36.4	35.7	11.9	8.1	2.2
Ruvuma	58.6	27.1	25.1	9.2	6.0	2.5
Iringa	75.9	41.4	43.0	15.2	8.6	3.0
Mbeya	53.3	25.4	20.8	6.1	7.3	2.1
Singida	43.2	21.4	22.2	9.8	8.1	3.0
Tabora	29.6	13.9	9.4	4.3	6.2	2.7
Rukwa	51.1	22.2	27.5	12.2	9.2	3.9
Kigoma	55.4	24.0	37.2	11.2	9.5	3.2
Shinyanga	36.7	15.6	25.4	5.2	9.2	3.5
Kagera	48.8	20.4	29.4	11.7	12.5	5.1
Mwanza	40.8	18.4	22.0	6.8	6.1	1.2
Mara	38.3	15.3	18.6	6.4	10.9	5.2
Zanzibar North Zanzibar South Town West	35.2	15.7	22.1	8.4	11.2	0.9
Pemba North Pemba South	49.8	27.2	39.9	18.7	14.4	6.1

Source: GDCGM (2011).
Note: Prevalence rates of child undernutrition are estimated with reference to the WHO Child Growth Standards, adopted in 2006.

Table A.5—Child undernutrition in Tanzania by residence and region in 1992

	Undernutrition among children (under 5 years)					
	Stunting		Underweight		Wasting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Total	**49.7**	**22.8**	**25.1**	**8.5**	**7.9**	**2.8**
Mainland	49.6	22.5	24.8	8.4	7.6	2.7
Residence						
Dar es Salaam City	31.6	11.3	15.1	6.2	7.2	2.6
Other urban	45.3	17.5	21.6	5.6	6.9	3.0
Rural, mainland	50.8	24.0	26.0	9.2	8.1	2.7
Region						
Dodoma	64.3	30.1	32.6	9.1	4.7	1.3
Arusha (incl. Manyara area)	43.5	18.8	29.2	7.8	12.4	4.4
Kilimanjaro	41.1	19.4	21.4	7.4	7.6	2.8
Tanga	43.9	20.3	30.1	9.4	17.5	7.9
Morogoro	61.0	27.7	28.6	8.8	5.3	1.3
Pwani (Coast)	57.7	31.8	33.5	13.0	9.4	2.3
Lindi	65.4	33.7	23.9	11.2	5.7	2.8
Mtwara	69.4	37.8	38.6	11.9	8.5	3.0
Ruvuma	60.3	30.7	29.1	9.5	6.7	2.1
Iringa	62.0	35.3	30.3	13.7	5.7	0.7
Mbeya	53.0	27.8	19.3	10.7	7.7	3.7
Singida	43.6	16.5	26.4	6.7	8.9	1.7
Tabora	46.7	21.9	21.6	6.7	6.5	2.4
Rukwa	52.0	24.5	21.3	7.6	7.1	2.8
Kigoma	55.4	23.9	28.4	8.1	6.6	1.2
Shinyanga	38.8	14.0	18.6	6.8	7.1	2.5
Kagera	47.5	19.7	23.6	8.3	5.3	3.0
Mwanza	43.3	16.3	17.3	6.0	7.2	3.3
Mara	41.9	16.6	17.5	4.9	6.8	2.2
Zanzibar North Zanzibar South Town West Pemba North Pemba South	55.1	32.3	37.2	12.7	15.1	5.0

Source: GDCGM (2011).
Note: Prevalence rates of child undernutrition are estimated with reference to the WHO Child Growth Standards, adopted in 2006.

Table A.6—Changes in the number of stunted children in mainland Tanzania

	Stunted Children				
	2010	2005	1999	Annual change 2005–2010	Annual change 1999–2010
Mainland	*3,167*	*2,784*	*2,350*	*77*	*74*
Arusha	120	80	119	8	
Dar es Salaam	91	88	60	0	3
Dodoma	210	162	144	9	6
Iringa	127	143	158	–3	–3
Kagera	236	182	149	11	8
Kigoma	194	184	118	2	7
Kilimanjaro	58	53	83	1	–2
Lindi	70	70	68	0	0
Manyara	124	103		4	
Mara	119	139	68	–4	5
Mbeya	261	182	150	16	10
Morogoro	146	124	147	4	0
Mtwara	91	105	88	–3	0
Mwanza	242	194	219	10	2
Pwani (Coast)	55	62	54	–1	0
Rukwa	156	131	90	5	6
Ruvuma	106	114	90	–2	1
Shinyanga	357	283	194	15	15
Singida	89	90	93	0	0
Tabora	170	161	109	2	6
Tanga	145	132	149	3	0

Source: Based on NBS and ICF Macro (2011), GDCGM (2011), and NBS (2011).

Table A.7—Prediction results under TAFSIP scenario

	Stunted children, 2010		Growth in per capita GDP, 2011–2015	Stunted children, 2015, acc. to SSA path		Stunted children, 2015, acc. to LMIC path		Annual change in stunting prevalence (percentage points), 2011–2015			
	Percentage	Thousand	Percent	Percentage	Thousand	Percentage	Thousand	SSA path	LMIC path	Confidence range	
Mainland	*42.3*	*3,167*	*3.63*	*40.5*	*3,351*	*39.3*	*3,247*	*–0.36*	*–0.60*	*–0.28*	*–0.63*
Arusha	43.9	120	4.14	41.7	115	40.1	111	–0.44	–0.75	–0.34	–0.80
Dar es Salaam	18.8	91	3.94	17.7	82	16.7	77	–0.21	–0.42	–0.16	–0.45
Dodoma	56.0	210	4.05	53.6	194	52.3	189	–0.48	–0.74	–0.38	–0.77
Iringa	51.9	127	4.19	49.2	118	47.2	113	–0.54	–0.94	–0.41	–1.00
Kagera	43.6	236	2.85	42.3	274	41.5	269	–0.27	–0.41	–0.21	–0.43
Kigoma	48.2	194	3.34	46.4	225	45.4	220	–0.35	–0.55	–0.27	–0.58
Kilimanjaro	27.6	58	3.49	26.4	57	25.6	56	–0.23	–0.40	–0.18	–0.42
Lindi	53.5	70	2.11	52.2	72	51.5	70	–0.25	–0.40	–0.20	–0.42
Manyara	45.8	124	4.19	43.5	144	42.0	138	–0.46	–0.77	–0.35	–0.81
Mara	31.0	119	3.80	29.6	135	28.8	131	–0.27	–0.45	–0.21	–0.47
Mbeya	49.8	261	3.07	48.0	275	46.7	268	–0.37	–0.62	–0.28	–0.66
Morogoro	44.4	146	4.18	42.2	146	40.7	140	–0.44	–0.75	–0.34	–0.79
Mtwara	43.5	91	3.64	41.8	91	40.7	89	–0.35	–0.56	–0.27	–0.58
Mwanza	38.7	242	4.38	36.7	247	35.3	238	–0.40	–0.67	–0.31	–0.71
Pwani (Coast)	31.7	55	3.51	30.5	57	29.8	55	–0.24	–0.39	–0.19	–0.41
Rukwa	50.4	156	4.32	47.8	176	46.2	170	–0.51	–0.85	–0.39	–0.90
Ruvuma	46.2	106	4.04	43.9	113	42.2	109	–0.46	–0.80	–0.35	–0.85
Shinyanga	43.3	357	5.13	40.9	408	39.5	394	–0.48	–0.77	–0.38	–0.81
Singida	39.0	89	4.48	37.2	87	36.2	85	–0.36	–0.56	–0.29	–0.59
Tabora	33.6	170	5.25	31.6	190	30.4	183	–0.40	–0.63	–0.31	–0.67
Tanga	49.4	145	3.57	47.2	145	45.7	141	–0.43	–0.73	–0.33	0.78

Source: See text.

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