AN INVESTMENT FRAMEWORK FOR NUTRITION IN UGANDA: REDUCING STUNTING AND OTHER FORMS OF CHILD MALNUTRITION

DISCUSSION PAPER
OCTOBER 2016

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WORLD BANK GROUP
Health, Nutrition & Population

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Health, Nutrition and Population (HNP) Discussion Paper

An Investment Framework for Nutrition in Uganda:
Reducing Stunting and Other Forms of Child Malnutrition

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Abstract: This paper builds on global experience and Uganda's specific context to estimate costs, benefits, and cost-effectiveness of key nutrition interventions. It is intended to help guide the selection of the most cost-effective interventions as well as strategies for scaling these up. The paper considers both relevant "nutrition-specific" interventions, largely delivered through the health sector, and multisectoral "nutrition-sensitive" interventions, delivered through other sectors such as agriculture, education, and water and sanitation. We estimate that the costs and benefits of implementing 10 nutrition-specific interventions in all regions of Uganda would require a yearly public investment of $68 million. The expected benefits are enormous: annually over 8,000 lives would be saved, while at least 375,000 DALYs and 8,700 cases of stunting among children under five would be averted. Economic productivity could potentially increase by $280 million annually over the productive lives of the beneficiaries, with an impressive internal rate of return of 18 percent. However, because it is unlikely that the Government of Uganda or its partners will be able to find the $68 million necessary to reach full coverage, we also consider scale-up scenarios based on considerations of their potential for impact, burden of stunting, resource requirements, and implementation capacity. The most cost-effective scenario considered would provide a subset of key interventions in regions with the highest rates of stunting and would cost between $19 and $60 million, depending on how many regions are covered. We then identify and cost five nutrition-sensitive interventions relevant to Uganda for which there is both evidence of positive impact on nutrition outcomes and some cost information. These findings point to a powerful set of nutrition-specific interventions and a candidate list of nutrition-sensitive approaches that represent a highly cost-effective approach to reducing child malnutrition in Uganda.

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ACKNOWLEDGMENTS

ABBREVIATIONS AND ACRONYMS

BMGF	Bill & Melinda Gates Foundation
COHA	Cost of Hunger in Africa
COMESA	Common Market for Eastern and Southern Africa
DALYs	disability-adjusted life years
DCP2	Disease Control Priorities Project
DFID	Department for International Development
DHS	Demographic and Health Survey
FANTA-2	Food and Nutrition Technical Assistance II Project
FAO	United Nations Food and Agriculture Organization
GAFSP	Global Agriculture and Food Security Program
GBD	global burden of disease
GDP	gross domestic product
GHE	Global Health Estimates
GNI	gross national income
HNP	Health, Nutrition and Population
IFPRI	International Food Policy Research Institute
IHME	Institute for Health Metrics and Evaluation
IITA	International Institute for Tropical Agriculture
LDF	lifetime discount factor
LiST	Lives Saved Tool
M&E	monitoring and evaluation
MNCH	maternal, newborn and child health
NIH	National Institutes of Health
NPV	net present value
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
ORS	oral rehydration solution
PAF	population attributable fractions
SUN	Scaling Up Nutrition
UBOS	Uganda Bureau of Statistics
UNAP	Uganda Nutrition Action Plan
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WASH	water, sanitation and hygiene
WAZ	weight-for-age Z-score
WFP	World Food Program
WHO	World Health Organization
WHO-CHOICE	Choosing Interventions that are Cost-Effective
WHZ	weight-for-height Z-score
YLD	years of life spent with disability (from a disease)
YLL	years of life lost (from a disease)

All dollar amounts are U.S. dollars.

GLOSSARY OF TECHNICAL TERMS

Aflatoxins are a group of toxic compounds produced by certain molds, especially *Aspergillus flavus*, which contaminate stored food supplies such as animal feed, maize, and peanuts. Research shows that human consumption of high levels of aflatoxins can lead to liver cirrhosis (Kuniholm et al. 2008) and liver cancer in adults (Abt Associates 2014). It is widely understood that there is a relationship between aflatoxin exposure and child stunting, but this relationship has not yet been adequately quantified in the published literature (Abt Associates 2014; Unnevehr and Grace 2013).

A **benefit-cost ratio** summarizes the overall value of a project or proposal. It is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. The benefit-cost ratio takes into account the amount of monetary gain realized by implementing a project versus the amount it costs to execute the project. The higher the ratio, the better the investment. A general rule is that if the benefit from a project is greater than its cost, the project is a good investment.

Biocontrol (also called *biological control*) is the use of an invasive agent to reduce pest or mold population below a desired level. Aflatoxins can be reduced through biocontrol; the most effective method involves a single application of a product (such as aflasafe™) that contains strains unique to the specific country or location.

Biofortification is the breeding of crops to increase their nutritional value. This can be done either through conventional selective breeding or through genetic engineering.

Capacity development for program delivery is a process that involves increasing in-country human capacity and systems to design, deliver, manage, and evaluate large-scale interventions (World Bank 2010). This includes developing skills by training public health personnel and community volunteers to improve the delivery of services. These efforts typically accompany program implementation or, when possible, precede program implementation. In this costing analysis we allocate 9 percent of total programmatic costs to capacity development for program delivery.

Cost-benefit analysis is an approach to economic analysis that weighs the cost of an intervention against its benefits. The approach involves assigning a monetary value to the benefits of an intervention and estimating the expected present value of the net benefits, known as the *net present value*. Net benefits are the difference between the cost and monetary value of benefits of the intervention. The net present value is defined mathematically as:

$$Net\ present\ value = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

where C_t is net cash inflows, C_0 is the initial investment, the index t is the time period, and r is the discount rate. A positive net present value, when discounted at appropriate rates, indicates that the present value of cash inflows (benefits) exceeds the present value of cash outflows (cost of financing). Interventions with net present values that are at least as high as alternative interventions provide greater benefits than interventions with net present values equal to or lower than alternatives. The results of cost-benefit analysis can also be expressed in terms of the benefit-cost ratio.

Cost-effectiveness analysis is an approach to economic analysis that is intended to identify interventions that produce the desired results at the lowest cost. Cost-effectiveness analysis requires two components: the total cost of the intervention and an estimate of the intervention's impact, such as the number of lives saved. The cost-effectiveness ratio can be defined as:

$$\text{Cost-effectiveness ratio} = \frac{total\ cost\ of\ implementing\ the\ intervention}{impact\ of\ the\ intervention\ on\ a\ specific\ outcome}$$

The analysis involves comparing the cost-effectiveness ratios among alternative interventions with the same outcomes. The intervention with the lowest cost per benefit is considered to be the most cost-effective intervention among the alternatives.

A **DALY** is a **disability-adjusted life year**, which is equivalent to a year of healthy life lost due to a health condition. The DALY, developed in 1993 by the World Bank, combines the years of life lost from a disease (YLL) and the years of life spent with disability from the disease (YLD). DALYs count the gains from both mortality (how many more years of life lost due to premature death are prevented) and morbidity (how many years or parts of years of life lost due to disability are prevented). An advantage of the DALY is that it is a metric that is recognized and understood by external audiences such as the World Health Organization (WHO) and the National Institutes of Health (NIH). It helps to gauge the contribution of individual diseases relative to the overall burden of disease by geographic region or health area. Combined with cost data, DALYs allow for estimating and comparing the cost-effectiveness of scaling up nutrition interventions in different countries.

A **discount rate** refers to a rate of interest used to determine the current value of future cash flows. The concept of the time value of money suggests that income earned in the present is worth more than the same amount of income earned in the future because of its earning potential. A higher discount rate reflects higher losses to potential benefits from alternative investments in capital. A higher discount rate may also reflect a greater risk premium of the intervention.

The **internal rate of return** is the discount rate that produces a net present value of cash flows equal to zero. An intervention has a non-negative net present value when the internal rate of return equals or exceeds the appropriate discount rate. Interventions yielding higher internal rates of return than alternatives tend to be considered more desirable than the alternatives.

The **Lives Saved Tool (LiST)** is an estimation tool that translates measured coverage changes into estimates of mortality reduction and cases of childhood stunting averted. LiST is used to project how increasing intervention coverage would impact child and maternal survival. It is part of an integrated set of tools that comprise the Spectrum policy modeling system.

Monitoring and evaluation, operations research, and **technical support for program delivery** are all elements of cost-effective and efficient program implementation**. Monitoring** involves checking progress against plans through the systematic and routine collection of information from projects and programs in order to learn from experience to improve practices and activities in the future, to ensure internal and external accountability of the resources used and the results obtained, and to make informed decisions on the future of the intervention. Monitoring is a periodically recurring task. **Evaluation** is the assessing, as systematically and objectively as possible, of a completed project or intervention (or a phase of an ongoing project). **Operations research** aims to inform the program designers about ways to deliver interventions

more effectively and efficiently. **Technical support** entails ensuring that training, support, and maintenance for the physical elements of the intervention are available. In this costing exercise we allocate 2 percent of total intervention costs for monitoring and evaluation, operations research, and technical support.

Nutrition-sensitive interventions are those that have an indirect impact on nutrition and are delivered through sectors other than health such as the agriculture, education, and water, sanitation, and hygiene sectors. Examples include biofortification of food crops, conditional cash transfers, and water and sanitation infrastructure improvements.

Nutrition-specific interventions are those that address the immediate determinants of child nutrition, such as adequate food and nutrition intake, feeding and caregiving practices, and treating disease. Examples include community nutrition programs, micronutrient supplementation, and deworming.

Sensitivity analysis is a technique that evaluates the robustness of findings when key variables change. It helps to identify the variables with the greatest and least influence on the outcomes of the intervention, and it may involve adjusting the values of a variable to observe the impact of the variable on the outcome.

Stunting is an anthropometric measure of low height-for-age. It is an indicator of chronic undernutrition and is the result of prolonged food deprivation and/or disease or illness. It is measured in terms of Z-score (or standard deviation score; see definition below); a child is considered stunted with a height-for-age Z-score of −2 or lower.

Underweight is an anthropometric measure of low weight-for-age. It is used as a composite indicator to reflect both acute and chronic undernutrition, although it cannot distinguish between them. It is measured in terms of Z-score (or standard deviation score; see definition below); a child is considered underweight with a weight-for-age Z-score of −2 or lower.

Wasting is an anthropometric indicator of low weight-for-height. It is an indicator of acute undernutrition and the result of more recent food deprivation or illness. It is measured in terms of Z-score (or standard deviation score; see definition below). A child with a weight-for-height Z-score of −2 or lower is considered wasted.

A **Z-score** or **standard deviation score** is a calculation used to explain deviations from an established norm. It is calculated with the following formula:

$$Z\text{-}score = \frac{(observed\ value) - (median\ reference\ value)}{standard\ deviation\ of\ reference\ population}$$

EXECUTIVE SUMMARY

The overall objective of this report is to support the Government of Uganda in developing a costed scale-up plan for nutrition. It builds on the recently developed the Uganda Nutrition Action Plan (UNAP) by costing the interventions proposed therein. The goal is for this analysis to serve as an input into the strategic multisectoral plan to fight malnutrition currently in development. The executive summary is written for policy makers; it highlights the study's main findings and discusses their implications for nutrition policy in Uganda. The paper itself is more technical in nature and is written for planners and programmers. The analysis is expected to bring evidence of potential for impact and allocative efficiency into nutrition programming in Uganda.

One-third of Ugandan children under the age of five were chronically undernourished in 2011 as measured by stunting. Although this represents steady improvement from 39 percent in 2000, Uganda still compares unfavorably with neighbor and peer countries, suggesting that better nutritional outcomes can be expected even without improving incomes. Micronutrient deficiencies (*hidden hunger*) are also prevalent, with vitamin A deficiency and anemia rates particularly high among young children and women.

Malnutrition, particularly in very young children, leads to increased mortality rates, increased illness, and longer-term effects on cognitive abilities. These effects produce irreversible losses to human capital that contribute to later losses in economic productivity. Undernutrition is responsible for about 60 percent of under-five child mortality and at least one-fourth of maternal mortality in Uganda (FANTA-2 2010). Children who have been malnourished early in life are more likely to experience cognitive deficiencies and poor schooling outcomes. In the longer term, stunting results in a loss of 10 to 17 percent in wages earned over a lifetime. In Uganda the combined effects of stunting and micronutrient deficiencies were estimated to cost $899 million, or about 5.6 percent of the country's GDP, in 2009 (COHA 2012).

At the same time, high-impact nutrition interventions are consistently identified as being among the most cost-effective development actions, with a huge potential to contribute to the World Bank Group's twin goals of reducing poverty and boosting shared prosperity. Cost-benefit analysis shows that nutrition interventions are highly effective (Hoddinott et al. 2013; World Bank 2010). It is estimated that investing in nutrition can increase a country's GDP by 3 to 11 percent annually (Horton and Steckel 2013). Stunted children are less likely to attend school, more likely to drop out, and less likely to be able to learn when in school, thereby compromising future human capital and national productivity. On the other hand, investments in early nutrition lock in human capital for life and help drive future productivity and growth. Evidence also shows that these early investments in nutrition have the potential to boost wage rates by 5 to 50 percent, supercharge the demographic, make children 33 percent more likely to escape poverty in the future, and address gender inequities.

The costs of scaling up nutrition interventions are modest, especially when compared with the potential benefits. At a global level, the cost of scaling up key nutrition interventions across 68 high-burden countries is estimated at $10.3 billion per annum (World Bank 2010). These investments would provide preventive nutrition services to about 356 million children, save at least 1.1 million lives, avert 30 million disability-adjusted life years (DALYs), and reduce the number of stunted children by about 30 million worldwide (World Bank 2010).

This report builds on global estimates to identify costs and benefits of key nutrition programs in Uganda and is intended to help guide the selection of the most cost-effective interventions and

scenarios for scaling these up. The report uses the costing framework established by *Scaling Up Nutrition: What Will It Cost?* (World Bank 2010) as a starting point, and applies this framework to the country-specific context of Uganda. Combining costing with estimates of impact (in terms of lives saved, DALYs averted, and cases of stunting averted) and cost-effectiveness analysis will make the case for nutrition stronger and aid in priority-setting by identifying the most cost-effective packages of interventions in situations where financial and human resources are constrained.

We first estimate the costs and benefits of implementing 10 nutrition-specific interventions in all regions of Uganda.[1] We refer to this as *full coverage* and estimate that it would require an annual public investment of $68 million. The expected benefits are enormous: over 8,000 lives would be saved annually, while at least 375,000 DALYs and 211,000 cases of stunting among children under five would be averted. *This investment of $68 million also has the potential to increase economic productivity by $280 million annually over the productive lives of the beneficiaries and to yield an impressive internal rate of return on the investment of 18 percent.*

Given resource constraints, however, few countries are able to effectively scale-up all 10 nutrition-specific interventions to full national coverage immediately. We therefore consider three potential scale-up scenarios, based on considerations of burden of stunting, potential for impact, costs, and capacity for implementation in Uganda:

- Scenario 1: Scale up by region
- Scenario 2: Scale up by intervention
- Scenario 3: Scale up by region and intervention

When considered in terms of resource requirements and cost-effectiveness (cost per benefit unit), three scenarios stand out as equally cost-effective and the choice between them will depend on the amount of resources available for nutrition interventions (see Box 1). The first would scale up nationwide all interventions except the public provision of complementary food for the prevention of moderate acute malnutrition; this scenario would require an annual public investment of $60 million. The second requires fewer resources ($45 million) and would provide the same set of cost-effective interventions in the seven regions where stunting rates are higher than 30 percent. The third would require even fewer resources ($19 million) and would target only the three regions with stunting rates above 40 percent.

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[1] The 10 nutrition-specific interventions are community nutrition programs for growth promotion, vitamin A supplementation, therapeutic zinc supplement with oral rehydration solution, micronutrient powders, deworming, iron-folic acid supplementation for pregnant women, iron fortification of staples, salt iodization for the general population, public provision of complementary food for prevention of moderate acute malnutrition, and community-based management of severe acute malnutrition in children.

Recognizing the difficulty of scaling to full coverage in one year, we consider the costs of scaling up over five years for the most attractive scenarios. The resources required over five years range from $54 to $168 million. These total five-year costs are significantly less than the $188 million needed for full coverage, but still represent a significant increase over current spending on nutrition in Uganda. Interventions are assumed to scale from current coverage as follows: 20 percent of coverage in Year 1, 40 percent in Year 2, 60 percent in Year 3, 80 percent in Year 4, and 100 percent in Year 5.

A critical next step will be to identify potential sources of financing for the enormous gap between what is currently being invested in nutrition interventions and the most modest of the scale-up scenarios proposed here. The cost-effectiveness analysis presented here identifies a large financing gap over five years above and beyond the $20 million of government budget plans for the four years 2013–16 (Table 15). The additional Global Agriculture and Food Security Program (GAFSP) funding of $27.6 million over the next five years is a large contribution toward closing the gap, but additional resources will need to be mobilized to cover the additional costs identified in this analysis.

Although every attempt has been made to use real programming costs for these estimates, the costs presented here are likely to be slight overestimates, while the benefits are likely to be underestimated. In many cases, actual program costs will

Box 1: Three Cost-Effective Scale-Up Options

If full coverage is not immediately feasible, three gradual scale-up scenarios are equally cost-effective:

<u>**Greatest Benefits:**</u> Scale up a subset of the most cost-effective interventions nationwide (Scenario 2):
- **$60 million** required annually ($168 million over five years)
- 337,000 life years saved*
- 8,200 lives saved
- *cost per life year saved = $185*

<u>**Moderate Benefits:**</u> Scale up the same subset of the most cost-effective interventions in the seven highest- and middle-burden burden regions (Scenario 3a):
- **$45 million** required annually ($125 million over five years)
- 254,000 life years saved*
- 6,200 lives saved
- *cost per life year saved = $182*

<u>**Lowest Cost:**</u> Scale up a subset of the most cost-effective interventions in only the three highest-burden regions:
- **$19 million** required annually ($54 million over five years)
- 108,000 life years saved*
- 2,700 lives saved
- *cost per life year saved = $182*

*Life years adjusted for disability (DALYs)

be lower than estimated because these programs can be added to existing ones. Program experience shows that the incremental costs of adding to an existing program are lower than the cost of starting an entirely new program because existing implementation arrangements can be used, thereby minimizing costs for staffing, operations, and training. The estimate of costs presented here is therefore high because it does not account for expected economies of scale. With respect to the benefits of these programs, estimates are likely to be underestimates of the true benefits because the LiST tool we use has limitations, making it possible to estimate the full benefits of only some of the interventions that are proposed to be scaled up.

This analysis takes an innovative approach to nutrition costing by not only estimating the costs and benefits of nutrition-specific interventions, but also exploring costs for selected nutrition-

sensitive interventions implemented outside of the health sector. While recognizing that the evidence base for the impact of nutrition-sensitive interventions is less conclusive than the evidence for nutrition-specific interventions, we consider four nutrition-sensitive interventions in other sectors that have shown some potential for improving nutrition outcomes. These include the biofortification of vitamin A–rich orange sweet potatoes and aflatoxin control in maize. Although interventions to promote the cultivation of iron-rich beans are underway in Uganda and show tremendous potential, we were not able to include this intervention in our analysis. In the education sector, school-based deworming and school-based promotion of good hygiene are considered. The estimated costs we report must be considered rough approximations because there are significant limitations in the available data and in the methodological approaches. In addition, we were not able to estimate the benefits of these interventions because of data and methodological shortcomings, although we do report benefits calculated by others. Overall, more robust data on nutrition-sensitive interventions are needed to inform future scale-up priorities.

These findings point to a powerful set of nutrition-specific interventions and a candidate list of nutrition-sensitive approaches that, taken together, represent a highly cost-effective approach to reducing the high levels of child malnutrition in Uganda. Some nutrition-specific and nutrition-sensitive (e.g. Feed the Future) activities are currently being implemented in Uganda by the Government, donors, and partners, yet they are not carried out at scale and not always in alignment with the National Nutrition Action Plan. Many of these efforts are still at the pilot phase and lack the coordination and funds needed for maximum scale-up to achieve optimal nutrition outcomes. Critical next steps for the Government of Uganda and its partners are to develop a road map of key actions to pursue, to identify milestones to be reached in addressing undernutrition in the country, and to implement a business plan to mobilize funds to scale up the high-impact intervention package identified in this report.

PART 1 – BACKGROUND

COUNTRY CONTEXT

Uganda is a large, landlocked East African country with great economic and human potential, although currently about one-quarter of Ugandans live in poverty. Its 36.4 million inhabitants are distributed across a land area of 241,038 square kilometers. The southern part of the country borders Lake Victoria and the climate is equatorial (see Appendix 1 for a map of Uganda and its regions). Uganda gained its independence from Great Britain in 1962; since then it has suffered a lengthy civil war that has caused tens of thousands of casualties and displaced more than a million people. The Ugandan economy is dependent mainly on coffee, tea, and other agricultural exports, although it also possesses large mineral deposits (copper and cobalt), crude oil, and natural gas. Between 2003 and 2011 the economy grew at over 6 percent per year, although the growth rate in 2012 was only 3.4 percent. The GDP per capita of $696 in 2014 (World Bank 2014b) does not reflect the poor living conditions for most. Uganda ranked 164th out of 187 countries on the Human Development Index in 2013 (UNDP 2015).

HEALTH AND NUTRITIONAL STATUS IN UGANDA

Overall, the health status of Ugandans has been improving in recent years, although the civil conflict and other factors have slowed improvements. Life expectancy was 58 years in 2012, up from 49 in 2001. Under-five mortality was 69 per 1,000 live births in 2012, down from 140 in 2001. The infant mortality rate was 45 per 1,000 live births in 2012, having dropped from 85 in 2001 (World Bank 2014b). Figure 1 shows that child mortality declined by over 6 percent in Uganda between 2005 and 2010, a rate that surpassed many of its neighbors.

Figure 1. Changes in Child Mortality, Selected Countries in Sub-Saharan Africa, 2005–10
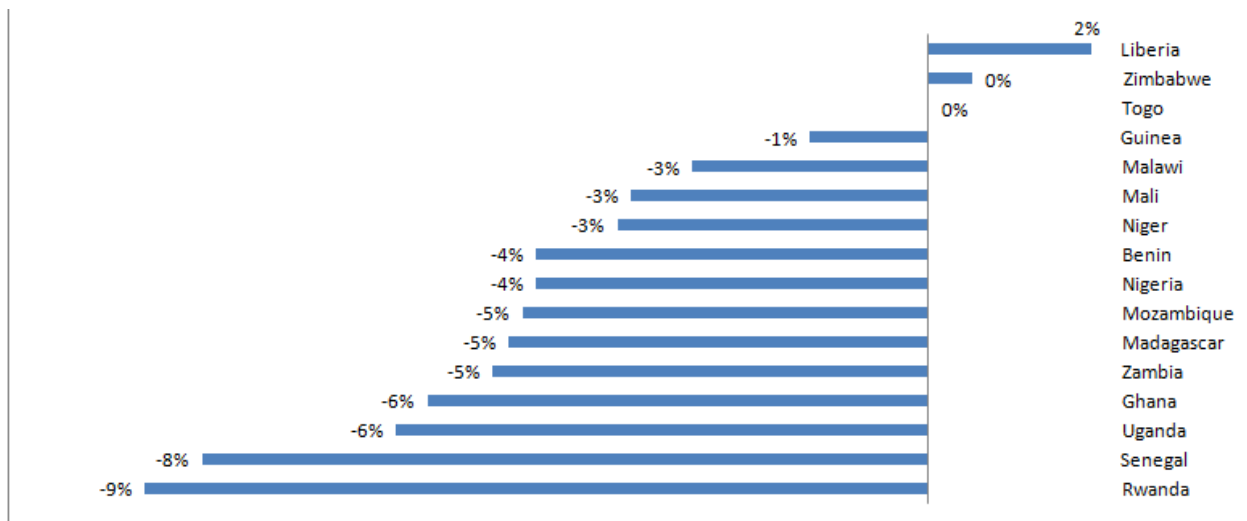
Source: World Bank analysis, based on DHS data sets.

Nevertheless, one-third of Ugandan children under the age of five were chronically undernourished in 2011 as measured by stunting (Figure 2).[2] Although this is still a high rate of stunting, it represents steady improvement from 39 percent in 2000. The share of children who were underweight also declined from 23 percent in 2000 to 14 percent in 2011. Wasting, which represents acute or recent short-term malnutrition, remained virtually unchanged during the same period. Although gains have been made, Uganda still compares unfavorably with neighbor and peer countries, suggesting that better nutritional outcomes can be expected even without improving incomes (Figure 3).

Figure 2. Rates of Stunting, Wasting, and Underweight in Uganda, 1988–2011
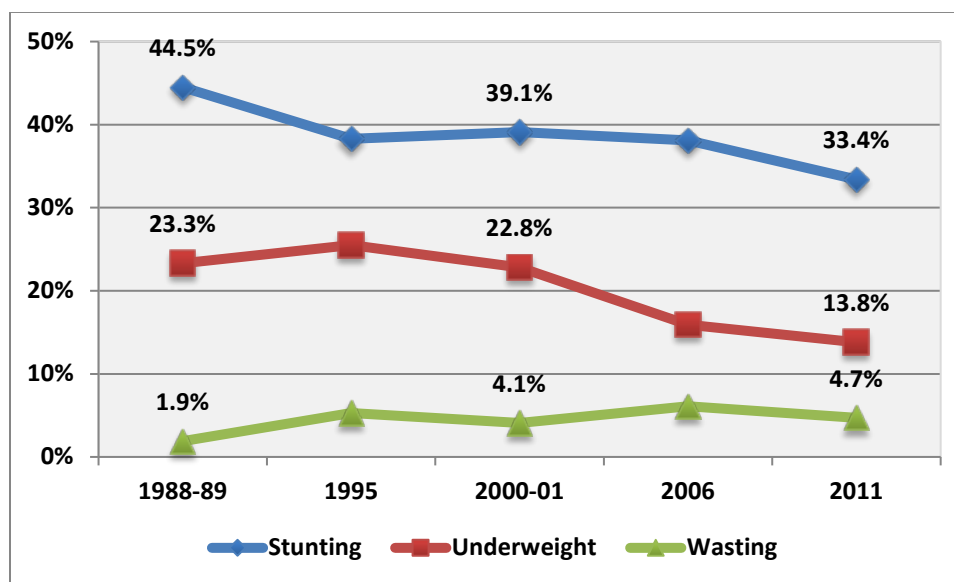
Sources: DHS 1988–2011.

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[2] The analysis in this report was completed before the 2016 Uganda DHS was undertaken. As of the final revisions of this report, the preliminary results for the 2016 survey had become available (See http://www.dhsprogram.com/publications/publication-PR80-Preliminary-Reports-Key-Indicators-Reports.cfm). These preliminary findings show that national rate of stunting in Uganda was 29 percent in 2016, for wasting was 4 percent and underweight was 11 percent. 53 percent of children under 5 were anemic in 2016 and 32 percent of women aged 15-49 percent were anemic.

Figure 3. Income and Prevalence of Stunting in Uganda and Neighboring and Peer Countries, 2008
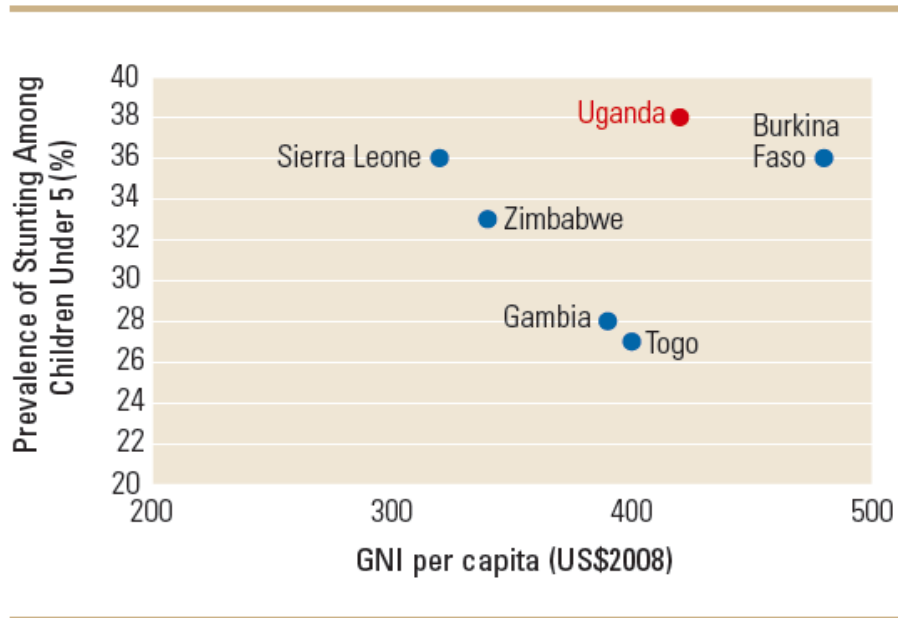
Source: World Bank 2011.

There is considerable geographic variation in the prevalence of stunting and poverty, although the patterns are different (Figure 4). Malnutrition rates are highest in the Karamoja, Western, and Southwest regions, which all have stunting rates over 40 percent. Poverty rates are also highest in Karamoja, where over 75 percent of people live in poverty. But poverty rates are relatively lower in in Western and Southwestern provinces. The West Nile and Central 2 regions have stunting rates over 35 percent. But poverty rates are relatively lowere there. Conversely, poverty rates are high (approximately 40 percent) in the North and West Nile regions, whereas stunting rates are relatively lower there.

Figure 4. Stunting and Poverty Rates in Uganda in 2011, by Region

Stunting Rates by Region   Poverty Rates by Region
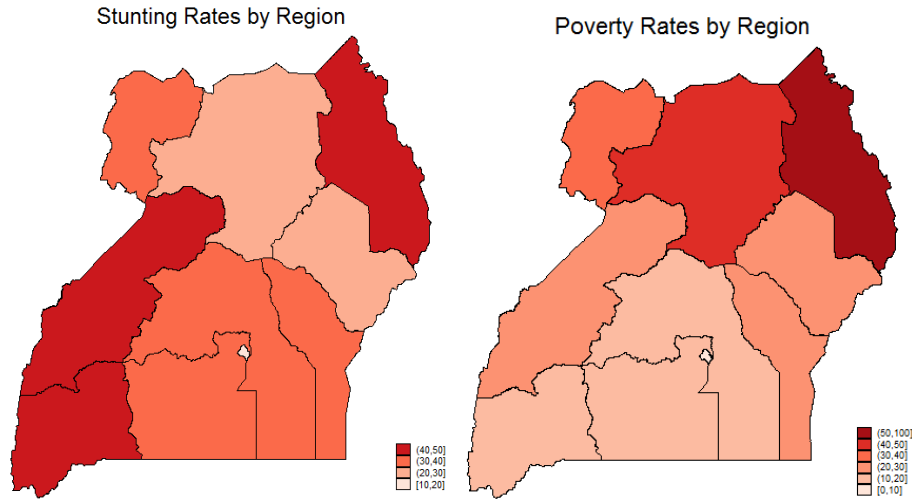
Source: Stunting and poverty rates from DHS 2011.
Note: For the stunting map: dark orange indicates a childhood stunting rate of greater 40 percent; medium orange between 30 and 40 percent; and light orange between 20 and 29 percent. For the poverty map: darkest orange indicates a poverty rate greater than 50 percent; dark orange between 40 and 49 percent; and medium orange between 30 and 39 percent; and paler orange between 29 and 20 percent.

Although income and malnutrition are related in Uganda, other factors—such as feeding practices—also influence malnutrition. The prevalence of stunting in the poorest households is three times the prevalence in the richest households (Figure 5). Stunting prevalence among households in the poorest quintile is almost twice as high as that for households in richest quintile. However, even among households in the richest quintile, 21 percent of children are stunted. This highlights the fact that undernutrition is not limited to impoverished households, underscoring the importance of effectively communicating the need for optimal child feeding and caregiving practices.

Figure 5. Stunting Prevalence among Children Under Five by Wealth Quintiles, 2011
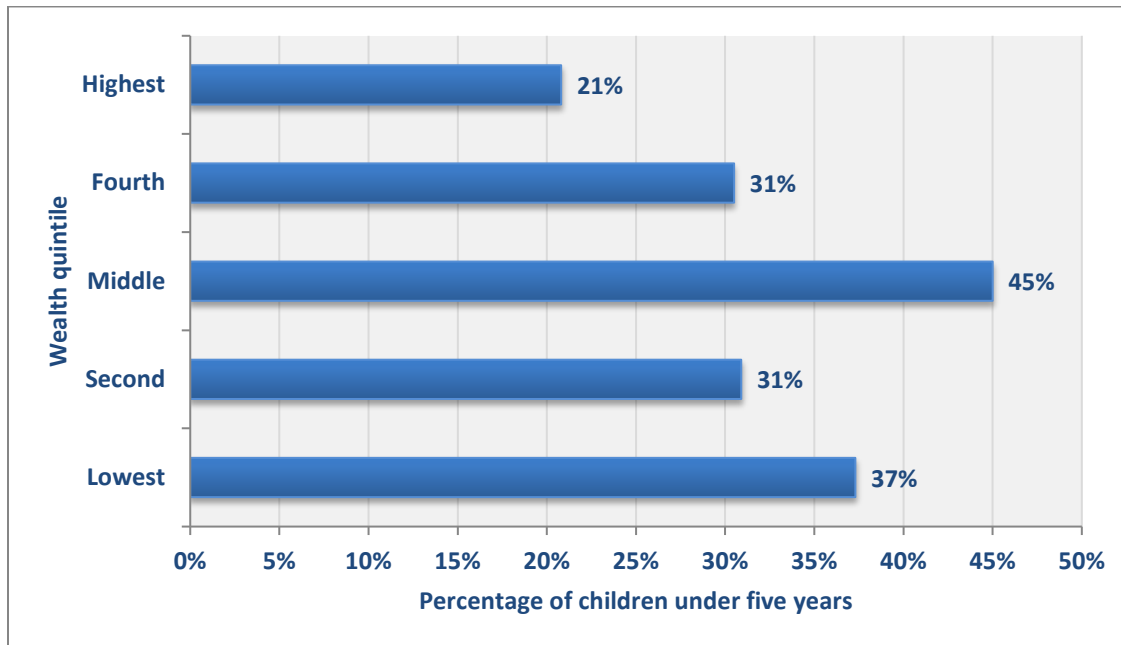
Source: DHS 2011.

Although not visible to the naked eye, vitamin and mineral deficiencies (hidden hunger) remain pervasive in Uganda. About half of all children under five and about one-fifth of women of childbearing age were anemic in 2011; this represents a significant improvement from 2006 (Figure 6). Twenty percent of preschool-aged children and 19 percent of pregnant women were deficient in vitamin A in 2006 (DHS 2006).[3] Vitamin A deficiency is well documented as a leading cause of morbidity and mortality among children: it increases the severity of infections; slows recovery from illness; and, in extreme cases, causes blindness and death (Fawzi et al. 1993; Sommers, Katz, and Tarwotjo 1984; Sommers and West 1996). Nationally almost all children (99 percent) live in households that use iodized salt (DHS 2011).

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[3] It is not possible to compare 2001 and 2006 results for vitamin A deficiency because the methodology changed between the two surveys. The results on vitamin A deficiency from the 2011 DHS are not reported because they are not considered reliable. Heavy rains during and after data collection are thought to have compromised the quality of the data samples (DHS 2011).

Figure 6. Prevalence of Anemia, 2006 and 2011
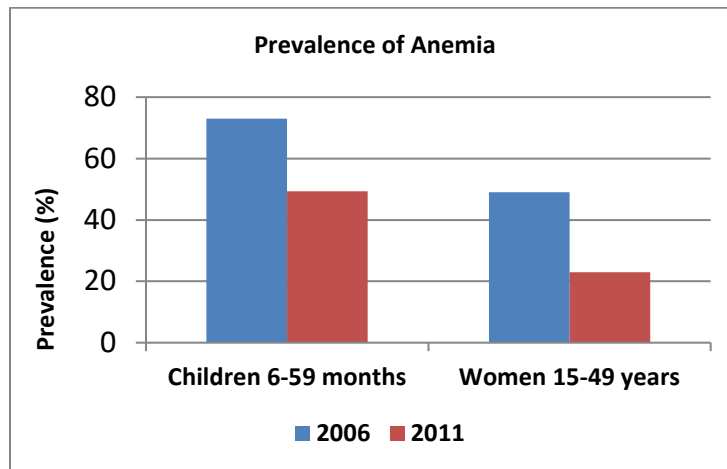
Sources: DHS 2011, 2006.

Another health burden in Uganda is the presence of high levels of aflatoxins—naturally occurring carcinogenic byproducts of common fungi on crops—in maize and groundnuts. An article reviewing recent research on aflatoxin prevalence in Uganda finds that the majority of maize and groundnut samples test positive for aflatoxins and that prevalence levels often exceed the WHO/FDA safety threshold of 20 parts per billion (Kaaya and Warren 2005). Another study of mean aflatoxin levels in a variety of groundnut forms in markets finds mean levels well above 20 parts per billion (Kaaya, Eigel, and Harris 2006). Consumption of high levels of aflatoxin can lead to growth impairment in children (Khlangwiset 2011) as well as liver cirrhosis (Kuniholm et al. 2008) and liver cancer in adults (Abt Associates 2014). It is widely understood that there is a relationship between aflatoxin exposure and stunting, but this has not been quantified in the published literature (Abt Associates 2014; Unnevehr and Grace 2013).

Parasitic intestinal worms also pose a significant nutritional problem in Uganda. A national prevalence study conducted between 1998 and 2005 finds that 55 percent of school-aged children in Uganda were infected with at least one species of intestinal worm. Most prevalent was hookworm, and there was little variation by region in prevalence of hookworms (Kabatereine et al. 2005). In the short term, parasitic worm infections can cause anemia and increase morbidity, undernutrition, and the impairment of mental and physical development (Hotez et al. 2008). In the long term, infected children are estimated to have an average IQ loss of 3.75 points per child and they earn less as adults (43 percent less) than those who grow up free of worms (Bleakley 2007).

Deworming programs have recently expanded coverage in response to the problem: the number of children receiving deworming medication increased dramatically between 2006 and 2011. In 2011, half of all children aged 6 to 59 months had received deworming medication in the previous 6 months, although there was significant regional variation with Karamoja, Kampala, and Western regions having the highest rates, as shown in Figure 7 (DHS 2006, 2011). There are no figures on what proportion of school-aged children receive deworming medication, although intestinal parasite infections tend to be most prevalent and intense in this cohort (Bundy 2011).

Figure 7. Percentage of Children Aged 6 to 59 Months Receiving Deworming Medication in the Previous 6 Months by Region, 2006 and 2011
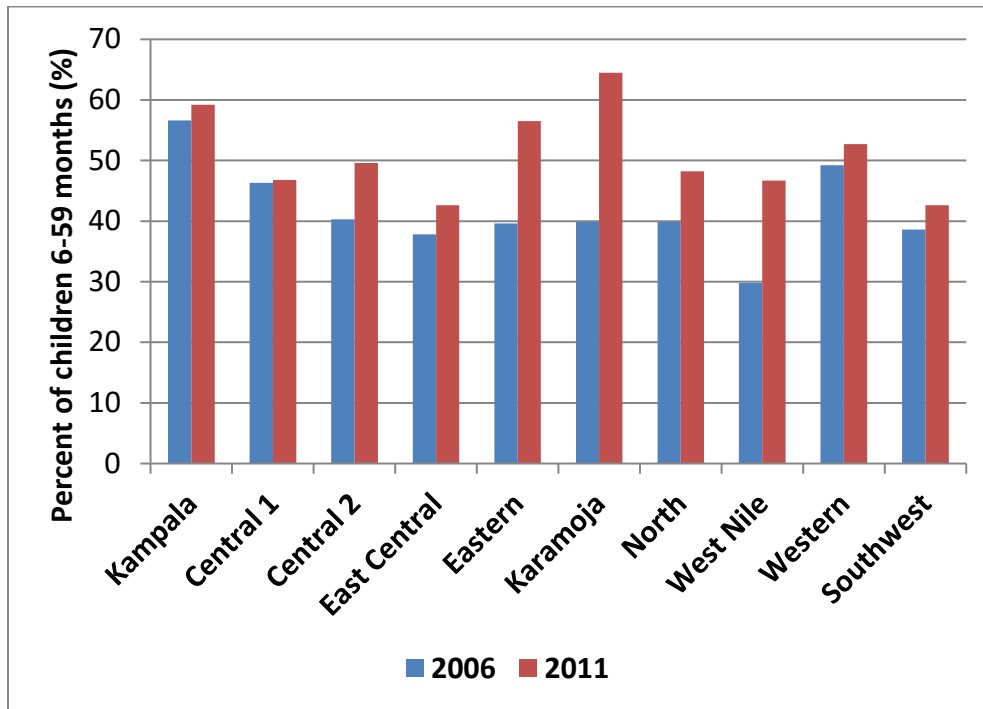
Sources: DHS 2006, 2011.

THE IMPORTANCE OF INVESTING IN NUTRITION

Undernutrition is an underlying cause of approximately half of the deaths of children under five and one-fifth of maternal deaths in developing countries. The joint effect of suboptimum breastfeeding and fetal growth restriction in the neonatal period alone contributes 1.3 million deaths or 19 percent of all deaths of children under five (Black et al. 2013). Undernourished children are more likely to die from illnesses such as diarrhea, measles, pneumonia, malaria, and HIV/AIDS. Child and maternal malnutrition accounts for over 10 percent of all disability-adjusted life years (DALYs) in Uganda. This is the second biggest risk factor affecting DALYs in Uganda (after unsafe sex) (IHME 2010).

Those malnourished children who survive face long-lasting health and schooling consequences, including cognitive deficits and poorer schooling outcomes. Children with impaired cognitive skills have lower school enrollment, attendance, and graduation, which in turn results in lower productivity, earnings, and economic well-being. Stunted children lose 0.7 grades of schooling and are more likely to drop out of school. An adequate intake of micronutrients—particularly iron, vitamin A, iodine, and zinc—is critical for growth and cognitive development. Iodine- deficient children lose on average 13 IQ points, and iron deficiency anemia reduces performance on tests by 8 IQ points, making these children less educable and less productive in the long run (World Bank 2006). Behrman et al. (2009) show improved schooling and test scores from supplementation in early childhood.

Malnutrition costs developing countries billions of dollars in lost revenue through reduced economic productivity, particularly through lower wages, lower physical and mental capabilities, and more days away from work as a result of illness. The Cost of Hunger in Uganda study estimated the annual cost of child malnutrition at $899 or about 5.6 percent of Uganda's GDP in 2009 (COHA 2012). At the individual level, childhood stunting is estimated to reduce a person's potential lifetime earnings by at least 10 percent (World Bank 2006). Other studies have shown that a 1 percent loss in adult height results in a 2 to 2.4 percent loss in productivity (Caulfield et al. 2004; Strauss and Thomas 1998). In addition, micronutrient deficiencies in childhood and adulthood have tremendous economic cost for both individuals and countries. Childhood anemia alone is associated with a 2.5 percent drop in adult wages. Anemia in adults has been estimated to be equivalent to 0.6 percent of GDP; this estimate goes up to 3.4 percent when including the secondary effects of retarded cognitive development in children (Horton 1999). Horton and Ross (2003) estimate that eliminating iron-deficiency anemia would result in a 5 to 17 percent increase in adult productivity. Micronutrient deficiencies in Uganda collectively add up to an estimated loss of over $145 million in GDP every year (World Bank 2011). The economic costs of undernutrition have the greatest effect on the most vulnerable in the developing world. A recent analysis estimates these losses at up to 11 percent of GDP in Africa and Asia each year (Horton and Steckel 2013)—equivalent to about $149 billion of productivity losses.

Investing in early childhood nutrition interventions has the potential to supercharge the potential demographic dividend in Uganda. The term *demographic dividend* refers to the growth in a country's economy that results from certain changes in the age structure, leading to a youth bulge and reduced dependency ratios in the population. This dividend is more likely to be realized if these cohorts are better nourished and productive. By increasing investment in human capital as fertility rates decline, Uganda could potentially harness its demographic dividend.

Because most of the detrimental effects of malnutrition that occur in the first 1,000 days of a child's life are essentially irreversible, the window of opportunity for preventing malnutrition is the first 1,000 days, until the child is two years of age. After that age, most actions are too little, too late, and too expensive (Black et al. 2008, 2013; World Bank 2006). Figure 8 shows that the rates of return from nutrition investments are highest for programs targeting the earliest years, since these investments build a foundation for future learning and productivity, prevent irreversible losses, and lock in human capital for life (Heckman and Masterov 2004).

Figure 8. Rates of Return to Investment in Human Capital
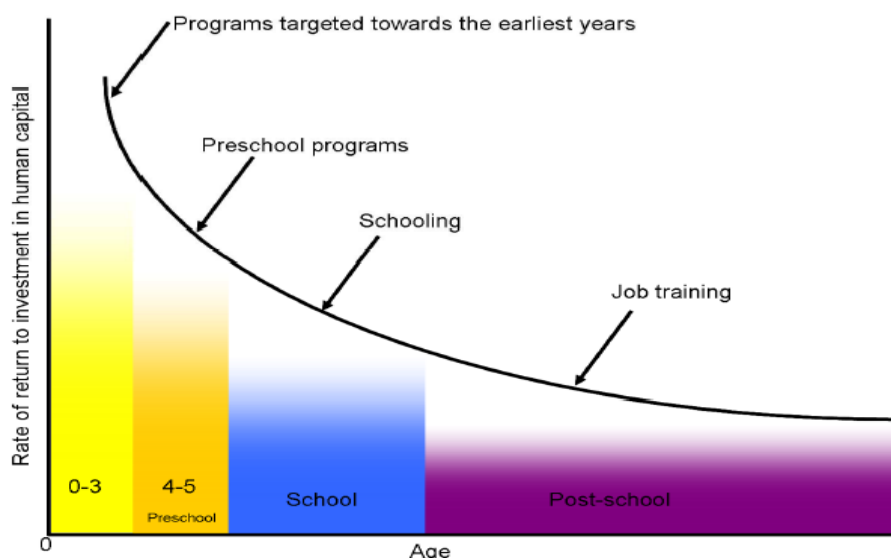
Source: Heckman and Masterov 2004.
Note: Age refers to the child's age from birth, depicted in years for infancy and preschool, then in aggregate for school age and adulthood.

Malnutrition and poverty are interrelated and exacerbate each other. A recent study (Hoddinott et al. 2011) concludes that individuals who are not stunted at 36 months are one-third less likely to live in poor households as adults. Poverty increases the risk of malnutrition by lowering poor households' purchasing power, reducing access to basic health services, and exposing these households to unhealthy environments, thereby compromising food intakes (both quality and quantity) and increasing infections. Poor households are also more likely to have frequent pregnancies, larger family sizes with high dependency ratios, more infections, and increased health care costs. Conversely, malnutrition causes poor health status, poor cognitive development, and less schooling, resulting in poor human capital and long-term productivity losses. However, as Figure 5 shows, *while child stunting rates are highest among the poorest four quintiles in Uganda, even among the richest quintile more than 20 percent children are stunted.* As discussed above, this suggests that factors other than income (informational asymmetries, feeding and child-care practices, and so on) influence nutritional status.

Nutrition interventions are consistently identified as cost-effective development actions, and the costs of scaling up nutrition interventions are modest. The global benefit-cost ratio of micronutrient powders for children is 37 to 1; of deworming it is 6 to 1; of iron fortification of staples it is 8 to 1; and of salt iodization it is 30 to 1 (World Bank 2010).

A recent World Bank study estimates that investing in nutrition can increase a country's GDP by at least 3 percent annually (World Bank 2010). The same study estimates these costs at $10.3 billion per annum globally, to be financed through domestic public and private sector and donor resources. These investments would provide preventive nutrition services to about 356 million children, save at least 1.1 million lives, avert at least 30 million DALYs, and reduce the number of stunted children by about 30 million worldwide. Bhutta et al. (2013) come up with similar estimates. In another study, Hoddinott, Rosegrant, and Torero (2012) estimate that, for just $100

per child, interventions including micronutrient provision, public provision of complementary food for the prevention of moderate acute malnutrition, treatments for worms and diarrheal diseases, and behavior change programs could reduce chronic undernutrition by 36 percent in developing countries. Clearly there is huge potential pay-off for dedicating more resources to the scale-up of evidence-based, cost-effective nutrition interventions.

A MULTISECTORAL APPROACH FOR IMPROVING NUTRITION

The determinants of malnutrition are multisectoral. Therefore, to successfully and sustainably improve nutrition outcomes, a multisectoral approach is needed. At a proximate level, access to food, health, hygiene, and adequate child-care practices is key to reducing malnutrition. At a more distal level, poverty, women's status, and other social factors play important roles. It has been demonstrated that direct actions taken to address the proximate determinants of malnutrition can be enhanced by action on some of the more distal levels. For example, programs supporting improved infant and young child feeding practices will be more effective if they are complemented with programs to address gender issues by reducing women's workloads, thus allowing women more time for child care. Similarly, conditional cash transfer programs that target the poor, if designed appropriately, have the potential not just to address poverty but also to increase demand for nutrition services and good nutrition behaviors.

Although the health sector is key to delivering *nutrition-specific* interventions to the poor (such as vitamin A supplementation and deworming), multisectoral *nutrition-sensitive* actions through the agriculture sector as well as through social protection, water and sanitation, and poverty reduction programs have the potential to strengthen nutritional outcomes in several ways (Box 2). Examples of these include (1) improving the context in which the nutrition-specific interventions are delivered—for example, through investment in food systems, empowerment of women, and equitable education; (2) integrating nutrition considerations into programs in other sectors as delivery platforms (such as conditional cash transfer programs) that will potentially increase the scale and coverage of nutrition-specific interventions; and (3) increasing policy coherence through government-wide attention to policies or strategies and trade-offs, which may have positive or unintended negative consequences for nutrition. The synergy with other sectors is critical to breaking the cycle of malnutrition and sustaining the gains from direct nutrition-specific interventions (World Bank 2013b).

Guidance on costing for nutrition-sensitive interventions is currently very limited for at least two reasons. First, evidence of the effectiveness of nutrition-sensitive interventions with respect to nutritional outcomes is limited. Second, compared with nutrition-specific interventions, estimating and attributing the costs of nutrition-sensitive interventions is quite complex since these interventions have multiple objectives and improved nutrition outcomes is only one of them. Notwithstanding these limitations, the availability of costing information is crucial to assess the cost-effectiveness of these interventions. This series of papers on costing nutrition interventions makes a first-ever attempt to address these issues.

For Uganda, we identify and cost four nutrition-sensitive interventions for which there is evidence of the positive impact on nutrition outcomes, and for which there is some cost information. First, we consider two interventions delivered through the agriculture sector: biofortification of orange sweet potatoes and aflatoxin reduction through biocontrol. We then consider two interventions delivered through the education sector: school-based deworming and school-based promotion of good hygiene. Other potential nutrition-sensitive interventions, not included in this analysis due to data limitations, are the reduction of women's workloads through appropriate technologies in agriculture and water and sanitation programs that reduce the exposure to infections and childhood diseases, among others.

Uganda would be a strong candidate for scaling up the biofortification of orange sweet potatoes: sweet potato is a staple in the Ugandan diet and a pilot program in Uganda shows extremely promising results. Biofortification uses plant breeding techniques to enhance the micronutrient content of staple foods. In the case of Uganda, this involves introducing varieties of orange sweet potatoes selected to thrive in Uganda and promoting the

> **Box 2: Nutrition-Specific and Nutrition-Sensitive Interventions Distinguished**
>
> **Nutrition-specific interventions** address the immediate determinants of child nutrition, such as adequate food and nutrition intake, feeding and caregiving practices, and treating disease. Examples include:
>
> - Community nutrition programs
> - Micronutrient (e.g., vitamin A) supplementation
> - Deworming
>
> **Nutrition-sensitive interventions** are delivered through the agriculture; education; and water, sanitation, and hygiene sectors and have the potential to have an impact on nutrition outcomes more indirectly than nutrition-specific interventions. Examples include:
>
> - Biofortification (e.g., vitamin A–rich sweet potato or cassava)
> - Conditional cash transfers
> - Water and sanitation sector infrastructure improvements

substitution of these orange sweet potatoes, which are high in vitamin A, for white and yellow sweet potatoes, which are traditionally eaten in Uganda and have an extremely low vitamin content. This intervention is designed to complement vitamin A supplementation by reaching subsistence farmers. Forty-five percent of farmers in Uganda grow sweet potatoes for both consumption and sale (HarvestPlus 2012). Evaluation of the orange sweet potato biofortification program in Uganda shows high farmer adoption, a significant increase in vitamin A intake, and improvement of child vitamin A status (Arimond et al. 2011; Hotz et al. 2012b). An ex-ante cost study of biofortification in 14 countries suggests that the costs per DALY averted fall in the highly cost-effective category, particularly in South Asia and Africa (Meenakshi et al. 2010). A recent study by HarvestPlus that ranks countries according to their suitability for investment in biofortification interventions identifies Uganda as being among those countries most likely to benefit from biofortification of the orange sweet potato (Asare-Marfo et al. 2013). Uganda is also identified as a top country to benefit from vitamin A maize, high-iron beans, and high-iron pearl millet (Asare-Marfo et al. 2013), although these are not costed in this report due to lack of country-specific data. In particular, interventions to promote the cultivation of iron-rich beans are underway in Uganda and show tremendous potential. As data on costs of these interventions becomes available, it will be important to consider their cost-effectiveness.

Uganda has high rates aflatoxin exposure (COMESA 2014). Aflatoxin is a poison naturally produced by strains of fungus that occur in maize, groundnuts and other common crops produced and eaten in Uganda. It is widely understood that there is a relationship between aflatoxin

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exposure and child stunting, albeit the evidence base for this relationship is more tentative and it has not yet been adequately quantified in the published literature (Unnevehr and Grace 2013; Abt Associates 2014). However, links with liver cancer are well established: consuming high levels of aflatoxins can lead to liver cirrhosis and liver cancer in adults (Kuniholm et al. 2008; Abt Associates 2014).

Reduction of aflatoxins in maize is possible through multiple means, the most promising of which are biocontrol and improved storage and handling. Biocontrol of aflatoxins has the potential to reduce aflatoxins in maize and groundnuts by at least 80 to 90 percent (Bandyopadhyay and Cotty 2013). Field testing of biocontrol products in Burkina Faso, Kenya, Nigeria, and Senegal, although not formally published, is producing extremely positive results. The method involves a single application of a biocontrol product containing strains unique to a given country. The development of a biocontrol product for Uganda is expected to begin soon (COMESSA 2014). Improved storage and handling is another option which shows potential in trials in other countries (IFPRI 2012). In Mali, promising pre- and post-harvest interventions for groundnuts have been analyzed, including the use of improved seed varieties, better granaries, and practices such as hand sorting and drying on wooden mats (World Bank 2015).

School-based deworming has been proven to be an efficient and cost-effective intervention to address health and nutrition outcomes, with a cost per DALY saved estimated at $4.55 (J-PAL 2012). Delivering deworming tablets through schools is inexpensive because it uses existing infrastructure and delivery platforms in schools and community links with teachers. Teachers need only minimal training to safely administer the tablets, so their workloads are not significantly increased. The delivery costs of school-based deworming in schools are about $0.04 per treatment (Guyatt 2003), yet the benefits are enormous. Bi-annual deworming significantly boosted school attendance and reduced self-reported illness and anemia, while providing modest gains in height-for-age Z-scores in Kenya (J-PAL 2012). Evidence from India also suggests that deworming has the potential to reduce cases of childhood stunting and underweight (Awasthi et al. 2013). In the long term, deworming improves self-reported health, increases total schooling years, and increases earnings by 20 percent (Baird et al. 2011).

Improved hygiene behaviors through the promotion of handwashing and good hygiene behavior would decrease the risk of stunting in one in three children. Correct handwashing at critical times can reduce the severity of diarrhea by 42 to 47 percent, lower the incidence of diarrhea in children by 53 percent, and reduce the incidence of acute respiratory infections by 44 percent (World Bank 2013b). A recent campaign promoting handwashing with soap in primary schools in China, Colombia, and Egypt demonstrates significant reduction in absenteeism related to diarrhea and respiratory illness (UNICEF 2012b). A study in Brazil shows a relationship between the effects of early childhood diarrhea on later school readiness and school performance, revealing the potential long-term human and economic costs of early childhood diarrhea (Lorntz et al. 2006).

The effectiveness of promoting good hygiene behavior in schools is demonstrated by the long-term impact and broad effect of good hygiene on communities. Schools are ideal settings for hygiene education, where children can learn and sustain lifelong proper hygiene practices through peer-to-peer teaching, classroom sessions with focused training materials, and role-playing or interactive songs. A study on the long-term effect of a hygiene education program for both adults and children finds that hygiene behaviors are sustained beyond the end of an intervention. The study also finds that educated students can influence family members by sharing this information, which may in turn affect behavior change at the community level (Bolt and Cairncross 2004).

At the same time, water, sanitation and hygiene (WASH) interventions—which provide improved water sources, hygienic latrines, and behavior change communication programs—can help to reduce the incidence of diarrhea and child mortality. The World Bank argues that the reduction in diarrhea from improved WASH ultimately depends on both the quality of existing WASH infrastructure and on child mortality levels in the country (Gunther and Fink 2011). Given the high levels of child mortality in Uganda and the poor quality of its current infrastructure, it follows that WASH interventions could have a significant impact. A recent study by Chase and Ngure (2016) reviews the ways in which WASH has an impact on nutrition outcomes and suggests specific ways WASH have an improved effect on nutrition outcomes. In studying the potential benefits of scaling up WASH interventions in Uganda, the Department for International Development (DFID) cites estimates that these programs could reduce diarrhea-related DALYs by 39 percent and save an average of $7.50 per person per year in reduced health care costs (DFID 2012). Additionally, DFID claims that by reducing the time that households, and women in particular, spend gathering water, WASH interventions could save an average of 1.5 hours per household per day (DFID 2012).

GOVERNMENT AND PARTNER EFFORTS TO ADDRESS MALNUTRITION IN UGANDA

The Uganda Nutrition Action Plan (UNAP) is Uganda's framework for scaling up multisectoral efforts to establish a strong nutrition foundation for Uganda's development. UNAP's goal is to focus public resources and national efforts to bring about sharp improvements in nutrition among young children and women of reproductive age by scaling up the implementation of a package of proven and cost-effective interventions. One of the resources leveraged under UNAP is the World Bank-supervised Uganda Multisectoral Food Security and Nutrition Project which is partially financed with a grant from the Global Agriculture and Food Security Program (GAFSP). The project supports smallholder households to increase production and consumption of micronutrient-rich foods and increase utilization of community-based nutrition services. The project is delivered through the agriculture, education, and health sectors.

In Uganda, donors and nongovernmental organizations support most nutrition interventions other than wages and administration (FANTA-2 2010). The United States Agency for International Development (USAID) acts as the Scaling Up Nutrition (SUN) Donor Convener and is the lead agency for the U.S. Government's global hunger and food security initiative, Feed the Future. Several Feed the Future-funded nutrition projects are being implemented by nongovernmental organizations in Uganda, including the Food and Nutrition Technical Assistance (FANTA)-III, Strengthening Partnerships and Results in Nutrition Globally (SPRING), and Production for Improved Nutrition (PIN). FANTA-III focuses on capacity building, system strengthening and implementation and evaluation of nutrition programs, while SPRING is working to expand fortification of cooking oil to over 90 percent of the market, through technical assistance to support and implement national-level activities and policies related to food fortification and other micronutrient initiatives. The PIN initiative supports local production of ready-to-use therapeutic foods (RUTF) and fortified complementary foods for infants and young children. Other donors contributing to nutrition activities in Uganda include the Food and Agriculture Organization of the United Nations, the United Nations Children's Fund (UNICEF), the World Food Program, and the World Health Organization (WHO).

PART II – COSTED SCALE-UP SCENARIOS: RATIONALE, OBJECTIVES, AND METHODOLOGY

The overall objective of this research is to support the Government of Uganda in developing a costed scale-up plan that furthers the operationalization of the recently released Uganda National Action Plan (UNAP). These efforts will provide the Government of Uganda with the tools needed to leverage adequate resources from its domestic budgets, as well as from development partners, in support of the costed scale-up plan. Within this context, the objectives of this analysis are as follows:

- To estimate scale-up costs in Uganda for a set of well-proven nutrition-specific interventions that have the potential to be scaled up through tested delivery mechanisms
- To conduct a basic economic analysis to calculate the potential benefits and cost-effectiveness associated with the proposed scale-up
- To propose a series of scenarios for a costed scale-up plan that rolls out this package of nutrition-specific interventions in phases, based on considerations of impact, geography, implementation capacity, and costs
- To explore initial costs for a limited number of nutrition-sensitive interventions through the agriculture, education, and water and sanitation sectors

Although the economic arguments for increasing investments in nutrition are sound, one of the first questions raised by key decision makers in any country is "How much will it cost?" In 2010 the World Bank spearheaded a study called *Scaling Up Nutrition: What Will It Cost?* to answer that question at the global level. The analysis estimates the level of global financing required to scale up 10 evidence-based nutrition-specific interventions in 36 countries that account for 90 percent of the world's stunting burden and 32 smaller countries that also have a high prevalence of undernutrition. The results of the study highlight the global financing gap, underscore the importance of investing in nutrition at the global level, and lay out a methodology for estimating the costs of nutrition-specific interventions. However, these global estimates do not capture the nuances and context in each country, nor are these estimates contextualized to every individual country's policy and capacity setting or its fiscal constraints. This report builds on the early work to address this gap and contextualize the cost estimates for Uganda.

The multisectoral approach requires nutrition-sensitive approaches or interventions that can be delivered through other sectors. As discussed above, globally there is currently very limited guidance on costing for nutrition-sensitive interventions. Therefore this present report provides an exploratory analysis to be used primarily to engage other sectors in planning for improved nutritional outcomes. This initial exercise will contribute to a broader discussion about methodological and other issues for costing nutrition-sensitive interventions, and will thereby encourage the formulation of standard definitions, methodologies, and guidance for costing these interventions in the future.

Scope of the Analysis and Description of the Interventions

The costed scale-up plan is presented in two sections. The first section presents estimated costs and benefits for the set of 10 nutrition-specific interventions that have strong evidence of impact and were included in the World Bank's *Scaling Up Nutrition* report (2010) and are primarily delivered through the health sector. These interventions and the associated target population and current coverage for each intervention are specified in Table 1.

The nutrition-specific interventions considered are a modified package of the interventions included in the 2008 and 2013 *Lancet* series on Maternal and Child Undernutrition, tailored to the Ugandan context. These 10 interventions are based on current scientific evidence, and there is general consensus from the global community about the impact of these interventions. Some interventions—such as deworming and iron-fortification of staple foods—that were included in the 2008 *Lancet* series but no longer listed in the 2013 *Lancet* series are included here because they remain relevant to Uganda. Others—such as calcium supplementation for women and prophylactic zinc supplementation—are excluded because delivery mechanisms are not available in client countries, including Uganda, and/or there are no clear WHO protocols or guidelines for large-scale programming. In other cases, there are limited capacities for scaling up the interventions. Only those nutrition-specific interventions that are relevant to the Ugandan context and that have strong evidence of effectiveness, a WHO protocol, and a feasible delivery mechanism for scale-up are included in the proposed scale-up package below. As this evidence base grows, other interventions can be added over time.

Table 1. Nutrition-Specific Interventions Delivered Primarily Through the Health Sector

Intervention	Description	Target population	Current coverage
Breastfeeding and complementary feeding promotion	Behavior change communication focusing on optimal breastfeeding and complementary feeding practices	Children 0–23 months of age	Negligible
Vitamin A supplementation	Semi-annual doses	Children 6–59 months of age	56.8%
Therapeutic zinc supplementation with ORS	Part of diarrhea management with ORS	Children 6–59 months of age	1.9%
Multiple micronutrient powders	For in-home fortification of complementary food (60 sachets between 6 and 11 months of age, 60 sachets between 12 and17 months of age, and 60 sachets between 18 and 23 months of age)	Children 6–23 months of age who are not receiving complementary food	Negligible
Deworming	Two rounds of treatment per year	Children 12–59 months of age	50.2%

Intervention	Description	Target population	Current coverage
Iron-folic acid supplementation	Iron-folic acid supplementation during pregnancy	Pregnant women	75.1%
Iron fortification of staple foods	Fortification of wheat flour with iron	General population	Negligible
Salt iodization	Iodization of centrally processed salt	General population	99.0%
Complementary food for the treatment of moderate acute malnutrition	Provision of a small amount (~250 kilocalories per day) of nutrient-dense complementary food for the treatment of moderate malnutrition (moderate acute malnutrition and/or moderate stunting)	Twice the prevalence of underweight (WAZ < −2) among children 6–23 months of age	Negligible
Community-based treatment of severe acute malnutrition	Includes the identification of severe acute malnutrition, community or clinic-based treatment (depending on the presence of complications), and therapeutic feeding using ready-to-use therapeutic food	Incidence (estimated as twice the prevalence) of severe wasting (WHZ <−3) among children 6–59 months of age	Negligible

Note: ORS = oral rehydration salts; WAZ = weight-for-age Z-score; WHZ = weight-for-height Z-score.

The analysis in the following section focuses on nutrition-sensitive interventions that are relevant to the Ugandan context and that have the potential to have an impact on nutrition outcomes. A description of these interventions, associated target populations, and responsible sectors are listed in Table 2. As discussed above, the evidence base for nutrition-sensitive interventions is not as strong as it is for nutrition-specific interventions. Therefore these estimates are exploratory and are limited to six potential interventions relevant to the Ugandan context that can be scaled up and have potential for impact on nutrition outcomes. Additional interventions were not included in these initial estimates because their impact on nutrition is yet to be clearly documented (Masset et al. 2011; Ruel et al. 2013; World Bank 2013b), because this is an exploratory instead of an exhaustive effort, or because they were not considered relevant to the needs of Uganda. Furthermore, cost attribution is complex because these nutrition-sensitive interventions are designed for multiple purposes.

Table 2. Multisectoral, Nutrition-Sensitive Interventions: An Exploratory Process

Intervention	Description	Target population	Potential for impact
Interventions to be delivered through the agricultural sector			
Biofortification: orange-flesh sweet potatoes	Promote use of vitamin A–rich sweet potatoes	Children aged 6–59 months and pregnant women	Increased vitamin A intake and improve vitamin A status (Hotz 2012a, 2012b)
Aflatoxin control for maize: biocontrol application	Promote application of biocontrols for maize	Farmers of maize	Reduce aflatoxins and therefore improve child nutrition status (stunting) and reduce morbidity (Khlangwiset and Wu 2011)
Aflatoxin control for maize: improving post-harvest and storage techniques	Promote safe post-harvest handling and storage techniques	Farmers of maize	Reduce aflatoxins and therefore improve child nutrition status (stunting) and reduce morbidity (Khlangwiset and Wu 2011)
Interventions to be delivered through the education sector			
Deworming for school-aged children	Distribution of albendazole to school-aged children and training to school teachers, community workers, and health workers	School-aged children	Reduce anemia and morbidity, improve cognitive outcomes (Miguel and Kremer 2004)
Promotion of good hygiene behaviors	Hygiene education program to teach healthy practices in schools	School-aged children	Improve child nutrition outcomes (stunting) (Spears 2013)

ESTIMATION OF TARGET POPULATION SIZES, CURRENT COVERAGE LEVELS, AND UNIT COSTS

Target population estimates are presented in Appendix 2. These estimates are based on projections from the 2010 Census that used 2.84 percent as the annual population growth rate. The prevalence of child stunting (height-for-age Z-score <–2), underweight (weight-for-age Z-score <–2), and severe wasting (weight-for-height Z-score <–3) among children under five years of age in each region were obtained from the 2011 Uganda DHS.

Data on current coverage levels was obtained from various sources. To avoid underestimating costs, current coverage levels for multiple micronutrient powders, iron fortification of staple foods,

and public provision of complementary food for the prevention of moderate malnutrition were set to 0 percent either because the intervention was not being implemented and coverage was very minimal, or because current reliable coverage data were not available. Programmatic data on the coverage of breastfeeding and complementary feeding promotion was provided by UNICEF. The treatment of severe acute malnutrition was assumed to be negligible. Coverage data on vitamin A supplements, deworming, zinc supplements, iron-folic acid supplementation, and salt iodization were obtained from the 2011 Uganda DHS.

The unit costs and delivery platforms for the nutrition-specific interventions and nutrition-sensitive interventions are listed in Tables 3 and 4, respectively. Whenever possible, the unit costs of the nutrition-specific interventions were estimated using programmatic data provided by UNAP or UNICEF. The only exception is the unit cost for breastfeeding and complementary feeding promotion, which comes from a similar costing exercise in Kenya. A complete index of data sources and relevant assumptions for each intervention can be found in Appendix 3.

Table 3. Unit Costs and Delivery Platforms Used in the Calculations for Nutrition-Specific Interventions

Intervention	Unit cost (US$) per beneficiary per year	Delivery platform
Breastfeeding and complementary feeding promotion	$6.90[b]	Community and facility nutrition programs
Vitamin A supplementation	$0.16[a]	Biannual campaign with deworming and prophylactic zinc supplementation
Therapeutic zinc supplementation with ORS	$0.90[c]	Health system delivery
Multiple micronutrient powders	$2.60[a]	Community nutrition programs
Deworming	$1.10[c]	Biannual campaign with vitamin A and prophylactic zinc supplementation
Iron-folic acid supplementation	$2.11[c]	Health system delivery during first antenatal care visit
Iron fortification of staple foods	$0.16[c]	Market-based delivery
Salt iodization	$0.05[d]	Market-based delivery
Complementary food for the treatment of moderate acute malnutrition (children)	$66.50[a]	Community nutrition programs
Community-based treatment of severe acute malnutrition	$87.21[a]	Primary health care and community nutrition programs

Note: ORS = oral rehydration salts.
    a. Unit cost from the Uganda Nutrition Action Plan.
    b. Unit cost from Kenya (Dayton-Eberwein et al. 2016a).
    c. Unit cost from Zambia (Dayton-Eberwein et al. 2016b)

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d. d.Unit cost based on global experience (World Bank 2010).
b.

For the nutrition-sensitive interventions in the agriculture sector, the unit costs and the delivery platforms are listed in Table 4. The unit costs for the biofortification of orange sweet potatoes are based on the HarvestPlus research project implemented in Uganda in 2007–09 (HarvestPlus 2012). That project reports actual and "reduced" average and marginal unit costs. Average costs include the fixed costs of overall management of implementation. Marginal costs represent the additional cost of increasing the number of extension workers and target households under the overall management structure of the size of that project. The "reduced" costs represent a more realistic or real-world setting, rather than a research project. The reduced cost estimates are $26 for average costs and $10 for marginal costs. These are the costs used here, divided by three to arrive at an annualized unit cost.[4] In scaling up throughout Uganda one could expect the unit cost to be similar to the average cost at the beginning and closer to the marginal cost after initial implementation. Also, the unit cost does not include research and development (R&D) or adaptive breeding activities, since these phases were already completed. Two sources of unit costs are used. First, a per hectare unit cost for biocontrol comes from the International Institute for Tropical Agriculture (IITA) in Nigeria (Bandyopadhyay 2013) and is considered a best approximation of costs for Uganda. This cost estimate includes material and distribution costs. A second approximation is cost per 90 kg. bag of maize from Kenya (IFPRI 2012). The cost for storage in plastic containers also comes from the same study in Kenya (IFPRI 2012).

Unit costs for interventions in the education sector come from both Ugandan and international sources. The unit cost for school-based deworming is based on analysis by Kabatereine et al. (2005) and is between $0.063 and $0.105 for four districts in Uganda. We use the average across the four districts of $0.09. The unit cost of $2 per student for school-based promotion of good hygiene is obtained from the UNICEF report (2012b) on WASH in schools. This includes the cost of capacity building, monitoring, advocacy, and social mobilization, but does not include the cost of providing washing facilities in schools. For school-based feedings in Uganda, the unit cost of $40 per student is derived from programs in The Gambia, Kenya, Lesotho, and Malawi as reported in World Bank 2013a.

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[4] The HarvestPlus research project spanned three years.

Table 4. Unit Costs and Delivery Platforms Used in the Estimations for Selected Nutrition-Sensitive Interventions

Intervention	Unit cost (US$) per benefit unit per year	Delivery platform
Interventions delivered through the agriculture sector		
Biofortification: orange flesh sweet potatoes	Average cost: $8.70 per child/woman[a] Marginal cost: $3.30 per child/woman[a]	Agriculture production
Aflatoxin control for maize: biocontrol application	$15.60 per hectare[b] $194.44 per 90 kg. bag[c]	Agriculture production
Aflatoxin control for maize: improving post-harvest and storage techniques	$120.14 per 90 kg. bag[c]	Agriculture production
Interventions delivered through the education sector		
School-based deworming	$0.09 per student[d]	School-based deworming distribution
School-based promotion of good hygiene	$2.00 per student[e]	School-based hygiene education campaign

a. Unit cost for Uganda from HarvestPlus (2012).
b. Unit cost for Nigeria from Bandyopadhyay (2013).
c. Unit cost for Kenya from IFPRI (2012).
d. Unit cost for Uganda from Kabatereine et al. (2005).
e. Unit cost is global estimate from UNICEF (2012b)

ESTIMATION OF COSTS AND BENEFITS

The *program experience* methodology employed in the *Scaling Up Nutrition* report (World Bank 2010) is used for calculating the cost of scaling up in Uganda. This approach generates unit cost data that capture all aspects of service delivery, including the costs of commodities, transportation and storage, personnel, training, supervision, monitoring and evaluation, relevant overhead, wastage, and so on for each intervention from actual programs that are already in operation in Uganda, and considers the context in which they are delivered. Another commonly used method is the *ingredients approach,* in which selected activities are bundled into appropriate delivery packages (such as the number of visits to a health center; see Bhutta et al. 2013, for example). Although the program experience approach tends to yield cost estimates that are higher than the ingredients approach, the estimates more accurately reflect real programmatic experience, including inefficiencies in service delivery. It should be noted, however, that the calculated costs are reported in financial or budgetary terms. They do not capture the full social resource requirements, which account for the opportunity costs of the time committed by beneficiaries accessing the services.

We calculate the annual public investment required to scale up the interventions as follows:

$$Y = (x_1 + x_2) - x_3$$

where:

Y = annual public investment required to scale up to full coverage[5]
x_1 = additional total cost to scale up to full coverage
x_2 = additional cost for capacity development, M&E, and technical assistance
x_3 = cost covered by households living above poverty line for selected interventions

Appendix 4 describes the methodology in detail.

The expected benefits from scaling up nutrition interventions are calculated in terms of (1) DALYs averted, (2) number of lives saved, (3) cases of childhood stunting averted, and (4) increased program coverage. To calculate the number of DALYs averted, we use the method employed by Black et al. (2008) to estimate the averted morbidity and mortality from scaling up different nutrition interventions. The method uses population attributable fractions (PAF) based on the comparative risk assessment project (Ezzati et al. 2002; Ezzati et al. 2004) to estimate the burden of infectious diseases attributable to different forms of undernutrition using most recent *Global Burden of Disease Study* (IHME 2010). DALY estimates in this study are neither discounted nor age-weighted, in line with the methodology used in the *Global Burden of Disease Study* and the WHO *Global Health Estimates* (2012). Appendix 5 describes the methodology for estimating DALYs. The projected number of lives saved and cases of childhood stunting averted are calculated using the Lives Saved Tool (LiST), which translates measured coverage changes into estimates of mortality reduction and changes in the prevalence of under-five stunting. This analysis includes all ten interventions to calculate the number DALYs averted. However, because of the methodological limitations of the LiST tool, the calculation for the number of lives saved is

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[5] *Full coverage* is defined as 100 percent of the target population for all interventions except for community-based treatment of severe acute malnutrition, for which full coverage is assumed to be 80 percent.

based on only six of the ten interventions,[6] and cases of childhood stunting averted is based on only four of the ten.[7] As such, our estimates are likely to underestimate the number of lives saved and cases of childhood stunting averted. Appendix 6 describes the methodology for the LiST estimates.

The measures for the cost-effectiveness of nutrition-specific interventions are calculated in terms of *cost per DALY averted, cost per life saved*, and *cost per case of stunting averted*. Estimates of benefits were combined with information on costs to produce the cost-effectiveness measures for each intervention as well as for the overall package of interventions. The evaluation of the cost-effectiveness ratio in terms of DALYs averted is based on the categorization used by WHO-CHOICE (Choosing Interventions that are Cost-Effective):[8] an intervention is considered to be "very cost-effective" if the range for the cost per DALY averted is less than GDP per capita;[9] it is considered to be "cost-effective" if it is between one and three times GDP per capita; and it is considered "not cost-effective" if it exceeds three times GDP per capita (WHO 2014).

The cost-benefit analysis is based on the estimated economic value of the benefits attributable to nutrition-specific interventions. In order to arrive at a dollar value for the impact on mortality and morbidity of a five-year scale-up plan, we use estimates of the number of lives saved and the reduction in stunting prevalence produced by the LiST tool. Following established practice, a life year saved is valued as equivalent to gross national income (GNI) per capita; this is considered to be a conservative measure because it accounts for only the economic and not the social value of a year of life. In order to estimate the value of the reduction in stunting, we follow the methodology used in Hoddinott et al. (2013), which values a year of life lived without stunting based on the assumption that stunted individuals lose an average of 66 percent of lifetime earnings. Future benefits are then age-adjusted and discounted at three potential discount rates (3, 5, and 7 percent) in order to arrive at their present value. The present value of future benefits is then compared with the annual public investment required, which allows us to estimate the net present value (NPV) and internal rate of return of the investment. A detailed explanation of the benefit estimation methodology can be found in Appendix 7.

The annual increase in economic productivity attributable to each package of interventions is calculated based on the same estimates of future benefits. Although these benefits occur only once beneficiaries have reached productive age, we assume that they serve as an approximation of the present value of economic productivity lost each year as a result of mortality and morbidity that would otherwise be prevented by scaling up nutrition interventions. Values presented are taken from a year in which all beneficiaries have reached productive age.

The approach for estimating the potential costs and benefits of nutrition-sensitive interventions differs from the methodology used for nutrition-specific interventions. Similar to nutrition- specific

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[6] The six interventions are community nutrition programs for growth promotion, vitamin A supplementation, therapeutic zinc supplementation with oral rehydration salts, iron-folic acid supplementation, the public provision of complementary food for the prevention of moderate acute malnutrition, and community-based management of severe acute malnutrition.

[7] The four interventions are community nutrition programs for growth promotion, vitamin A supplementation, iron-folic acid supplementation, and the public provision of complementary food for the prevention of moderate acute malnutrition.

[8] Information on the cost-effectiveness thresholds used by WHO-CHOICE can be found at http://www.who.int/choice/costs/CER_levels/en/.

[9] Uganda's GDP per capita in current U.S. dollars was $696 in 2014 (World Bank 2014b).

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interventions, the total cost for scaling up the interventions is calculated by multiplying the unit cost by the target population (either country unit costs for Uganda or Africa regional unit costs are used, depending on availability). However, since most nutrition-sensitive interventions have multiple objectives, it is not always feasible to attribute the nutrition-related benefits to the overall costs of the interventions. Because these constraints limit the accuracy of cost-effectiveness estimates, we instead rely on secondary sources and published literature when available, with cost-effectiveness presented in terms of cost per DALY averted.

SCENARIOS FOR SCALING UP NUTRITION INTERVENTIONS

When estimating the costs and benefits of scaling up nutrition interventions, we begin with estimates for scaling all 10 interventions to full national coverage, followed by estimates for various scale-up scenarios. The full coverage estimates can be considered the medium-term policy goal for the Government of Uganda. However, resource constraints will likely limit the government's ability to achieve full national coverage in the short-term. Therefore we also propose several scenarios for prioritizing the scale-up of nutrition interventions over the short-term time frame of five years:

- Scenario 1: Prioritize scale up by region
- Scenario 2: Prioritize scale up by intervention
- Scenario 3: Prioritize scale up by region and by intervention

Within each of the above scenarios, we consider multiple variations and analyze their cost-effectiveness in terms of cost per DALY averted, cost per life saved, and cost per case of childhood stunting averted. After our initial analysis, we present the most attractive scale-up scenarios and discuss them in more detail.

Full coverage is defined as 100 percent of the target population for all interventions except for community-based treatment of severe acute malnutrition, for which full coverage is assumed to be 80 percent. This definition is consistent with the methodology used in World Bank's *Scaling Up Nutrition* report (2010), and is based on the reality that few community-based treatment programs have successfully achieved more than 80 percent coverage at scale.

PART III – RESULTS FOR NUTRITION-SPECIFIC INTERVENTIONS

TOTAL COST, EXPECTED BENEFITS, AND COST-EFFECTIVENESS

The total additional public investment required to scale up 10 nutrition-specific interventions from current coverage levels to full coverage nationwide in Uganda is estimated to be $68 million annually (Table 5). This cost includes the additional cost of scaling up all 10 interventions across the entire country from current levels ($87 million per year), plus additional resources for capacity development for program delivery and for monitoring and evaluation, operations research, and technical support for program delivery (together estimated at $10 million). Of this total amount, part of the costs for iron fortification, multiple micronutrient powders, salt iodization, and complementary food would be covered by private households with incomes above the poverty line, resulting in an annual financing gap of $68 million required to reach full national scale.

Table 5. Estimated Cost of Scaling Up 10 Nutrition-Specific Interventions to Full Coverage

Intervention	Annual cost (US$, millions)
Breastfeeding and complementary feeding promotion	23.9
Vitamin A supplementation for children	0.5
Therapeutic zinc supplement with ORS for children	6.5
Micronutrient powders for children	6.0
Deworming for children	3.6
Iron-folic acid supplementation for pregnant women	0.9
Iron fortification of staples for general population	5.8
Salt iodization for general population	0.02
Public provision of complementary food for prevention of moderate acute malnutrition in children	24.6
Community-based management of severe acute malnutrition in children	15.3
Total cost for scaling up all 10 interventions	87.0
Capacity development for program delivery	7.8
Monitoring and evaluation, operations research, and technical support for program delivery	1.7
Household contributions	(28.8)
ANNUAL PUBLIC INVESTMENT REQUIRED	67.8

Note: ORS = oral rehydration salts. *Full coverage* refers to the full implementation of all 10 interventions countrywide.

The expected benefits from scaling up these 10 nutrition-specific interventions to full national coverage are enormous (Table 6). More than 375,000 DALYs would be averted and over 8,000 lives would be saved annually, while more than 211,000 cases of stunting among children under five would be averted. Program coverage is assumed to increase to cover the following beneficiaries:

- The families of 3.5 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 3.3 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 7.2 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 2.3 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 3.3 million children 12–59 months of age would receive deworming medication
- 0.4 million pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 36 million people would be able to consume staple foods fortified with iron
- 0.3 million people who do not currently use iodized salt would be able to obtain it
- 370,000 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices
- 0.2 million children 6–23 months of age would receive a small amount of nutrient-dense complementary food (~250 kilocalories/day) for the prevention or treatment of moderate malnutrition

Table 6. Estimated Annual Benefits for Scaling Up 10 Nutrition-Specific Interventions to Full Coverage

Intervention	Beneficiaries covered	DALYs averted[a]	Lives saved	Cases of stunting averted
Breastfeeding and complementary feeding promotion	3,459,590	118,128	2,863	102,998
Vitamin A supplementation for children	3,278,253	28,242	700	28,704
Therapeutic zinc supplementation with ORS for children	7,234,699	59,840	2,094	—
Micronutrient powders for children	2,295,352	—	—	—
Deworming for children	3,291,698	36,753	—	—
Iron-folic acid supplementation for pregnant women	403,109	2,764[b]	83	844
Iron fortification of staples for general population	35,993,950	—	—	—
Salt iodization for general population	335,127	—	—	—
Public provision of complementary food for prevention of moderate acute malnutrition in children	369,891	37,117	564	84,425
Community-based management of severe acute malnutrition in children	219,688	93,140	2,996	—
Total when all interventions implemented simultaneously[c]	—	**375,468**	**8,708**	**211,906**

Note: ORS = oral rehydration salts; — = not available.
a. DALY estimates in this study are neither discounted nor age-weighted, in line with the methodology used in the IMHE's 2010 *Global Burden of Disease Study* and the WHO *Global Health Estimates* 2012. For more information on the methodology used to calculate DALYs averted, see Appendix 5.
b. DALY estimates for iron-folic acid supplementation are calculated for DALYs averted among pregnant women. They do not include the DALYs averted among children born to mothers who received these supplements.
c. The total of the interventions implemented simultaneously does not equal to the sum of the individual interventions. This is because some interventions affect nutrition outcomes via similar pathways, causing their combined impact to be different than the individual sums.

For the package as a whole, we estimate the total cost per DALY averted at $232, the total cost per life saved at $9,996, and the total cost per case of child stunting averted at $411 (Table 7). Variation in cost among the interventions is high and, as a result, some interventions have a lower estimated cost per DALY averted ($19 for vitamin A supplementation), whereas others have much higher costs ($663 for the public provision of complementary food). Overall, these cost estimates

translate into an increase in annual public resource requirements of $8.28 per child, which is well under the cost of $30 per child found in the global costing exercise (World Bank 2010).

All of the 10 nutrition-specific interventions are very cost-effective according to the WHO-CHOICE criteria (WHO 2014)—that is, less than three times the GDP per capita of $696 (World Bank 2014b). However, the public provision of complementary food for the prevention of moderate acute malnutrition has a relatively higher cost per DALY averted ($663) than the other interventions. Therefore, in a country such as Uganda, where fiscal and capacity constraints will limit scale-up, certain expensive interventions—such as the public provision of complementary food—may be a lower priority. Furthermore, issues of governance, accountability, and supply logistics will all put pressure on the cost and complicate the scale-up of the public provision of complementary food.

Table 7. Cost-Effectiveness of Scaling Up 10 Nutrition Interventions to Full Coverage, US$

Intervention	Cost/DALY averted		Cost/life saved	Cost/case of stunting averted
	Uganda	Global		
Breastfeeding and complementary feeding promotion	202	53–153	8,417	232
Vitamin A supplementation of children	19	3–16	749	18
Therapeutic zinc supplementation with ORS for children	109	73	3,109	-
Micronutrient powders for children	-	12.2	-	-
Deworming for children	99	—	-	-
Iron-folic acid supplementation for pregnant women	308	66–115	10,248	1,007
Iron fortification of staples for general population	-	—	-	-
Salt iodization for general population	-	—	-	-
Public provision of complementary food for prevention of moderate acute malnutrition in children	663	500–1,000	43,613	291
Community-based management of severe acute malnutrition in children	165	41	5,116	-
TOTAL	232	—	9,996	411

Source: Authors' calculations for Uganda; World Bank 2010 for global estimates.
Note: ORS = oral rehydration salts; — = not available.
a. Very cost-effective according to WHO-CHOICE criteria (WHO 2014).

POTENTIAL SCALE-UP SCENARIOS

Scenario 1: Scaling Up by Region

Table 8 shows the estimated costs and benefits of scaling up the 10 nutrition-specific interventions according to the burden of stunting in each region. Stunting rates exceed 40 percent in the three highest-burden regions (Karamoja, Southwest, and Western). The four middle-burden regions have stunting rates between 30 and 39 percent (Central 1, Central 2, East Central, and West Nile) and the three lowest-burden regions (Eastern, Kampala, and North) have stunting rates less than 30 percent.

Table 8. Scenario 1: Costs and Benefits of Scaling Up 10 Nutrition-Specific Interventions by Region

Region	Annual public investment (US$, millions)	Annual benefits	
		DALYs averted	Lives saved
Highest-burden regions[a] (stunting rates greater than 40%)	**21.8**	120,879	2,871
Middle-burden regions[b] (stunting rates between 30 and 39%)	**28.7**	161,967	3,749
Subtotal of highest and middle-burden regions when interventions implemented simultaneously[d]	**50.5**	--	--
Lowest-burden regions[c] (stunting rates less than 30%)	17.3	91,651	2,088
TOTAL when interventions implemented simultaneously[d]	67.8	375,468	8,708

Note: Cells in red indicate recommended interventions under this scenario.
a. Karamoja, Southwest, and Western.
b. Central 1, Central 2, East Central, and West Nile.
c. Eastern, Kampala, and North.
d. The total of the interventions implemented simultaneously does not equal to the sum of the individual interventions. This is because some interventions affect nutrition outcomes via similar pathways, causing their combined impact to be different than the individual sums.

To scale up interventions in the highest- and middle-burden regions would require an annual public investment of $51 million. This scenario would avert 282,000 DALYs and save over 6,600 lives. It would also increase program coverage as follows:

- The families of 0.6 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 0.7 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 1.2 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 0.4 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders

- 0.5 million children 12–59 months of age would receive deworming medication
- 71,000 pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 6 million people would be able to consume staple foods fortified with iron
- 0.04 million people who do not currently use iodized salt would be able to obtain it
- 17,700 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices
- 50,000 children 6–23 months of age would receive a small amount of nutrient-dense complementary food (~250 kilocalories/day) for the prevention or treatment of moderate malnutrition

Scenario 2: Scaling Up by Intervention

Scenario 2 considers prioritizing the scale-up by intervention according to cost-effectiveness. The proposed plan for a step-wise scale-up by intervention is summarized below and illustrated in Figure 9.

- **Step 1** focuses on a package of micronutrient and deworming interventions that can be scaled up quickly, either with existing capacities or with modest investment in capacity building for community nutrition programs and national campaigns. The cost of scaling up all micronutrient and deworming interventions and breastfeeding and complementary feeding promotion to full national coverage and 30 percent of community-based management of severe acute malnutrition is $53 million. An additional $6 million for capacity development for program delivery as well as for monitoring and evaluation, operations research, and technical support brings the total cost of Step 1 to $59 million. Once the costs covered by households above the poverty line ($10 million) are deducted, the total public investment required for Step 1 is estimated at **$49 million**.

- **Step 2** includes the costs of reaching the remaining 50 percent of community-based management of acute malnutrition programming to attain 80 percent national coverage. The estimated cost of this scale-up is $10 million. We include an additional $1 million for capacity development for program delivery and for monitoring and evaluation, operations research, and technical support for program delivery, which brings the total public investment required for Step 2 to **$11 million**.

- **Step 3** scales up the public provision of complementary food for the prevention of moderate malnutrition to full national coverage. This intervention requires an investment of $25 million in addition to the $3 million needed for capacity development for program delivery and for monitoring and evaluation, operations research, and technical support for program delivery. Households above the poverty line are expected to contribute $19 million, leaving a total public investment required of **$8 million**.

Figure 9. Scenario 2: Step-Wise Scale-Up by Intervention

Step 1: Additional public investment of $49.1 million

- **$52.9 million** — Breastfeeding and complementary feeding promotion, all micronutrient supplementation, deworming and 30% scale-up of community-based management of severe acute malnutrition
- **$4.8 million** — Capacity development for program delivery
- **$1.1 million** — Monitoring and evaluation, operations research, and technical support for program delivery
- **$9.6 million** — Household contribution

Step 2: Additional public investment of $10.6 million

- **$9.6 million** — Reach full scale-up of community-based management of severe acute malnutrition
- **$0.9 million** — Capacity development for program delivery
- **$0.2 million** — Monitoring and evaluation, operations research, and technical support for program delivery

Step 3: Additional public investment of $8.0 million

- **$24.6 million** — Public provision of complementary food for the prevention of moderate acute malnutrition
- **$2.2 million** — Capacity development for program delivery
- **$0.5 million** — Monitoring and evaluation, operations research, and technical support for program delivery
- **$19.3 million** — Household contribution

Note: There is no household contribution for Step 2 interventions.

The public provision of complementary food for the prevention of moderate acute malnutrition (Step 3) is assigned the lowest priority for the following reasons: (1) the 2013 *Lancet* nutrition series concluded that there are no additional benefits to the public provision of complementary food beyond those provided by dietary counseling and education; (2) at $663 per DALY averted, the cost-effectiveness of the public provision of complementary food is less attractive than that of the other proposed interventions; and (3) governance, accountability, supply-chain, and logistics are key challenges associated with large-scale food distribution and are not inconsequential in a country the size of Uganda. Under these circumstances, rapid scale-up is neither feasible nor recommended.

The preferred scale-up scenario (Scenario 2) would be to scale up Step 1 and Step 2 interventions, requiring an annual public investment of $60 million (Table 9). This scenario would avert over 337,000 DALYs and save at least 8,100 lives. It would also provide the following program benefits:

- The families of 3.5 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 3.3 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 7.2 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
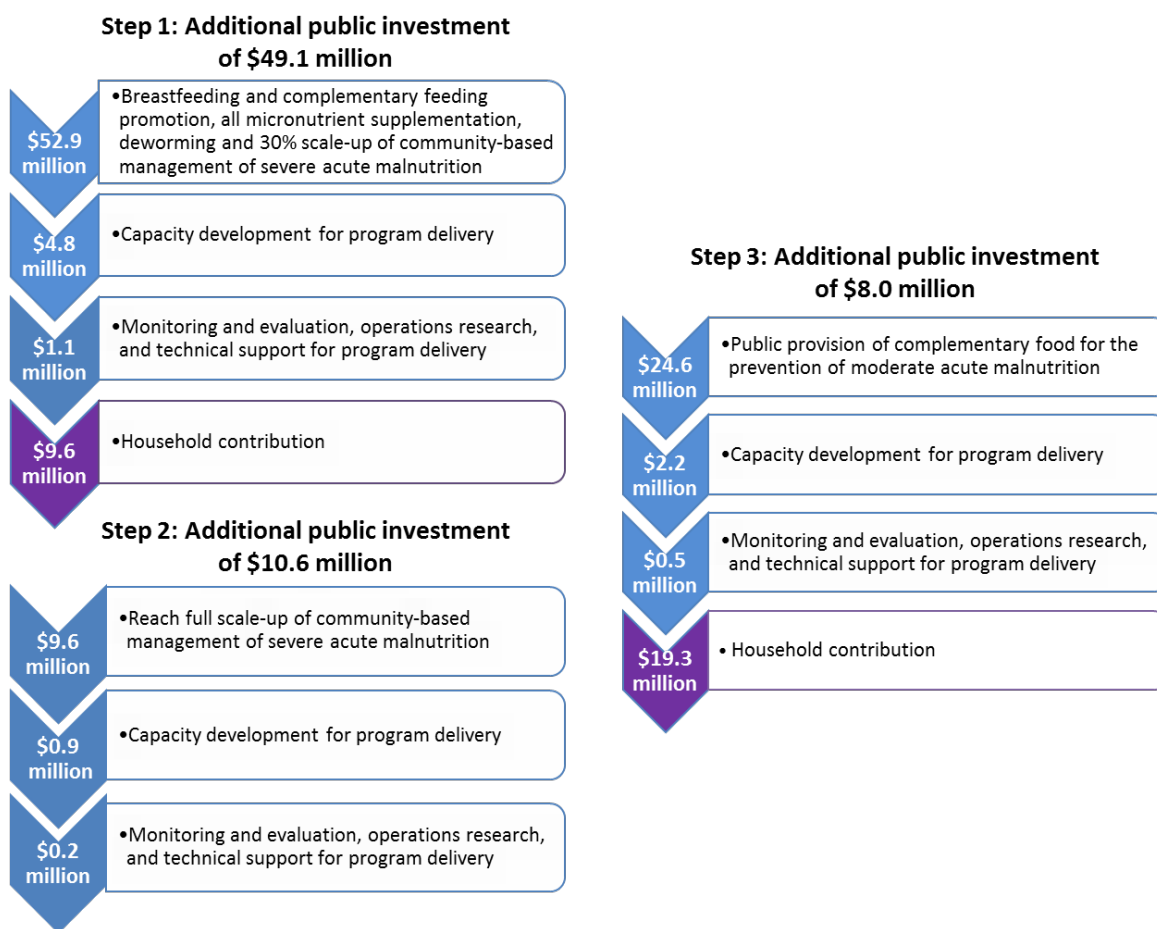- 2.3 million children 6–23 months would receive vitamins and minerals through multiple micronutrient powders
- 3.3 million children 12–59 months of age would receive deworming medication
- 0.4 million pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 36 million people would be able to consume staple foods fortified with iron
- 0.3 million people who do not currently use iodized salt would be able to obtain it
- 219,690 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices

Table 9. Scenario 2: Costs and Benefits of Scaling Up 10 Nutrition-Specific Interventions by Intervention

Intervention	Annual public investment (US$, millions)	Annual benefits	
		DALYs averted	Lives saved
Step 1: All micronutrient, deworming, and breastfeeding and complementary feeding promotion to full national coverage and 30 percent of community-based management of severe acute malnutrition	49.1	279,168	6,411
Step 2: Full national coverage of community-based management of severe acute malnutrition	10.6	58,213	1,748
SUBTOTAL when Steps 1 and 2 are implemented simultaneously[a]	59.8	--	--
Step 3 : Public provision of complementary food for prevention of moderate acute malnutrition	8.0	37,117	549
Total when interventions implemented simultaneously[a]	67.8	375,468	8,708

Note: Cells in red indicate recommended interventions under this scenario.
a. The total of the interventions implemented simultaneously does not equal the sum of the individual interventions. This is because some interventions affect nutrition outcomes via similar pathways, causing their combined impact to be different than the individual sums.

Scenario 3: Scaling Up by Region and by Intervention

Scenario 3 proposes scaling up certain interventions according to geographic targeting criteria based on the prevalence of child stunting in each region. The public resource requirements for each variation under this scenario are shown in Table 10.

Table 10. Scenario 3: Cost of Scaling Up 10 Nutrition-Specific Interventions by Region and Intervention (US$, millions)

Intervention/Region	Highest-burden regions[a]	Middle-burden regions[b]	Lowest-burden regions[c]
Step 1: All micronutrient, deworming and breastfeeding and complementary feeding promotion to full national coverage and 30% of community-based management of severe acute malnutrition	**14.7**	**20.8**	13.6
Step 2: Full national coverage of community-based management of severe acute malnutrition	**4.3**	**4.6**	1.6
Step 3: Public provision of complementary food for the prevention of moderate acute malnutrition	2.7	3.3	2.0

Note: Cells in red indicate recommended interventions under this scenario.
a. Karamoja, Southwest, and Western.
b. Central 1, Central 2, East Central, and West Nile.
c. Eastern, Kampala, and North.

Under Scenario 3 we consider two variations. **Scenario 3a** *would scale up Step 1 and Step 2 interventions in regions with stunting rates above 30 percent (highest- and middle-burden regions),[10] requiring an annual public investment of $45 million. This scenario would avert over 253,000 DALYs and almost 6,200 lives (Table 11) and provide the following program benefits:*

- The families of 0.6 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 0.7 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 1.2 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 0.4 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 0.5 million children 12–59 months of age would receive deworming medication
- 71,000 pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 6.1 million people would be able to consume staple foods fortified with iron
- 44,500 people who do not currently use iodized salt would be able to obtain it

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[10] The highest-burden (> 40 percent) regions are Karamoja, Southwest, and Western. The middle-burden (30 to 39 percent) regions are Central, Central 1, East Central, and West Nile.

- 17,600 children 6–59 months of age would treated for severe acute malnutrition using community-based management practices

A second scenario (**Scenario 3b**) would scale up Step 1 and Step 2 interventions only in the three highest-burden regions (Karamoja, Southwest, and Western), where stunting rates are higher than 40 percent. Scenario 3b would require an annual public investment of $19 million and would avert over 108,000 DALYs and save over 2,600 lives. Furthermore, Scenario 3b would provide the following program benefits:

- The families of 0.2 million children 0–59 months would be reached by community programs for behavior change
- 160,000 children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 0.3 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 0.1 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 116,000 children 12–59 months of age would receive deworming medication
- 11,200 pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 1.6 million people would be able to consume staple foods fortified with iron
- 0.03 million people who do not currently used iodized salt would be able to obtain it
- 10,200 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices

Table 11. Scenarios Considered Under Scenario 3

Scenario	Annual public investment (US$, millions)	Annual benefits	
		DALYs averted	Lives saved
3a: Micronutrients, deworming, community nutrition programs, and community-based management of severe acute malnutrition in highest- and middle-burden regions	44.5	253,734	6,190
3b: Micronutrient and deworming, community nutrition programs, and community-based management of severe acute malnutrition in highest-burden regions ONLY	19.0	108,022	2,681

COST-BENEFIT ANALYSIS OF THE SCALE-UP SCENARIOS

When considered in terms of cost-effectiveness (cost per life saved and DALY/case of stunting averted), all scenarios promise significant value for money. Table 12 presents a comparison of full scale-up and all four scenarios, shows that the three scenarios that exclude the public provision of complementary food for the preventions of moderate acute malnutrition stand out as the most cost-effective, with a cost per DALY averted of between $182 and $185. These three scenarios (2, 3a, and 3b) are equally cost-effective but each has a very different total price tag: providing nine interventions nationwide would require $60 million in annual public investment versus $45 million for these services in the seven highest-burden regions, and only $19 million in the three highest-burden regions. The choice between scenarios will therefore depend on how many public resources can be mobilized for nutrition interventions.

Table 12. Costs and Benefits by Scenario

Full scale-up and scenarios	Annual public investment (US$, millions)	Annual benefits			Cost per benefit unit (US$)		
		DALYs averted	Lives saved	Cases of stunting averted	DALY averted	Life saved	Case of stunting averted
All interventions nationwide	67.8	375,468	8,708	211,906	$232	$9,996	$411
1. Scale up all interventions in the highest and middle-burden regions	50.5	282,846	6,620	—	$232	$9,908	—
2. Scale up all interventions except the public provision of complementary food nationwide	59.8	337,381	8,159	—	$185	$7,654	—
3a. Scale up all interventions except the public provision of complementary food in the highest and middle-burden regions	44.5	253,734	6,190	—	$182	$7,481	—
3b. Scale up all interventions except the public provision of complementary food in the highest-burden regions	19.0	108,022	2,681	—	$182	$7,342	—

Note: — = not available.

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ESTIMATING COSTS OVER A FIVE-YEAR SCALE UP PERIOD

Recognizing the difficulty of scaling to full coverage in one year, and assuming a five-year time frame for any potential strategic plan, we consider the costs of a gradual scale-up over five years for each scenario. Scenarios 3a and 3b require fewer resources over five years than the other scenarios. Interventions are assumed to scale from current coverage as follows: 20 percent of coverage in Year 1, 40 percent in Year 2, 60 percent in Year 3, 80 percent in Year 4, and 100 percent in Year 5 (Table 13). For these calculations, we consider the expenditures on capacity development for program delivery required to scale to full coverage to be a fixed cost, with some additional funds allocated to refresher training and rehiring in the years after scale has been reached. Thus the average annual amount spent on capacity development is allocated across the five years rather than increasing in proportion to coverage, as is the case with the other costs.

Table 13. Annual Public Investment Required for Gradual Scale-Up Over Five Years, All Scenarios (US$, millions)

Full scale-up and scenarios	Year 1 (20% of scale-up)	Year 2 (40% of scale-up)	Year 3 (60% of scale-up)	Year 4 (80% of scale-up)	Year 5 (100% of scale-up)	Total scale-up costs over five years
All interventions nationwide	15.1	26.3	36.8	48.8	60.8	187.8
1. Scale up all interventions in the highest- and middle-burden regions	11.3	19.6	27.4	36.3	45.2	139.7
2. Scale up all interventions except the public provision of complementary food nationwide	13.1	23.3	33.0	43.9	54.7	168.1
3a. Scale up all interventions except the public provision of complementary food in the highest- and middle-burden regions	9.7	17.4	24.6	32.7	40.7	125.2
3b. Scale up all interventions except the public provision of complementary food nationwide in the highest-burden regions	4.2	7.4	10.5	14.0	17.4	53.6

ESTIMATED ECONOMIC ANALYSIS AND ECONOMIC BENEFITS

A high burden of malnutrition negatively impacts a nation's human capital. An investment in improving nutrition outcomes among children in Uganda is therefore also an investment in the country's economic future. The two main ways in which malnutrition affects economic productivity are increased mortality and morbidity—in other words, lives lost and years lived with a disease or disability. For the purposes of this analysis, we estimate the potential economic benefits of scaling up nutrition interventions in terms of lives saved (reduction in mortality) and cases of stunting averted (reduction in morbidity). Because each life lost results in one less citizen contributing to the nation's economy, and because stunted children tend to earn and consume less, these impact estimates help us to arrive at approximations of the return on investment attributable to the scale-up of a particular package of interventions.

The economic benefits of investing in these effective nutrition interventions are tremendous (Table 14). Scaling up all 10 interventions nationwide could produce an annual increase of $280 million in national economic productivity over the productive lives of the children affected. (Because of methodological limitations, we were not able to calculate the increases in economic productivity for the other scenarios.)

These estimates of economic benefits are based on a conservative methodology that does not necessarily account for all of the potential benefits associated with improving nutrition outcomes among Ugandan children. For example, these figures do not account for future growth in GDP per capita, which would also be expected to increase with improved nutritional outcomes. Furthermore, it is likely that these estimated increases in GDP would also improve equity in Uganda because productivity among the poor would benefit the most from improved nutritional outcomes.

Our analyses also show that these nutrition interventions are excellent economic investments (Table 14). Because an increase in the assumed discount rate reduces the present value of future benefits, we present the results using three possible discount rates: 3, 5, and 7 percent. The investment would provide highly positive net present values across this range of discount rates, indicating that it would be an excellent economic investment. In addition, this investment would yield a highly positive internal rate of return, another indicator that it is an excellent economic investment.

Table 14. Estimated Economic Benefits and Economic Analysis

Economic measure	Estimate for full scale-up of all 10 interventions nationwide (US$, millions)
Annual increase in economic productivity[a]	$279.5
Net present value at 3% discount rate	$4,077
Net present value at 5% discount rate	$2,162
Net present value at 7% discount rate	$1,188
Internal rate of return	20%

Note: Because of methodological limitations of the LiST tool, this analysis is limited to scenarios that include all 10 interventions nationwide.
a. Annual increase in productivity over the productive lives of the beneficiaries.

FINANCING CURRENT AND PROPOSED NUTRITION-SPECIFIC INTERVENTIONS

The cost-effectiveness analysis presented here identifies an annual financing gap of between $19 and $51 million over five years, depending on which scenario is scaled up. This is above and beyond the $20 million of government's budget earmarked for the four years 2013–16 (Table 15). The additional GAFSP funding of $37 million over the next five years is a large contribution toward closing the gap, but additional resources will need to be mobilized to cover the additional financing gap that we have identified in this analysis.

Table 15. Estimated Budget for Nutrition Activities, 2013–16

Activity and source of funding	Estimated total (US$, millions)
UNAP: Ministry of Health	18.9
UNAP: Ministry of Education and Sports	1.2
UNAP: WASH (through the Ministry of Education)	0.1
UNAP total	*20.2*
GAFSP	36.9[a]
Total available financing	**57.1**

Source: UNAP figures are from Kakitahi 2013 using exchange rates from the International Monetary Fund 2014. GAFSP figures are from the Uganda Ministry of Finance, Planning and Economic Development et al. 2013.
Note: GAFSP = Global Agriculture and Food Security Program.
a. The GAFSP budget is for five years.

UNCERTAINTIES AND SENSITIVITY ANALYSES

Because actual unit costs may differ from our estimates, it is important to consider the effects of both an increase and a decrease in these costs on the overall cost of the interventions. This uncertainty is greatest for higher-cost interventions and less significant for those with lower costs. For example, given the prevalence of information on and experience with the less-expensive micronutrient and deworming interventions, there is a relatively high degree of certainty around their estimated costs and financing needs. On the other hand, the costs of community nutrition programs can vary greatly depending on their context: the intensity of community nutrition programs for growth promotion, the number of community health workers employed, and the amount of incentives provided all affect unit costs. Finally, there is very little information on the costs associated with the public provision of complementary food for the prevention of moderate acute malnutrition. In Uganda, no delivery mechanism is available to be used as a reference for these programs, while unit costs are highly dependent on the choice of targeting method and other factors, such as widespread corruption and diversion of food supplies. In order to account for these uncertainties, we perform a partial sensitivity analysis that describes the impact of variation in unit costs while holding other variables constant. These results are presented in Appendix 8.

PART IV – NUTRITION-SENSITIVE INTERVENTIONS

This section presents cost-benefit estimates for two nutrition-sensitive interventions delivered through the agriculture sector and three delivered through the education sectors. Table 16 summarizes the cost of scaling up these interventions and, when available, provides the number of DALYs averted and cost per DALY averted.

Table 16. Preliminary Results for Costing Nutrition-Sensitive Interventions

Intervention	Annual cost (US$, millions)	DALYs averted	Cost/DALY averted (US$)
Delivered through the agriculture sector			
Biofortification of vitamin A–rich orange sweet potatoes in the *Northern* area	10.6	—	4-7[a]
Biofortification of vitamin A–rich orange sweet potatoes in the *Western* area	11.1	—	4-7[a]
Biofortification of vitamin A–rich orange sweet potatoes in the *Eastern* area	11.9	—	4-7[a]
Biofortification of vitamin A–rich orange sweet potatoes in the *Central* area	11.4	—	4-7[a]
Aflatoxin control through improved post-harvest storage	—	—	—
Aflatoxin control of maize through biocontrol application	17.1	—	43[b]
Delivered through the education sector			
School-based deworming	0.46–0.77	—	4.6[c]
School-based promotion of good hygiene	14.6	—	—

Note: When data are not available for Uganda, estimates from countries with similar circumstances are used (see specific notes below). — = not available.
a. Estimate for Uganda (Birol et al. 2014).
b. Estimate for Nigeria (Khlangwiset 2011).
c. Estimate for Kenya (DCP2 2008).

NUTRITION-SENSITIVE INTERVENTIONS DELIVERED THROUGH THE AGRICULTURE SECTOR

To scale up the biofortification of vitamin A–rich (orange) sweet potatoes would cost approximately $11 million for each of the four areas of Uganda, or approximately $44 million to scale up across the whole country. We prioritize the areas based on the size of sweet potato production and the prevalence of vitamin A deficiency and stunting. Although sweet potatoes are produced all over Uganda, production is highest in the Northern area, followed by the Eastern area, the Western area, and the Central area (Bagama and Ilukor 2014). Vitamin A deficiency is most severe in the Eastern area of Uganda (42 percent of children 6–59 months were deficient in vitamin A in 2011). Stunting is most severe in the Northern and Western areas, and we therefore propose prioritizing these two areas. This cost calculation is based on the per person marginal cost of expanding production, as we assume that some infrastructure is already in place in Uganda as a result of the HarvestPlus pilot project. To fortify all orange sweet potato production in Uganda would require an investment of approximately $45 million. Birol and colleagues estimate per DALY averted for biofortication of sweet potatoes of $4-7 (HarvestPlus 2014); this is considered very cost effective by WHO standards and thus suggests large potential benefits from biofortication in Uganda. Although not included in this analysis, ex-ante estimates of the cost-effectiveness of biofortification of iron-rich beans in Honduras, Nicaragua and Northern Brazil also show cost-effective cost per DALY averted of between $20 and $439 (Meenakshi et al. 2010).

The total cost of scaling up aflatoxin reduction through the biocontrol of maize nationwide is estimated to be $17 million. This is based unit cost of a biocontrol product developed by IITA and tested in Nigeria (Bandyopadhyay 2013) and Uganda maize-planting area estimates of about 1.1 million hectares in 2012 (FAOSTAT 2014). It is assumed that biocontrol will be applied to all maize fields.[11] A study from Nigeria reports a cost per DALY averted of $43 (Khlangwiset 2011), which is considered very cost effective. We were not able to estimate total costs of a nationwide scale-up of improved food storage but a comparison of unit prices from Kenya (shown in Table 4) indicates that improved food storage would be less expensive but also less effective (IFPRI 2012). The analysis for Kenya as well as other studies suggest that successful control of aflatoxins will require a multifaceted strategy (IFPRI 2012, COMESA 2014).

NUTRITION-SENSITIVE INTERVENTIONS DELIVERED THROUGH THE EDUCATION SECTOR

The cost of scaling up school-based deworming is between $0.46 and $0.77 million as reported by Kabatereine et al. (2005), who use actual or estimated prevalence rates for each district in Uganda to categorize each into a prevalence category. The WHO recommends that where the prevalence of intestinal parasites is over 50 percent, treatment should occur twice yearly. In areas with a prevalence of 20 to 50 percent, treatment should be once a year. In areas with prevalence below 20 percent, it is recommended that medications be available at the health facility but no school-based treatment is needed. Using enrollment rates from the early 2000s, Kabatereine et al. (2005) estimate that 4.7 million school-aged children would be the target for twice-yearly treatment and 2.7 million would be the target for once-yearly treatment. Although the cost estimates are likely to be an underestimate because they rely on enrollment rates from the early 2000s and cost data from that same period, they provide a clear indication that school-based deworming is an attainable goal. *If every primary and secondary student enrolled in 2012 were*

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[11] Most maize in Uganda is consumed by humans, but some is also consumed by livestock. We were not able to estimate how many hectares produce maize for human consumption versus other purposes, so we estimate the cost for implementing biocontrol on all hectares of maize production.

treated twice a year for intestinal parasites, the cost would be $1 million. This is likely to be an overestimate because not every district would need twice-yearly treatment, but it indicates the upper boundary of cost.

The cost of scaling up school-based promotion of handwashing and good hygiene behavior is estimated to be $15 million. Although the promotion of WASH in schools normally includes sustainable and safe water supply points, handwashing stands, and sanitation facilities, the costing includes only the component of hygiene education. The target population is children enrolled in primary and secondary school and the current coverage is assumed to be negligible.[12]

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[12] Under UNAP, the Ministry of Education will undertake a mapping exercise to determine the number of schools with handwashing facilities and the state of those facilities and to identify gaps. There is also a small budget for monitoring facilities in schools, with an annual budget for WASH of about $50,000. However, none of this funding went toward supporting the teaching and practice of proper handwashing.

PART V – CONCLUSIONS AND POLICY IMPLICATIONS

Systematic costing of highly effective nutrition interventions is important for setting priorities, mobilizing resources, and advocating. Combining costing with estimates of impact (in terms of lives saved, DALYs averted, and cases of stunting averted) and cost-effectiveness analysis will make the case for investment in nutrition stronger and will aid in priority-setting by identifying the most cost-effective packages of interventions in situations where financing is constrained. This will potentially be a powerful evidence-based advocacy tool for policy makers—for example, it can assist the Ministry of Finance to make efficient budget allocations because it provides useful evidence on what the government can "buy" (in terms of lives saved, DALYs averted, or cases of stunting averted) given available resources.

Reaching full national coverage of the ten nutrition-specific interventions would require $68 million. Because it is unlikely that the government or its partners can allocate these resources, we consider strategies that make the most of the resources available. The report findings and recommendations are based on cost-benefit analyses that can help policy makers prioritize the allocation of resources more effectively to achieve maximum impact. The recommendations of this report represent a compromise between the need to increase coverage and the constraints imposed by limited resources and capacities. The most cost-effective scenarios would scale up nine of the ten interventions (excluding the public provision of complementary food) to full coverage levels (see Box). Whether these interventions are scaled up nationwide or only in the highest-burden regions will depend on the level of resources available for nutrition interventions. We estimate that expanding coverage of these nine interventions would cost between $19 and $60 million, depending on how many regions are included in the scale-up. As many as 7,600 lives could be saved and over 357,000 DALYs could be averted from these nine interventions.

Recognizing the challenges of scaling to full coverage in one year, we estimate the investment required to scale up over five years to be $188 million for full national scale up of all ten interventions and $54 million for the scale up of nine interventions (excluding the public provision of complementary food for the preventions of moderate acute malnutrition) in the highest-burden regions. An important next step will be the identification of sources of funding for these key nutrition interventions.

Box: Three Cost-Effective Scale-Up Options

If full coverage is not immediately feasible, three gradual scale-up scenarios are equally cost-effective:

Greatest Benefits: Scale up a subset of the most cost-effective interventions nationwide (Scenario 2):

- **$60 million** required annually ($168 million over five years)
- 337,000 life years saved*
- 8,200 lives saved
- *cost per life year saved = $185*

Moderate Benefits: Scale up the same subset of the most cost-effective interventions in the seven highest- and middle-burden burden regions (Scenario 3a):

- **$45 million** required annually ($125 million over five years)
- 254,000 life years saved*
- 6,200 lives saved
- *cost per life year saved = $182*

Lowest Cost: Scale up a subset of the most cost-effective interventions in only the three highest-burden regions:

- **$19 million** required annually ($54 million over five years)
- 108,000 life years saved*
- 2,700 lives saved
- *cost per life year saved = $182*
-

*Life years adjusted for disability (DALYs)

Although every attempt has been made to use real programming costs for these estimates, the costs estimated here are likely to be slight overestimates, while the benefits are likely to be underestimated, as discussed earlier. For some interventions, in particular breastfeeding promotion and complementary feeding education, unit costs were taken sources outside Uganda because at the time the research was conducted none were available for Uganda. An important next step will be to estimate costs using local information. Ideally this would involve comparing costs according to delivery platform and include consideration of how costs vary as greater coverage rates are achieved. Another limitation of the analysis is that it does not capture differences in costs across regions. In a large country such as Uganda, we would expect a wide range in actual costs because they depend in part on population density, social and cultural differences, available infrastructure, and other factors.

Even though this report focuses extensively on nutrition-specific interventions, the causes of malnutrition are multisectoral, so any longer-term approach to improving nutrition outcomes must also include nutrition-sensitive interventions. This analysis takes an innovative approach to nutrition costing by not only estimating the costs and benefits of nutrition-specific interventions but also considering costs of four nutrition-sensitive interventions implemented outside of the health sector. However, the analysis presented here is only a starting point and is meant to spur more analytical work to identify interventions that substantially improve nutritional status. As the government continues to develop a multisectoral nutrition policy, it would be useful to consult across sectors and ministries in order to identify other possible nutrition-sensitive interventions that are cost-effective. More robust data on nutrition-sensitive interventions are needed to do this.

Overall, the findings presented in this report point to a powerful set of nutrition-specific interventions and a candidate list of nutrition-sensitive approaches that represent a cost-effective approach to reducing the high levels of child malnutrition in Uganda. Key next steps are for the Government of Uganda and its partners to identify milestones in addressing undernutrition in Uganda, to develop a road map of key actions, and to develop and implement a business plan to mobilize funds to scale up the high-impact intervention package identified in this report.

APPENDIXES

APPENDIX 1: MAP OF UGANDA

Source: World Bank Group, internal map, 2012.

APPENDIX 2: TARGET POPULATION BY DHS REGION

DHS region	Breast-feeding/ comple-mentary feeding promotion	Vitamin A supplementation	Therapeutic zinc supplementa-tion	Multiple micro-nutrient powders	Deworm-ing	Iron-folic acid supplementa-tion	Iron fortifica-tion of staple foods	Salt iodiza-tion	Public provision of complemen-tary food	Community-based manage-ment for moderate and severe acute malnutri-tion
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Kampala	150,541	158,598	313,014	109,365	115,728	11,187	1,566,245	26,626	6,611	10,294
Central 1	431,509	588,310	906,440	289,548	432,539	60,152	4,489,463	17,958	42,884	7,377
Central 2	369,039	440,839	763,385	251,894	350,451	38,327	3,839,522	46,074	32,411	33,122
East Central	390,698	243,793	834,906	250,726	422,550	54,823	4,064,866	60,973	50,266	28,387
Eastern	512,320	317,494	1,083,858	355,219	419,909	54,863	5,330,227	-	39,469	13,138
Karamoja	98,139	55,156	207,621	51,487	65,644	4,168	1,021,047	2,042	24,118	10,905
North	355,572	308,496	729,450	240,237	347,042	30,692	3,699,413	-	33,693	10,638
West Nile	264,205	261,407	534,671	167,107	265,334	16,586	2,748,813	38,483	36,434	27,101
Western	459,402	392,689	946,381	299,062	409,429	56,618	4,779,667	71,695	54,858	27,488
Southwest	428,166	511,470	914,973	280,708	463,072	75,694	4,454,686	71,275	49,149	51,239
Total	**3,459,590**	**3,278,253**	**7,234,699**	**2,295,352**	**3,291,698**	**403,109**	**35,993,950**	**335,127**	**369,891**	**219,688**

Sources and Notes:
Column 1: UBOS 2014 (Children 0–23 months); **Column 2:** UBOS 2014 (Children 6–59 months), Vitamin A coverage from DHS 2011; **Column 3:** UBOS 2014 (Children 6–59 months), Zinc supplementation coverage from DHS 2011; **Column 4:** UBOS 2014 (Children 6–23 months), Percent < −2 WAZ from DHS 2011; **Column 5:** UBOS 2014 (Children 12–59 months), Deworming coverage from DHS 2011; **Column 6:** UBOS 2014, Number of pregnant women calculated using Crude Birth Rate from UNICEF 2012a, Still Birth Rate from WHO 2006, Iron-folic acid supplementation coverage from DHS 2011; **Column 7:** UBOS 2014 (Total population); **Column 8:** UBOS 2014 (Total population), Percent of households consuming iodized salt from DHS 2011; **Column 9:** UBOS 2014 (Children 6–23 months), Percent < −2 WAZ from DHS 2011; **Column 10:** UBOS 2014 (Children 6–59 months), Percent < −3 WHZ from DHS 2011. This represents the total population of children 6–59 months not treated for severe acute malnutrition although we expect to reach only 80 percent of this population. **Additional sources:** Population Growth Rate from the World Bank's World Development Indicators 2014; Population Census 2014 from UBOS 2014.

Intervention	Costed delivery platform	Unit cost (US$ per beneficiary per year)	Source	Assumptions
1. Breastfeeding/ Complementary feeding promotion	Community nutrition programs	6.90	Unit cost for Kenya (World Bank, 2017)	Breastfeeding counseling: $4.43 Complementary feeding counseling: $2.47 Both based on medical personnel (nutritionists, nurses, student volunteers, community health workers) time spent on each case
2. Vitamin A supplementation (children)	Child Health Weeks	0.16	Uganda Nutrition Action Plan (2011–16)	Commodity cost: $0.04 (each capsule) Delivery cost: $0.08
3. Therapeutic zinc supplementation with ORS (children)	Primary health care and community nutrition program	0.90	Unit cost for Zambia (World Bank 2015)	Assuming diarrhea three episodes/year and each required 12 tablets for treatment
4. Multiple micronutrient powders for children (children)	Community nutrition programs	2.60	Uganda Nutrition Action Plan (2011–16)	Commodity cost: $2.26 Delivery cost: $0.34
5. Deworming (children)	Child Health Weeks	1.10	Unit cost for Zambia (World Bank 2015)	Supplements are distributed through biannual maternal, neonatal and child health weeks, with overhead costs (for planning, advocacy, social mobilization, health worker and

				volunteer training, monitoring, supervision) shared with other interventions
6. Iron-folic acid supplementation of pregnant women	Primary health care and community nutrition programs	2.11	Unit cost for Zambia (World Bank 2015)	Assume daily iron-folic acid supplements for last two trimesters of pregnancy (about 180 tablets) delivered through maternal, newborn, and child health weeks
7. Iron fortification of staple foods (general public)	Market-based delivery system	0.16	Unit cost for Zambia (World Bank 2015)	Based on total annual capital and recurrent costs divided by total population
8. Salt iodization (general public)	Market-based delivery system	0.05	World Bank 2010	Global estimate is used; no specific information on is Uganda available
9. Public provision of complementary food for prevention of moderate acute malnutrition (children)	Community nutrition programs	66.50	Uganda Nutrition Action Plan (2011–16)	Commodity cost: $51.14 Delivery cost: $15.34
10. Community-based treatment of severe acute malnutrition (children)	Primary health care and community nutrition programs	87.21	Uganda Nutrition Action Plan (2011–16)	Commodity cost: $58.14 Delivery cost: $29.07

APPENDIX 4: METHODOLOGY FOR ESTIMATING COSTS FOR UGANDA

The following steps lay out the methodology used to estimate costs for each intervention:

1. Describe each intervention
2. Define target populations for each intervention
3. Estimate the size of the target populations for each intervention in each province using the most current demographic data
4. Specify the delivery platform or channel(s) for each intervention, based on the country context and the accepted delivery modes
5. Identify data on the current coverage levels for each intervention in each province
6. Estimate the unit cost per beneficiary for each intervention from program experience in Uganda, whenever possible, and/or Africa region
7. Calculate additional costs of scaling up to full coverage by multiplying the unit cost for each intervention with the size of the "uncovered" target population for each intervention by province. The formula for calculation is:

$$x_1 = z_1(100 - z_2)$$

where:

x_1 = additional costs of scaling up to full coverage
z_1 = unit cost per beneficiary
z_2 = current coverage level (percentage)

8. Estimate additional resources for (1) capacity development for program delivery and (2) M&E, operations research, and technical support, estimated at 9 percent and 2 percent of total cost of interventions, respectively
9. Estimate a portion of the total cost that can be covered by private household resources. It is assumed that households above the poverty line could cover their own cost of iron fortification, multiple micronutrient powders, salt iodization, and complementary food from private resources
10. Calculate the annual public investment required to scale up these interventions to full coverage using the following formula:

$$Y = (x_1 + x_2) - x_3$$

where:

Y = annual public investment required to scale up to full coverage
x_1 = additional total cost to scale up to full coverage
x_2 = additional cost for capacity development, M&E, and technical assistance
x_3 = cost covered by households living above poverty line for selected interventions

Full coverage is defined as 100 percent of the target population for all interventions except the treatment of severe acute malnutrition, which is set to 80 percent. This is consistent with World

Bank (2010) methods and is based on the reality that few community-based treatment programs have successfully achieved more than 80 percent coverage at scale.

The following steps were undertaken to estimate the impact in DALYs averted of implementing the various nutrition interventions:

1. Estimate the effectiveness of each intervention on mortality and morbidity for each targeted cause
2. Calculate the rate of YLL and YLD due to each cause-risk factor combination for the target population
3. Calculate the DALYs averted under current or counterfactual coverage scenario
4. Calculate the DALYs averted under the proposed intervention coverage scenario
5. Calculate the net DALYs averted by the proposed intervention

1. Estimate the effectiveness of each intervention on mortality and morbidity for each targeted cause

To estimate the effectiveness of the interventions, key articles by Black et al. (2013) and Bhutta et al. (2013) in the *Lancet* series on maternal and child undernutrition were first consulted. Additional literature searches for the latest evidence were conducted in the Pubmed online database and the Cochrane Library of systematic reviews and meta-analyses. Effectiveness figures that were reported as statistically significant were extracted and used for the calculations.

2. Calculate the rate of YLL and YLD

The WHO's 2012 Global Health Estimates (GHE 2012) data tables provide country-specific YLL and YLD rates for each cause of death or disease (WHO 2012). GHE 2012 morbidity and mortality estimates were used in combination with country-specific population attributable fractions (PAF) from the *Global Burden of Disease* (IHME 2010). This assumes that the risk factor impacts on morbidity and mortality did not differ significantly between the two estimates.

To calculate the rate of morbidity and mortality from a cause due to a specific risk factor, the first step is to calculate the PAF for the cause-risk factor combination. The PAF was extracted from the country-specific risk factor attribution table from the 2010 GBD data. This was done separately for YLL and YLD. In the second step, the country-specific YLLs and YLDs for the target population—in most cases children under five years old—were extracted from the GHE 2012 estimates. To calculate the YLL rate, the country-specific YLL is multiplied by the YLL PAF and then by 100,000. The final figure is divided by country-specific population of interest (usually children under five) to get the rate. The same final steps are followed to calculate the YLD, although instead multiplying country-specific YLDs by the YLD PAF. The population estimate for the rate calculation was extracted from GHE 2012.

YLL per 100,000 = (U-5_cause_total_YLL * YLL_PAF * 100,000)/U-5_ population
YLD per 100,000 = (U-5_cause_total_YLD * YLD_PAF * 100,000)/U-5_population

where:

U-5_population = the population of children under five

3. Calculate counterfactual DALYs averted

To calculate the DALYs averted if current intervention coverage were maintained, the following formula was used:

YLL = U-5_population_intervention_year * current_coverage
  * intervention_mortality_reduction * YLL_rate

YLD = U-5_population_intervention_year * current_coverage
  * intervention_morbidity_reduction * YLL_rate

DALY_current = YLL + YLD

4. Calculate total DALYs averted under intervention coverage

To calculate the potential DALYs averted under the intervention coverage, a similar formula as above was used:

YLL = U-5_population_intervention_year * intervention_coverage
  * intervention_mortality_reduction * YLL_rate

YLD = U-5_population_intervention_year * intervention_coverage
  * intervention_morbidity_reduction * YLL_rate

DALY_intervention = YLL+YLD

5. Calculate net DALYs averted

The potential net DALYs averted by the intervention is:

DALYs averted = DALY_intervention - DALY_current

APPENDIX 6: METHODOLOGY FOR UGANDA LiST ESTIMATES

The Lives Saved Tool (LiST) is a part of an integrated set of tools that comprise the Spectrum policy modeling system. These tools include DemProj for creating demographic projections; AIM to model and incorporate the impact of HIV/AIDS on demographic projections and child survival interventions; and FamPlan for incorporating changing fertility into the demographic projection. LiST is used to project how increasing intervention coverage would impact child and maternal survival. The table below summarizes data sources used for the Uganda LiST estimates.

Uganda LiST estimates	Data sources
Demographic data	
First year population	UN DESA 2012
Sex ratio at birth	UNData: http://data.un.org/Data.aspx?q=sex+ratio&d=PopDiv&f=variableID%3a52
Life expectancy	UN DESA 2012
Family planning	
Unmet need	Bradley et al. 2012
Total fertility rate	DHS 2011
Age-specific fertility rate	UN DESA 2012
Health, mortality, economic status	
Vitamin A deficiency	DHS 2011, Addendum to Chapter 11
Zinc deficiency	Wessells and Brown 2012
Diarrhea incidence	Fischer Walker et al. 2012
Severe pneumonia incidence	Rudan et al. 2013
Malaria exposure (women)	Guerra et al. 2008
Stunting distribution	LiST default; data have been calculated using DHS data sets
Wasting distribution	LiST default; data have been calculated using DHS data sets
Neonatal mortality	DHS 2011
Infant mortality	DHS 2011
Child mortality	DHS 2011
Distribution of causes of death	Liu et al. 2012
Maternal mortality ratio	DHS 2011
Household poverty status	World Bank 2012b, accessed 2014
Household size	LiST default; data have been calculated using DHS data sets

Once the demographic and health data have been updated, the coverage and scale-up plan for each intervention is introduced into LiST. LiST either can use a sequential method to calculate the impact of individual interventions or can calculate the simultaneous impact of a set of interventions implemented at the same time. The second, simultaneous method is likely to yield

slightly lower estimates because interventions may have overlapping benefits. In this analysis we present the both the individual/sequential results of the individual interventions for full coverage (with totals calculated using the simultaneous method) and the simultaneous impact in the various scale-up scenarios.

Note on Estimates of Cases of Stunting Averted

In order to estimate the number of cases of under-five stunting averted attributable to the annual investment in the scaling up of nutrition interventions, we use LiST to model changes in the prevalence of stunting over five years, during which the interventions are projected to have reached 100 percent of the target population. Next, we model changes in the prevalence of stunting over five years with no scale-up of the interventions. We then take the difference between the estimated stunting prevalence in Year 5 with the scale up and the prevalence in Year 5 absent the scale-up, and multiply this percentage point difference by the total population of children under five years of age.

Our reason for using stunting prevalence in Year 5 relates to the assumptions built into the LiST model, which assumes that stunting is itself a risk factor for becoming stunted in the next time period. As a result, stunting prevalence remains flat during the first two years of the scale-up, before dropping precipitously until Year 5, after which the prevalence begins to level out. We assume that continuing investments in maintaining scale after Year 5 will serve to maintain the gains in stunting prevalence reduction, and therefore we present this reduction as a benefit attributable to a one-year investment in scaling up nutrition.

On the other hand, when estimating stunting reduction (and lives saved) attributable to a five-year scale-up plan, we model this scale-up directly in LiST and use the annual results over five years in our cost-benefit analysis. Using annual results over five years provides a more accurate portrayal of the direct benefits attributable to a five-year scale up plan, and it does not assume that the scale will necessarily be maintained following the end of the period covered in the plan.

APPENDIX 7: METHODOLOGY FOR ESTIMATING ECONOMIC BENEFITS

There is considerable debate in the literature regarding the best methodology for monetizing the value of a life saved. In this analysis, we focus solely on the economic value of a life year, which we measure as equal to GNI per capita. Other studies attempt to estimate the social value of a life year as well as its economic value; because we do not, we acknowledge that our results underestimate the true value of a life year saved.

Still, valuing years of life saved alone does not account for the economic benefits of reduced morbidity, which include the long-term, nonlethal impacts of malnutrition on individuals. Although there are a number of long-term impacts of nutritional deficiencies, we choose to focus on stunting because of the availability of country-specific impact estimates produced by the LiST tool.[13]

In order to estimate the economic value of a case of childhood stunting averted, we follow the methodology used in Hoddinott et al. (2013), who begin by assuming that stunted individuals lose an average of 66 percent of lifetime earnings, based on direct estimates of the impact of stunting in early life on later life outcomes found in Hoddinott et al. (2011).[14] This estimate for the effects of stunting on future consumption is used as a proxy for the effect of stunting on lifetime earnings. Additionally, Hoddinott et al. (2013) account for uncertainty by assuming that only 90 percent of the total gains will be realized, which we also include in our calculations. However, unlike those authors, we adjust our calculations to reflect the country's labor force participation rate.

For both lives saved and cases of stunting averted, the benefits of a five-year scale-up plan are attributed to a group of children that is assumed to enter the labor force at age 15 and exit the labor force at age 59, which is equivalent to life expectancy at birth in Zambia. Benefits from both stunting and lives saved are then multiplied by a lifetime discount factor (LDF) in order to obtain the present value of benefits incurred during the expected years of productivity (years between the age of entry into and exit from the workforce). The LDF is derived from three potential discount rates (3 percent, 5 percent, and 7 percent), an adjustment for age at the time of investment (for simplicity, we assume an average age of two years for all children), and the years of lifetime productivity expected. The LDF represents the years of productivity that are "counted" in the calculation, discounted back to their present value in the year in which the investment in nutrition is made. Because we assume an average age of two years for all beneficiaries, we use an LDF that assumes that these children will enter the labor force 13 years from the time of investment. Importantly, given the time frame considered under this analysis, we do not attempt to account for projected growth in the country's GDP and per capita incomes. This downward bias contributes to the conservative nature of our estimates.

The following equations are used to estimate (1) the economic value of lives saved (reduced mortality) and (2) increased future productivity (reduced morbidity):

1. *Present value of reduced mortality* = (*lives saved attributable to intervention scale-up*)

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[13] It should be noted that because stunting is just one of many long-term consequences of poor nutrition, actual economic benefits of improving nutrition may be much higher than estimated here.

[14] Hoddinott et al. (2011) provided direct estimates of the impact of stunting in early life on later life outcomes, which found that an individual stunted at age 36 months had, on average, 66 percent lower per capita consumption over his or her productive life.

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*(GNI per capita) * LDF

2. *Present value of reduced morbidity =* (*cases of child stunting averted*)
    * (*coefficient of a deficit*) * (*percent of income actually realized*) * (*GNI per capita*)
    * (*LDF*)

where:

- Lives saved attributable to the intervention scale-up are estimated using the LiST tool.
- Cases of child stunting averted are calculated by subtracting the projected under-five stunting prevalence (%) after the interventions are scaled up calculated by LiST from the projected stunting prevalence under a scenario with no scale up and multiplying it by the total under-five population.
- The coefficient of deficit is equal to the reduction in lifetime earnings attributable to stunting.
- The lifetime discount factor (LDF) is used to discount future benefits to their value at the time of investment. It is derived from a discount rate, age at the time of investment and the estimated age of entry and exit into the workforce. The equation used to calculate the LDF is:

$$LDF = \sum_{t=13}^{t=T} \frac{1}{(1+r)^t}$$

where:

LDF = the lifetime discount factor
   $r =$ is the discount rate
   $t =$ the time period since the initial investment in scaling up the interventions (we assume that children are 2 years old at the time of investment and enter the labor force at 15 years old, which is reflected in the starting value for t)
   $T =$ the last time period before individuals exit the labor force (we assume individuals are out of the workforce at life expectancy at birth)

Note, the beginning time period t and ending period T is adjusted for each cohort based on the year of investment. For example, the first cohort is assumed to enter the labor force at time period t=13 and exit at time T, the second cohort is assumed to enter the labor force at time period t=14 and exit at time T+1, and so forth.

The following values and sources are used in our calculations:

Indicator	Value	Source
GNI per capita	US$660	World Bank 2013c
Life expectancy at birth	59 years	World Bank 2012b
Labor force participation rate	79%	World Bank 2012b
Coefficient of deficit (stunting)	0.66	Hoddinott et al. 2011
Actual gains realized	90%	Hoddinott et al. 2013

To arrive at a net present value (NPV), we use the following equation:

$$NPV = \sum_{c=1}^{5} (PV \ of \ reduced \ mortality)_c + (PV \ of \ reduced \ morbidity)_c$$

$$- \sum_{t=1}^{5} \frac{1}{(1+r)^t} (investment \ cost)_t$$

where c is the cohort group and t is the time period.

Finally, the annual addition to economic productivity is measured by taking the total economic benefits for the year in which all beneficiaries of the initial one-year investment have reached productive age. These benefits are not discounted back to their present value, as they are considered the annual opportunity cost of not investing in scaling up nutrition interventions. It should be noted that these benefits are derived from a progressive, five-year scale-up plan, and therefore subsequent investments that maintain the target scale will increase the total annual benefits as new beneficiaries are reached.

Assumption change	Effect on total annual cost
Iron fortification of staple foods unit cost doubles	Increase from $87.0 million to $92.8 million
All micronutrient and deworming unit costs double	Increase from $87.0 million to $110.3 million
Breastfeeding/complementary feeding promotion unit cost doubles	Increase from $87.0 million to $110.9 million
Complementary food unit cost doubles	Increase from $87.0 million to $111.6 million
Community-based management of severe acute malnutrition unit cost doubles	Increase from $87.0 million to $102.4 million
Iron fortification of staple foods costs reduced by 50%	Decrease from $87.0 million to $84.2 million
All micronutrient and deworming unit costs reduced by 50%	Decrease from $87.0 million to $75.4 million
Breastfeeding/complementary feeding promotion unit cost reduced by 50%	Decrease from $87.0 million to $75.1 million
Complementary food unit cost reduced by 50%	Decrease from $87.0 million to $74.7 million
Community-based management of severe acute malnutrition unit cost reduced by 50%	Decrease from $87.0 million to $79.4 million

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This paper builds on global experience and Uganda's specific context to estimate costs, benefits, and cost-effectiveness of key nutrition interventions. It is intended to help guide the selection of the most cost-effective interventions as well as strategies for scaling these up. The paper considers both relevant "nutrition-specific" interventions, largely delivered through the health sector, and multisectoral "nutrition-sensitive" interventions, delivered through other sectors such as agriculture, education, and water and sanitation. We estimate that the costs and benefits of implementing 10 nutrition-specific interventions in all regions of Uganda would require a yearly public investment of $68 million. The expected benefits are enormous: annually over 8,000 lives would be saved, while at least 375,000 DALYs and 8,700 cases of stunting among children under five would be averted. Economic productivity could potentially increase by $280 million annually over the productive lives of the beneficiaries, with an impressive internal rate of return of 18 percent. However, because it is unlikely that the Government of Uganda or its partners will be able to find the $68 million necessary to reach full coverage, we also consider scale-up scenarios based on considerations of their potential for impact, burden of stunting, resource requirements, and implementation capacity. The most cost-effective scenario considered would provide a subset of key interventions in regions with the highest rates of stunting and would cost between $19 and $60 million, depending on how many regions are covered. We then identify and cost five nutrition-sensitive interventions relevant to Uganda for which there is both evidence of positive impact on nutrition outcomes and some cost information. These findings point to a powerful set of nutrition-specific interventions and a candidate list of nutrition-sensitive approaches that represent a highly cost-effective approach to reducing child malnutrition in Uganda.

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