

SCALING UP NUTRITION IN THE DEMOCRATIC REPUBLIC OF CONGO: WHAT WILL IT COST?

DISCUSSION PAPER

MARCH 2015

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WORLD BANK GROUP
Health, Nutrition & Population

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Health, Nutrition and Population (HNP) Discussion Paper

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Health, Nutrition and Population (HNP) Discussion Paper

Scaling Up Nutrition in the Democratic Republic of Congo: *What Will It Cost?*

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Abstract: This paper builds on global experience and the DRC’s specific context to identify an effective nutrition approach along with costs and benefits 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 provinces of the DRC would require a yearly public investment of \$371 million. The expected benefits are enormous: annually over 5.4 million DALYs and over 76,000 lives would be saved, while at least 1 million cases of stunting among children under five would be averted. Economic productivity could potentially increase by \$591 million annually over the productive lives of the beneficiaries, with an impressive internal rate of return of 13.6 percent. However, because it is unlikely that the Government of the DRC or its partners will find the \$371 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 provinces with the highest rates of stunting and would cost between \$97 and \$185 million depending on how many provinces are covered. We then identify and cost six nutrition-sensitive interventions relevant to the DRC and for which there are 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 the DRC.

Keywords: nutrition-specific interventions, nutrition-sensitive interventions, cost-effectiveness of nutrition interventions, Democratic Republic of Congo, nutrition financing.

Disclaimer: The findings, interpretations and conclusions expressed in the paper are entirely those of the authors, and do not represent the views of the World Bank, its Executive Directors, or the countries they represent.

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ABBREVIATIONS AND ACRONYMS

BMGF	Bill & Melinda Gates Foundation
BMI	body mass index
CCT	Conditional cash transfers
CIDA	Canadian International Development Agency
DALYs	disability-adjusted life years
DFID	Department for International Development
DHS	Demographic and Health Survey
DRC	Democratic Republic of Congo
ECHO	European Commission for Humanitarian Aid and Civil Protection
EU	European Union
FAO	United Nations Food and Agriculture Organization
GBD	global burden of disease
GDP	gross domestic product
GHE	Global Health Estimates
GNI	gross national income
HKI	Helen Keller International
HNP	Health, Nutrition and Population
IDA	World Bank's International Development Assistance
IHME	Institute for Health Metrics and Evaluation
INS	National Institute of Statistics (Institut Nationale des Statistiques)
LiST	Lives Saved Tool
M&E	monitoring and evaluation
MICS/ELIM	Multiple Indicator Cluster Survey/Enquête Légère Intégrée auprès des Ménages (household income and expenditure survey)
MOB	Ministry of Budget
MOH	Ministry of Health
MQSUN	Maximising the Quality of Scaling Up Nutrition
NGO	nongovernmental organization
NIH	National Institutes of Health
NPV	net present value
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
ORS	oral rehydration solution
PRONANUT	Programme National de Nutrition (National Nutrition Program)
SUN	Scaling Up Nutrition
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

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 (Unnevehr and Grace 2013; Abt Associates 2014).

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:

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

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:

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

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:

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

EXECUTIVE SUMMARY

The overall objective of this report is to support the Government of the Democratic Republic of Congo (DRC) in developing a costed scale-up plan for nutrition. It builds on the recently developed national nutrition policy 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 the DRC. 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 the DRC.

Despite being home to only 1 percent of the world's population, the DRC is one of the five countries responsible for half of all deaths globally among children under five years of age (WHO 2012a). High prevalence of stunting among children is one of the major underlying causes of child mortality in the country. Between 2001 and 2014, the prevalence of stunting among children under five remained practically unchanged, at about 43 percent. Despite reductions in the prevalence of underweight (which dropped from 34 percent in 2001 to 23 percent in 2014) and wasting (21 percent in 2001 to 8 percent in 2014), progress in stunting has been very slow in recent years, with declines of just 1 percent over the last four years (DHS 2013–14). There is also considerable variation by province in the prevalence of stunting, with the highest prevalence rates concentrated in three provinces: Kasai-Occidental, Nord-Kivu, and Sud-Kivu. Micronutrient deficiencies (*hidden hunger*) are also prevalent, with vitamin A deficiency and anemia rates particularly high.

Malnutrition, particularly in very young children, leads to increased mortality rates, increased illness, and longer-term effects on cognitive abilities. These result in irreversible losses to human capital that contribute to later losses in economic productivity. Undernutrition is responsible for about one-half of under-five child mortality and one-fifth of maternal mortality in developing countries. 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 addition, it is estimated that vitamin and mineral deficiencies in the DRC collectively add up to an estimated loss of over \$100 million in gross domestic product (GDP) every year (World Bank 2011).

At the same time, nutrition interventions are consistently identified as being among the most cost-effective development actions, with 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 (World Bank 2010; Hoddinott et al. 2013). 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 and 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 the DRC 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 the DRC. Combining costing with estimates of impact (in terms of lives saved, DALYs saved, 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 provinces of DRC.¹ We refer to this as the *full coverage scenario* and estimate that it would require an annual public investment of \$371 million. The expected benefits are enormous: over 5.4 million DALYs and over 76,000 lives would be saved annually, while at least 1 million cases of stunting among children under five would be averted. *This investment of \$371 million also has the potential to increase economic productivity by \$591 million annually over the productive lives of the beneficiaries and to yield an impressive internal rate of return on the investment of 13.6 percent.*

Given resource constraints, 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 the DRC:

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

When considered in terms of resource requirements and cost-effectiveness (cost per benefit unit), two scenarios stand out as the most attractive (see Box 1). The first would scale up a limited set of effective interventions in the nine provinces that have rates of stunting over 40 percent, requiring an annual public investment of \$185 million. The second costs less (\$97 million) and would provide the same set of effective interventions in the five provinces where stunting rates are higher than 45 percent and severe stunting rates exceed 25 percent.

¹ The 10 nutrition-specific interventions are community nutrition programs for growth promotion, vitamin A supplementation, therapeutic zinc supplement with ORS, 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.

When the DRC is ready to commit substantially more resources to fighting undernutrition, another scenario offers an equally attractive cost per DALY saved of \$49, but it requires a much larger annual investment of \$279 million. This scenario would also provide the extraordinary benefits of over 5.3 million DALYs and 66,000 lives saved. This scenario has the added benefit of providing nutrition interventions in all provinces and is thus more politically feasible.

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 most cost-effective would require an investment of \$523 million over five years and the lowest-cost scenario would require \$275 million, assuming a full scale-up in five years. These total five-year costs are significantly less than the \$1.04 billion needed for the full coverage scenario, but still represent a significant increase over current spending on nutrition in the DRC. 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. As discussed above, currently there are negligible public budget allocations to nutrition interventions and to date the bulk of financing comes from international aid, which totaled about \$25 million in 2012. More recently, the Department for International Development (DFID) is providing \$7.3 million in support of nutrition interventions during 2013–2015, and the World Bank is planning \$16.4 million in support for key nutrition interventions for 2015–2020. USAID contributes about \$10 million a year to the treatment of severe acute malnutrition plus about \$30 million a year for food assistance programs. ECHO, the Government of Belgium and the Government of Japan also support emergency nutrition services and community based management of severe acute malnutrition. Nevertheless, given that the most modest of the scenarios presented here would require \$97 million in annual investment, a priority is to identify additional sources of funding.

Box 1: Three Cost-Effective Scale-Up Options

If full coverage is not immediately feasible, the annual costs and benefits of the three most cost-effective gradual scale-up scenarios are:

1. Most cost-effective: Scale up a subset of the most cost-efficient interventions in nine high-burden provinces:

- **\$185 million** required annually (\$523 million over five years)
- 3.6 million life years saved*
- 44,000 lives saved
- *cost per life year saved = \$48*

2. Lowest cost: Scale up the same subset of the most cost-efficient interventions in the five highest-burden provinces:

- **\$97 million** required annually (\$275 million over five years)
- 1.8 million life years saved*
- 22,000 lives saved
- *cost per life year saved = \$50*

3. Greatest benefits, very cost-effective: Scale up a subset of the most cost-efficient interventions in all provinces:

- **\$279 million** required annually (\$790 million over five years)
- 5.3 million life years saved*
- 66,000 lives saved
- *cost per life year saved = \$49*

*Life years saved adjusted for disability (DALYs)

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 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 estimating not only the costs and benefits of nutrition-specific interventions, but also by 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 six nutrition-sensitive interventions in other sectors that have shown some potential for improving nutrition outcomes. These include three interventions based in the agriculture sector: biofortification of vitamin A-rich yellow cassava, aflatoxin control in maize and groundnuts through biocontrol, and the promotion of the wetting method for konzo control. Two interventions based in the education sector are also considered: school-based deworming and school-based promotion of good hygiene. A water, sanitation and hygiene infrastructure intervention (WASH) with a behavior change component is also considered. The estimated annual costs are modest: \$13 million for the biofortification of yellow cassava; \$31 million for aflatoxin control; \$5 million for the promotion of the wetting method for konzo control; \$2 million for school-based deworming; \$13 million for school-based promotion of good hygiene, and \$1.04 billion for the WASH intervention. However, these costs must be considered rough approximations, as 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. More robust data on nutrition-sensitive interventions are needed to inform future scale-up priorities.

Overall, 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 the high levels of child malnutrition in the DRC. Critical next steps are for the Government of the DRC and its partners to develop a road map of key actions to pursue and to identify milestones to be reached in addressing undernutrition in the country.

PART 1 – BACKGROUND

COUNTRY CONTEXT

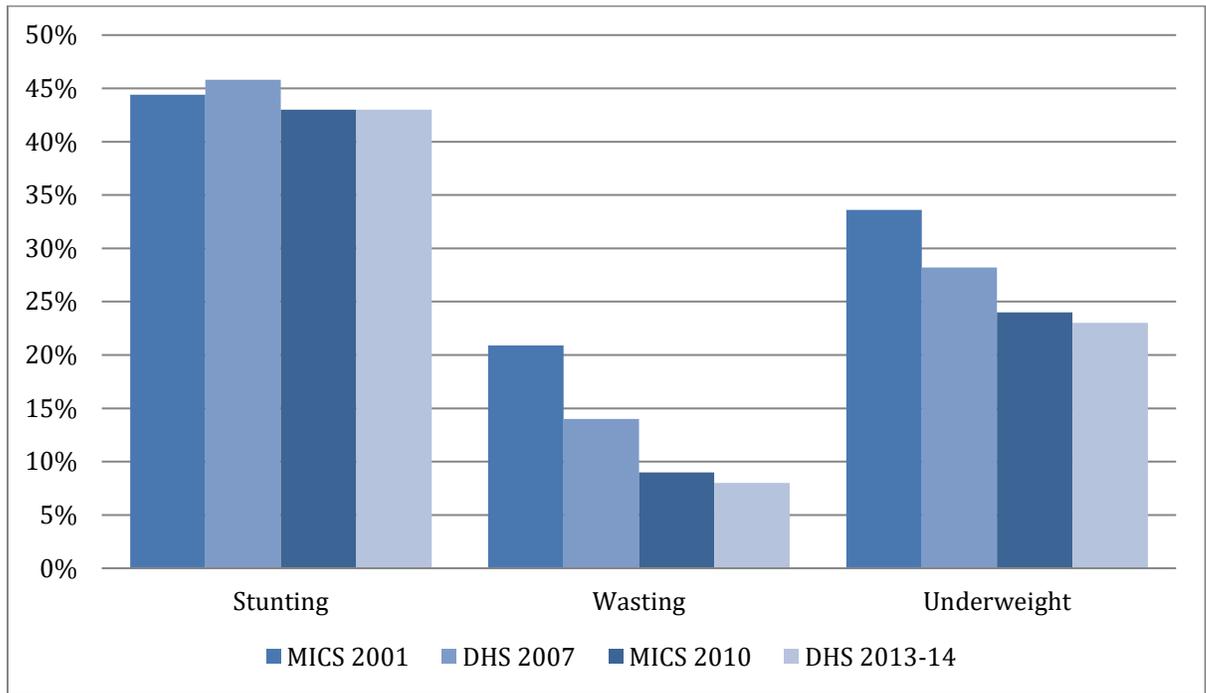
The Democratic Republic of Congo (DRC) is a vast, resource-rich country that nonetheless remains one of the world’s poorest nations. With more than 80 million inhabitants spread across a landmass roughly equivalent to two-thirds the surface area of the European Union and endowed with significant mineral and agricultural resources (see Appendix 1 for a map of the DRC and its provinces), the DRC has the potential to be one of the richest countries on the African continent (National Statistics Institute 2013; World Bank 2014). However, decades of armed conflict, weak institutions, underdeveloped infrastructure, and an overwhelmingly rural population (over 60 percent of its inhabitants live in rural areas) have prevented the DRC from exploiting its natural wealth (World Bank 2014a). According to the most recent World Bank estimates, 63 percent of the country’s inhabitants live in poverty, life expectancy stands at just 49 years, and the DRC ranks 186th out of 187 countries on the United Nations Development Programme’s (UNDP’s) 2013 *Human Development Index* (World Bank 2013a; UNDP 2014). Although GDP has increased at a solid annual rate of above 7 percent since 2010, driven largely by growth in the extractive industries, many Congolese—particularly those displaced by past and ongoing conflicts—continue to live hand to mouth (World Bank 2014a).

HEALTH AND NUTRITIONAL STATUS IN THE DRC

Despite being home to just 1 percent of the world’s population, the DRC is one of the five countries responsible for half of all deaths globally among children under five years of age (WHO 2012a).² About half of these deaths are caused by malnutrition. Even with efforts to improve the nutritional status of Congolese children, the prevalence of stunting among children under five has remained practically unchanged—just under 45 percent—between 2001 and 2014 (Figure 1). This prevalence has persisted despite reductions in the prevalence of underweight in children under five (this has dropped from 34 to 23 percent) and wasting (21 to 8 percent): reduction in child stunting has seen declines of just 1 percent over the last four years (DHS 2013–14). High child stunting rates remains one of the most intransigent health issues in the DRC.

² The other four countries are China, India, Nigeria, and Pakistan.

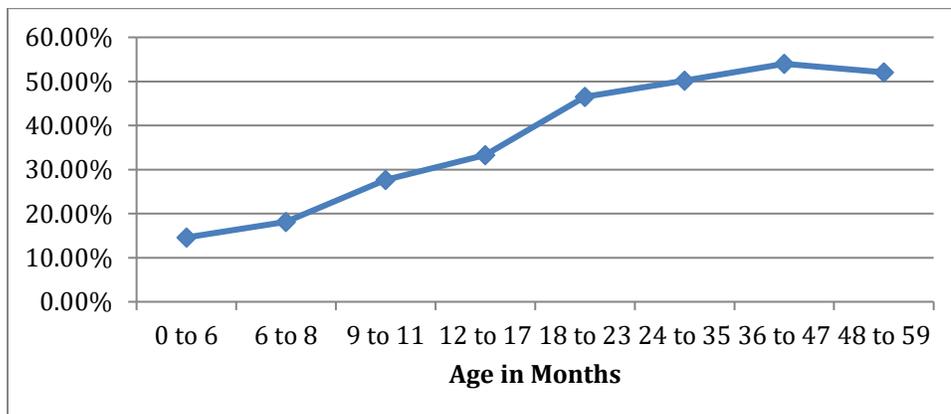
Figure 1: Trends in Malnutrition Indicators in the DRC, percent of Children under Five, 2010–2013/14



Source: MICS/ELIM 2001, 2010; DHS 2007, 2013–14.

Whether or not a child will be stunted is largely determined during the first 1,000 days of life. Stunting rates among Congolese children increase sharply from birth until 24 months of age, after which they begin to level off at about 50 percent (Figure 2). These data underscore the importance of investing in interventions that target the first 1,000 days of life, after which it becomes extremely difficult to reverse the physical and cognitive effects of stunting.

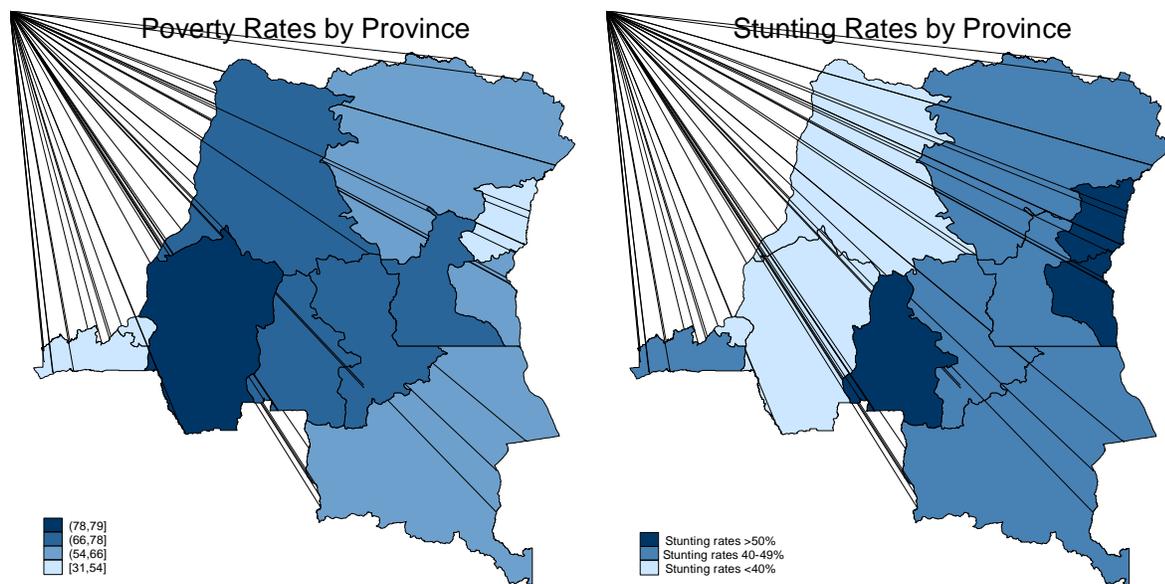
Figure 2. Child Stunting Rates in the DRC by Age Cohort



Source: DHS 2013–14.

Considerable variation is evident among the provinces in the prevalence of stunting, with stunting rates exceeding the national average in 8 out of 11 provinces. In fact, three provinces have stunting rates that exceed 50 percent: Kasai-Occidental (51.7 percent), Nord-Kivu (52 percent), and Sud-Kivu (53 percent). The stunting rates in the remaining provinces are much lower (MICS/ELIM 2010). Only three provinces have stunting rates below the national average: Bandundu (39 percent), Equateur (38 percent), and Kinshasa, where stunting prevalence is the lowest (16 percent) (MICS/ELIM 2010). Figure 3 demonstrates the disparities among provinces in the prevalence of stunting, as well as the fact that poverty is not necessarily the key determinant of nutritional status in the DRC.

Figure 3. Province-Level Prevalence of Stunting (2013) and Poverty Estimates (2013)

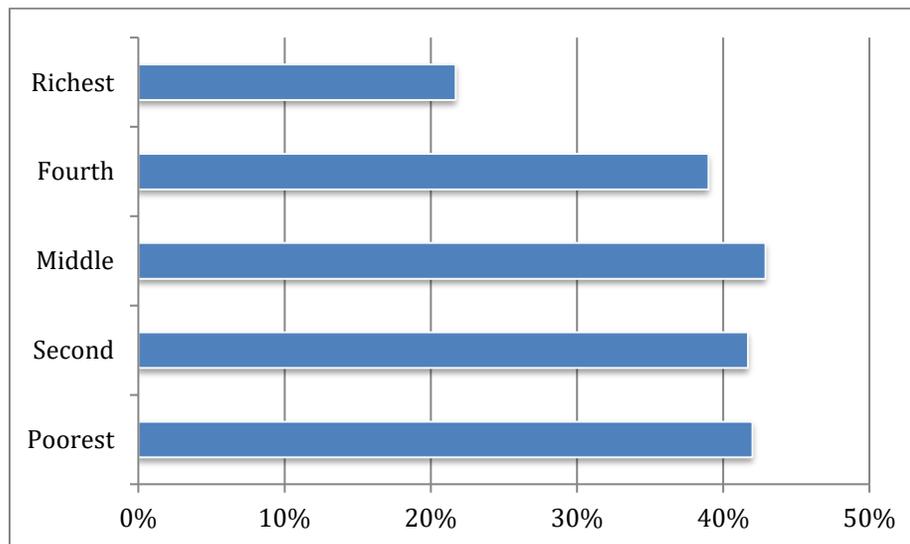


Sources: Poverty rates from World Bank 2013a (123 Survey, Preliminary Results); stunting rates from DHS 2013–14.

Note: For the poverty map: dark blue indicates a poverty rate over 78 percent; medium blue between 66 and 78 percent; light blue is between 54 and 65 percent; and lightest blue is between 31 and 53 percent. For the stunting map: dark blue indicates childhood stunting rate of greater than 50 percent; medium blue between 40 and 49 percent; and light blue less than 40 percent.

Child undernutrition and poverty do not have the same distribution in the DRC. As seen above in Figure 3, the geographic distributions of stunting and poverty differ substantially. Figure 4 presents stunting rates by income quintile and shows that stunting prevalence is more or less even across the bottom 80 percent of the population. Only children in the wealthiest quintile have lower stunting rates (22 percent), which is half the rate of children in the poorest quintile (42 percent). This suggests that factors such as informational asymmetries, disease, and optimal feeding and caregiving practices are more closely associated than income with nutrition outcomes.

Figure 4. Stunting Prevalence by Income Quintile, 2010



Source: MICS/ELIM 2010.

Vitamin and mineral deficiencies (*hidden hunger*) are also pervasive in the DRC and have caused the country to lose approximately \$100 million annually (UNICEF and the Micronutrient Initiative 2004; World Bank 2011). An estimated 61 percent of preschool-aged children and 16 percent of pregnant women are deficient in vitamin A, increasing the risk of child mortality, vulnerability to infectious diseases such as measles, and blindness among children under five years old (MOH et al. 2000; WHO 2009). In fact, the United Nations Children’s Fund (UNICEF) and the Micronutrient Initiative estimate that vitamin A deficiency alone precipitates 76,000 child deaths annually in the DRC (UNICEF and the Micronutrient Initiative 2004). Another study calculated that vitamin A deficiency caused the loss of approximately 390,000 DALYs per year (Meenakshi et al. 2010). After more than a decade of interventions designed to reduce vitamin A deficiencies, coverage of vitamin A supplementation is high in the DRC, with a reported 97.9 percent of children 6–59 months of age receiving a supplement in the last national campaign (PRONANUT 2013). However, given the inaccuracy of population projections and the absence of recent census data, the actual coverage rate is probably lower: data from MICS/ELIM 2010 reported vitamin A supplementation coverage at 82 percent, while DHS 2013–14 reports a rate of 70 percent.

In addition to vitamin A, deficiencies in iron, folate, and iodine also remain significant challenges. According to the most recent data, 60 percent of preschool-aged children and 38 percent of pregnant women are estimated to be anemic, down from 71 and 58 percent in 2007, respectively (DHS 2007, 2013–14). Although no data on iron folic acid supplementation are available, only 48 percent of pregnant women attend four or more prenatal consultations (DHS 2013–14), and folate deficiency is responsible for an estimated 5,250 neural tube birth defects each year (UNICEF and the Micronutrient Initiative 2004). Furthermore, just under half of all households do not consume adequately iodized salt, and in the Kasai-Occidental and Katanga provinces the rate of iodized salt consumption is as low as 26.1 percent and 23 percent, respectively. Children in these households are predisposed to IQ losses of up to 13 points and these mothers are at increased risk of still births; their risk of being underweight during their pregnancy is also higher.

Poor maternal health, early pregnancy, and short birth spacing—along with high levels of sexual and gender-based violence—set the stage for a poor nutritional start for many children in the DRC. The mother’s health, as measured by body mass index (BMI), is known to affect child morbidity and mortality. The DHS 2013–14 found that 14 percent of women aged 15–49 had a low BMI (<18.5) in 2014, but the youngest women were the most malnourished (27 percent of 15- to 19-year-olds). Coupled with low BMI, an early age of first pregnancy and short birth spacing in mothers are associated with poorer health outcomes in children. The average age of first birth was 19.9 for women aged 25–49, and more than one quarter of 15- to 19-year-olds had already begun procreating, while the average birth spacing was about 30 months and represented minimal change since 2007 (DHS 2013–14). High levels of sexual and gender-based violence have been documented in the DRC (UN News Centre 2013), and although there is no analysis of the relationship between gender-based violence and malnutrition for the DRC specifically, the relationship is well established in other countries (e.g., Bangladesh).

The DRC has the third highest morbidity from diarrhea globally among children under five. Diarrhea causes about 13 percent of the world’s child deaths each year, and an estimated 60,450 Congolese children died as a result of diarrhea-related illnesses in 2010 (Emina and Kandala 2012). Diarrheal episodes exacerbate the relationship between malnutrition and infection, as children experiencing these episodes tend to eat less, absorb fewer nutrients, and exhibit reduced resistance to infections. Prolonged diarrheal episodes lead to impaired growth and development (Ejemot et al. 2008). Poor sanitation also contributes—through its impact on malnutrition rates—to other leading causes of child mortality including malaria, acute respiratory infections, and measles. According to MICS/ELIM (2010), just 47 percent of the population has access to safe drinking water and only 14 percent of the population has access to adequate sanitation facilities.

In the DRC, a 2005 study found that an estimated 82 percent of children under five were infected with parasitic intestinal worms (helminth infections) (WHO 2006). In the short term, helminth infections potentially cause anemia and increase morbidity and undernutrition, as well as impair 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) than those who grow up free of worms (Bleakley 2007). Although the 2005 study prompted a national effort to expand deworming treatment among Congolese children, the last national campaign was able to treat only 38.3 percent of children 12–59 months old because of disruptions in the supply of anthelmintic medications (mebendazole) (PRONANUT 2013).

Another health burden in the DRC is the high level of aflatoxins—naturally occurring carcinogenic by-products of common fungi—growing on crops such as maize and peanuts. In the DRC, the average person consumes 57 and 52 grams of peanuts and maize (respectively) per person per day, which translates into an average daily exposure of 0.07–27 nanograms per kilogram of weight (assuming an average weight of 60 kilograms per consumer) (Liu and Wu 2010). Evidence shows that consuming high levels of aflatoxins can lead to liver cirrhosis and liver cancer in adults (Kuniholm et al. 2008; Abt Associates 2014). Furthermore, it is widely understood that there is a relationship between aflatoxin exposure and child stunting, although the evidence base is more tentative and this relationship has not yet been adequately quantified in the published literature (Unnevehr and Grace 2013; Abt Associates 2014). However, although the evidence of the links

between aflatoxins and child stunting is still tentative, the links with liver cancer are well established: aflatoxin exposure in the DRC is estimated to cause up to 724 new cases of liver cancer each year (Liu and Wu 2010). This provides sufficient impetus for actions to control aflatoxin exposure in the DRC.

Residents of some provinces in the DRC also face the threat of permanent disability and/or death as the result of a condition known as konzo, which is caused by eating poorly prepared cassava. Konzo is a sudden epidemic spastic paraparesis (paralytic) disease that leads to permanent paralysis of the lower limbs (Kasongo and Calo 2011), with children above the age of three years and women of childbearing age being most vulnerable to the effects of the disease (Nzwalo and Cliff 2011). It is caused by consuming cassava containing high levels of cyanide, which the plant produces naturally as a self-defense mechanism. Bitter varieties of cassava tend to contain higher levels of cyanide than sweet varieties (1 gram/kilogram versus 20 milligrams/kilogram), as do cassavas grown during drought (Kasongo and Calo 2011). The disease is present in four provinces in the DRC (Bandundu, Kasai-Oriental, Kasai-Occidental, and Sud-Kivu) (Banea et al. 2012). However, over 90 percent of all reported cases are found in Bandundu (FAO 2014). In 2009, the DRC had the highest number of reported cases in the five African countries where konzo is found (3,459 out of 6,768 total), but the actual incidence is likely much higher: a 2000 study by the Ministry of Health estimated that the number of konzo cases totaled 100,000 (Banea et al. 2012).

Vulnerability to konzo is thought to be the result of three broad factors: a lack of dietary diversity, poor soil quality, and drought/poor access to water. Families that are food insecure and rely primarily on cassava for their caloric intake are at the highest risk of developing konzo. Because of its natural toxicity, cassava must be properly prepared before consumption, which includes peeling, grating, and soaking it in warm water for several days. However, during the hungry season, families that rely primarily on cassava for calories sometimes take shortcuts in its preparation, not processing it long enough to remove the toxins. Families with low dietary diversity also do not consume sufficient quantities of protein-rich pulse crops such as peas and beans, which contain sulfur-based amino acids that help break down and eliminate cyanide in the bloodstream. Additionally, because bitter varieties of cassava produce more cyanide, people living in the areas with poor soil quality in which these varieties are more common are prone to consuming higher levels of cyanide. Finally, both drought and poor access to water influence the cyanide content of cassava. Droughts cause the cassava plant to produce more cyanide, and a lack of water resources prevents adequate processing (Kasongo and Calo 2011).

Although konzo itself is not fatal, its effects tend to potentiate the risk of morbidity and mortality from other diseases, including acute malnutrition. Moreover, the disease negatively affects visual-spatial aptitude and mental processing capacity. Recent research has also shown that in villages where konzo is present, even children who do not exhibit physical symptoms of the disease still suffer damage (Fogarty International Center 2014).

THE IMPORTANCE OF INVESTING IN NUTRITION

Undernutrition is an underlying cause of approximately half of deaths in 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 common childhood illnesses such as diarrhea, measles, pneumonia, malaria, or HIV/AIDS.

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) showed improved schooling and test scores from supplementation in early childhood.

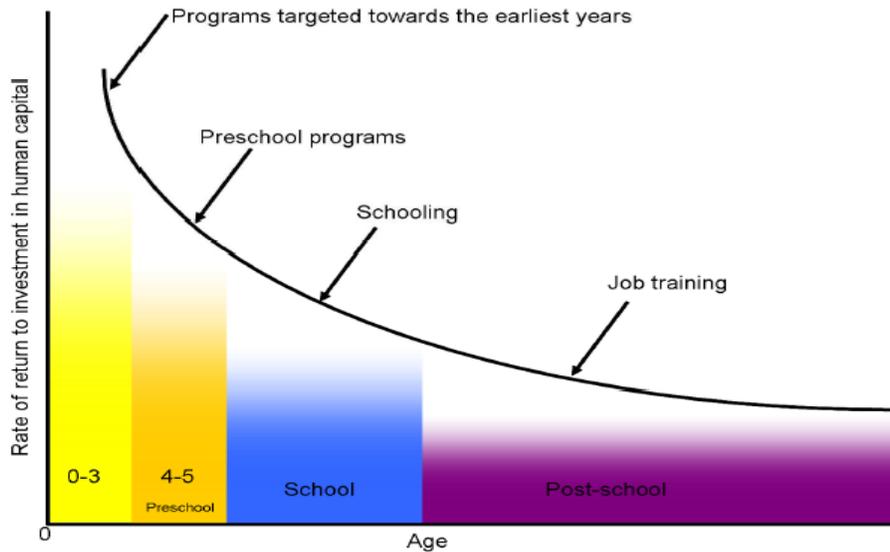
In the DRC, being underweight in the early years accounts for 13 percent of disability-adjusted life years (DALYs). This was the biggest risk factor affecting DALYs, with micronutrient deficiencies and suboptimal breastfeeding also among the 15 highest risk factors (IHME 2010b). The DRC also loses nearly 5 million DALYs as a result of diarrheal diseases each year among children under five years old (IHME 2010b).

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. 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 (Strauss and Thomas 1998; Caulfield et al. 2004). 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. As mentioned earlier in this report, micronutrient deficiencies in the DRC collectively add up to an estimated loss of over \$100 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 the DRC. The term *demographic dividend* refers to the growth in a country's economy that result 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, the DRC could potentially harness the 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 (World Bank 2006; Black et al. 2008, 2013). Figure 5 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 5. 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 in poor human capital and long-term productivity losses. However, as Figure 2 shows, *while child stunting rates are highest among the poorest four quintiles in the DRC, 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 childcare practices, etc.) influence nutritional status.

Nutrition interventions are consistently identified as cost-effective development actions, and the costs of scaling up nutrition interventions are modest. 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 is 30 to 1 (World Bank 2010).

A recent World Bank study estimated that investing in nutrition can increase a country's GDP by at least 3 percent annually (World Bank 2010). The same study estimated 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 and 30 million DALYs, and reduce the number of stunted children by about 30 million worldwide. Bhutta et al. (2013) came 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 an important role. 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 in delivering *nutrition-specific* interventions to the poor (such as vitamin A supplementation and deworming), multisectoral *nutrition-sensitive* actions through the agriculture sector and 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) by 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).

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

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.

We identify and cost six selected nutrition-sensitive interventions that are relevant for scale-up in the Congolese context, for which there is evidence of the positive impact on nutrition outcomes and for which there is some cost information. These include three interventions delivered through the agriculture sector—biofortification of cassava, aflatoxin reduction through biocontrol, and konzo control via promotion of the cassava flour wetting method; two delivered through the education sector—school-based deworming and school-based promotion of good hygiene; and one delivered through the water, sanitation and hygiene (WASH) sector—increasing access to improved WASH infrastructure. Other potential nutrition-sensitive interventions include reducing

women's workloads through improved technologies in agriculture; and conditional cash transfers, targeted toward the poor, which are designed to have an impact on nutrition outcomes.

Biofortification has the potential to reduce micronutrient deficiencies in a highly cost-effective manner. Biofortification uses plant breeding techniques to enhance the micronutrient content of staple foods. Evaluation of the orange-flesh sweet potato biofortification program in Uganda and Mozambique showed high farmer adoption, significant increase in vitamin A intakes, and improvement of child vitamin A status (Arimond et al. 2011; Hotz et al. 2012a; Hotz 2012b). An ex-ante cost study of biofortification in 14 countries suggests that most cost 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 ranked countries using country-level data according to their suitability for investment in biofortification interventions identified the DRC as a "top priority" country for the biofortification of cassava (Asare-Marfo et al. 2013). According to one estimate, biofortification of cassava has the potential to reduce the DALY burden of vitamin A deficiency by 32 percent for a cost per DALY averted of as little as \$8 (Meenakshi et al. 2010).

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 product (aflasafe™) that contains strains unique to the specific country.

Training women to utilize the wetting method for preparing cassava flour in villages where there is a high risk of children developing konzo has proven to be a highly cost-effective means of reducing or eliminating cases of the disease (Australian National University 2014). The wetting method involves soaking cassava flour in water, spreading it out in a thin layer, and allowing it to dry in the sun for two hours or in the shade for five hours. This process allows hydrogen cyanide gas to escape before the flour is used to make *fufu*, which is a type of traditional porridge. Each training intervention lasts nine months, during which time senior women are taught the wetting method and each, in turn, teaches 12–15 additional women. Women are also provided with a bowl, a knife, and a mat for drying (Australian National University 2014).

Follow-up studies in four villages where interventions were previously implemented found that the training efforts had a significant impact on both the women's behavior and the incidence of konzo. Most of the women who learned the wetting method continued to use it in preparing *fufu*, and they actually preferred the taste of *fufu* prepared with this method to that made with traditional preparation methods. Furthermore, there were no new reported cases of konzo and children showed a significant reduction in urinary thiocyanate. To date, Australian Aid has funded interventions to prevent konzo in 13 villages involving nearly 10,000 people in Kwango District, Bandundu Province (Australian National University 2014).

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 improved self-reported health, increased total schooling years, and increased earnings by 20 percent (Baird et al. 2011).

At one point, school-based deworming in the DRC was included as part of the World Food Program (WFP)'s school feeding programming. The last such campaign, which reached more than 1 million school-aged children, was undertaken in 2011 with supplies of mebendazole donated by the American nongovernmental organization (NGO) Deworm the World. Deworming proved extremely cost-effective when delivered with school feeding, even though it reached only children in school, but the future sustainability of the program is unclear.

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 diarrhea by 42 to 47 percent, lower the incidence of diarrhea for 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 demonstrated significant reduction in absenteeism related to diarrhea and respiratory illness (UNICEF 2012). A study in Brazil showed 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 found that hygiene behaviors are sustained beyond the end of an intervention. The study also found 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, 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 argued 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 the DRC and the poor quality of its current infrastructure, it follows that WASH interventions could have a significant impact. In studying the potential benefits of scaling up WASH interventions in the DRC, 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).

Although the DRC has a school feeding program, we do not include it in our analysis of nutrition-sensitive interventions because research has consistently shown no effects resulting from such programs on the nutritional status of children as measured by stunting and wasting (World Bank 2012a). The lack of impact from school feeding on nutritional status is probably because the most influential time in a child's life to address malnutrition is the first 1,000 days of life, which occurs before children are of school age. School feeding programs, however, undoubtedly have other benefits, such as attracting and keeping students in school and some educational gains (World Bank 2012a). Nevertheless, those outcomes are beyond the scope of this analysis.

GOVERNMENT AND PARTNER EFFORTS TO ADDRESS MALNUTRITION IN THE DRC

In spite of government and donor commitments to improving nutrition in the DRC, several constraints impede the implementation of strategies to improve nutrition outcomes. The first is the scarcity of funds for nutrition interventions: the Government of the DRC continues to rely heavily on the support of donors and implementing partners to deliver essential services. Second is the lack of clear implementation plans, with the result that the coverage of evidence-based interventions remains limited. A related constraint is the poor coordination among stakeholders. (DFID and MQSUN 2013).

Ongoing conflicts and crises in several provinces have led to a focus on humanitarian aid and emergency responses to nutrition challenges. This is apparent both in the large proportion of financing allocated to short-term humanitarian projects (see Financing Current and Proposed Nutrition Interventions in Part III), as well as the concentration of nutrition programs in conflict-affected areas. In its 2013 Humanitarian Action Plan, UN OCHA notes that although “stabilized” zones contribute most to the burden of malnutrition and under-five mortality, these are the least likely to receive funding for nutrition interventions (UN OCHA 2013). For example, high-burden provinces such as Équateur and Kasai-Occidental have not received the attention from donors that has poured resources into conflict-affected areas in the country's east (DFID and MQSUN 2013). Furthermore, given the continuing emphasis on treating acute malnutrition, crucial preventative interventions remain underfunded (UN OCHA 2013).

Current national programmatic efforts to improve nutrition outcomes are coordinated by the National Nutrition Program (PRONANUT) with significant funding and support from UNICEF, the United Nations Food and Agriculture Organization (FAO), WHO, the World Bank, the WFP, the United States Agency for International Development (USAID), the European Commission for Humanitarian Aid and Civil Protection (ECHO), DFID, the European Union, the Japanese International Cooperation Agency, the Canadian International Development Agency (CIDA), and national and international NGOs (SUN 2014). However, because government resources allocated to nutrition are limited, the coverage and duration of nutrition interventions depend largely on external support (DFID and MQSUN 2013).

The coverage of nutrition-specific interventions in the DRC is currently relatively limited; the exception is vitamin A supplementation, which is delivered twice per year through a door-to-door campaign. Salt iodization coverage is also reasonably high, and this is achieved largely through

import quality controls. The lowest level of the health system in the DRC is the health zone, which is comprised of health centers linked to a referral hospital. The health zones should and could provide basic preventive nutrition services such as growth promotion and nutrition counseling, distribution of zinc tablets with oral rehydration solution (ORS) for diarrhea treatment, iron-folic acid supplements as part of antenatal care for pregnant women, and multiple-micronutrient powders for young children to address anemia and other deficiencies, but the coverage of these interventions is currently low. These health centers can also screen children for severe acute malnutrition and refer them for treatment (in referral hospitals for cases with complications and community-based treatment for regular cases). The DRC also has a system of community extensions (*relais communautaires*) that could be used for behavior change communications and other community-based services for nutrition. There also exist national and international NGOs that deliver nutrition services, but these are not (yet) financed by the government and thus do not form part of the national service delivery system. A model could be developed whereby a body such as the Fonds Social de la République could contract NGOs to deliver key community-based services, including nutrition, building on successful experience in community-driven development projects. These various delivery channels are currently being used to deliver nutrition services to some extent, but this is not done systematically and the monitoring is weak. The responsibility for quality control and monitoring rests with PRONANUT within the Ministry of Health. PRONANUT is based in Kinshasa and has a presence in all the provinces, but the program's logistics and human capacity is weak.

Following the government's decision to join the Scaling Up Nutrition (SUN) Movement in 2013, there has been a renewed national commitment to multisectoral nutrition approaches to combat malnutrition. This includes the establishment of a national multisectoral nutrition committee, under the authority of the Prime Minister and composed of the heads of key ministries, including the Minister of Health and the Minister of Agriculture and Rural Development. The committee has formulated a comprehensive, evidence-based and rigorous national nutrition policy. Important next steps will include clear operational plans to implement the policy, the establishment of a donor network (led by World Bank), a UN network (led by UNICEF) and a civil society SUN network co-led by Helen Keller International and Save the Children.

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

The overall objective of this research is to support the Government of the Democratic Republic of Congo in developing a costed scale-up plan that furthers the operationalization of the recently released National Nutrition Policy. These efforts will provide the Government of the DRC with the tools needed to leverage adequate resources from their 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 the DRC 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 estimated 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 highlighted the global financing gap, underscored the importance of investing in nutrition at the global level, and laid out a methodology for estimating the costs of nutrition-specific interventions. However, these global estimates did not capture the nuances and context in each country, nor were 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 the DRC.

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 DRC 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 the DRC. Others—such as calcium supplementation for women and prophylactic zinc supplementation—are excluded because delivery mechanisms are not available in client countries, including the DRC, 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 DRC 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 Health Sector

Intervention	Description	Target population	Current coverage
1. Community nutrition programs for growth promotion (children)	Behavior change communication focusing on optimal breastfeeding and complementary feeding practices, proper handwashing, sanitation, and good nutrition practices	Mothers of children 0–59 months of age	Negligible
2. Vitamin A supplementation (children)	Semi-annual doses	Children 6–59 months of age	82.1% (MICS/ELIM 2010)
3. Therapeutic zinc supplementation with ORS (children)	As part of diarrhea management with ORS	Children 6–59 months of age	2.2% (MICS/ELIM 2010)
4. Multiple micronutrient powders (children)	For in-home fortification of complementary food (60 sachets between 6 and 11 months of age, 60 sachets between 12 and 17 months of age, and 60 sachets between 18 and 23 months of age)	Children 6–23 months of age not receiving fortified complementary food	Negligible

5. Deworming (children)	Two rounds of treatment per year	Children 12–59 months of age	68.1% (MICS/ELIM 2010)
6. Iron-folic acid supplementation for pregnant women	Iron-folic acid supplementation during pregnancy	Pregnant women	43.8% (MICS/ELIM 2010)
7. Iron fortification of staple foods (general public)	Fortification of wheat flour with iron	General population	Negligible
8. Salt iodization (general public)	Iodization of centrally processed salt	General population	58.6% (MICS/ELIM 2010)
9. Public provision of complementary food for the prevention of moderate acute malnutrition (children)	Provision of a small amount (~250 kilocalories per day) of nutrient-dense complementary food for the prevention 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
10. Community-based management of severe acute malnutrition (children)	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 1.6 times the prevalence) of severe wasting (WAZ < -3) plus edema among children 6–59 months of age	20.7% (UN OCHA 2013)

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

The analysis in the following section focuses on nutrition-sensitive interventions that are relevant to the DRC 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 DRC 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 the DRC. 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
<i>Interventions delivered through the agricultural sector</i>			
Biofortification	Promote the use of vitamin A–rich cassava varieties to 50,000 farming households	General population	Increase vitamin A intakes and improve vitamin A status (Hotz et al. 2012a, 2012b)
Aflatoxin control in maize and groundnuts using biocontrol	Promote the use of biocontrols such as aflasafe™ for maize and groundnuts	General population	Improve child nutrition status (stunting) and reduce morbidity (Khlungwiset and Wu 2011)
Promotion of wetting method for konzo control	Provide training in the wetting method of cassava preparation in order to reduce vulnerability to konzo	Food-insecure women in provinces where konzo is present	Reduce morbidity and mortality, improve cognition (Fogerty International Center 2014)
<i>Interventions delivered through the education sector</i>			
School-based deworming	Distribution of mebendazole/albendazole to school-aged children and training for school teachers, community workers, and health workers	School-aged children	Reduce anemia and morbidity, improve cognitive outcomes (Miguel and Kremer 2004)
School-based promotion of good hygiene	Hygiene education program to teach healthy practices in schools	School-aged children	Improve child nutrition outcomes (stunting) (Spears 2013)
<i>Interventions delivered through the water, sanitation and hygiene sector</i>			
WASH	Provide access to water, improved sanitation and hygiene education	Populations without access to improved water or sanitation infrastructure	Reduce diarrhea-related illness DALYs by 21–57%, save \$7.50/person/year in reduced health care costs, save households 1.5 hours/per day (DFID 2012)

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

Target population estimates are based primarily on demographic data obtained from the National Institute of Statistics (INS), PRONANUT, MICS/ELIM 2010, and the preliminary results from the DHS 2013–14, which are provided in Appendix 2.³ In the absence of recent census data, we use INS projected population estimates by province for 2013, while the population breakdown by age was calculated using the results of the MICS/ELIM (2010) survey. 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 province were obtained from the preliminary DHS (2013–14) survey data.

Data on current coverage levels of different interventions were obtained from various sources. Current coverage levels for multiple micronutrient powders for home fortification, iron fortification of staple foods, and the 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 data were not available. Coverage data for vitamin A supplementation and deworming coverage were obtained from MICS/ELIM (2010). For coverage of iron-folic acid supplementation for pregnant women, the percentage of women attending four or more prenatal consultations (MICS/ELIM 2010) was used as a proxy in the absence of reliable data. The MICS/ELIM (2010) survey data were also used to estimate the proportion of households consuming adequately iodized salt in each province. Finally, data on the number of children treated for severe acute malnutrition were obtained from the Annual Report for UN OCHA’s 2013 Humanitarian Action Plan in the DRC. Results from DHS 2013–14 provided estimates of the current incidence of severe acute malnutrition and moderate acute malnutrition. We also used DHS 2013–14 to classify the provinces according to levels of stunting.

Whenever possible, unit costs of the nutrition-specific interventions were estimated using programmatic data that were provided by local implementing partners and the Ministry of Health, based on actual program experience. The estimated unit costs and the delivery platforms are listed in Table 3. In cases where the intervention was not yet being implemented or local data were not available, the global unit cost estimate from the World Bank (2010) was used. A complete index of data sources and relevant assumptions for these interventions can be found in Appendix 3.

³ The bulk of the data used in the analysis comes from MICS/ELIM 2010. The full dataset from the 2013–14 DHS was not available at the time the analyses were undertaken. Although it is not feasible to re-do the analysis with the newer DHS data, a review of the 2013–14 DHS data suggests that the results would not change substantially were the newer data to be used.

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

Intervention	Unit cost (\$ per beneficiary per year)	Costed delivery platform
1. Community nutrition programs for growth promotion in children^b	5.00	Community nutrition programs
2. Vitamin A supplementation for children^a	0.55	Mass campaigns
3. Therapeutic zinc supplementation with ORS for children^a	0.92	Community nutrition programs (family health kits)
4. Multiple micronutrient powders for children^a	3.54	Community nutrition programs (family health kits)
5. Deworming for children^a	0.06	Mass campaigns (marginal cost for adding deworming to mass campaigns; campaign delivery costs are already included in vitamin A supplementation)
6. Iron-folic acid supplementation for pregnant women^b	2.00	Primary health care and community nutrition programs
7. Iron fortification of staple foods for general population^c	0.20	Market-based delivery system
8. Salt iodization for general population^c	0.05	Market-based delivery system
9. Public provision of complementary food for prevention of moderate acute malnutrition in children^a	40.25	Primary health care and community nutrition programs
10. Community-based management of severe acute malnutrition children^a	162.00	Primary health care and community nutrition programs

Note: ORS = oral rehydration salts.

a. Denotes unit cost based on cost data from the DRC.

b. Denotes unit cost based on Africa regional cost estimates.

c. Denotes unit cost based on global cost estimates.

For the nutrition-sensitive interventions, the unit costs were estimated using local cost data, with the exception of aflatoxin control and school-based deworming, which are taken from similar programs in Nigeria and Ghana, respectively. Biofortification cost estimates do not lend themselves to a unit cost framework, but country-specific, overall cost estimates were obtained from Meenakshi et al. (2010). The cost of school-based promotion of good hygiene was derived from financial data from the DRC's *Écoles Assainies* program. Konzo control interventions are costed using the estimated unit cost reported by Australian National University (2014). Finally, the costing of WASH interventions is based on average unit costs presented in a DFID Business

Case and Intervention Summary for the Village Assaini Project Extension (DFID 2012), as well as historical financing and coverage data presented in the Ministry of Health’s report (2013). The unit costs and the delivery platforms are listed in Table 4.

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

Intervention	Unit cost (\$ per beneficiary per year)	Costed delivery platform
1. Biofortification of vitamin A-rich yellow cassava	n.a.	Agriculture production
2. Aflatoxin control in maize and groundnuts using biocontrol	\$15.60 per hectare	Agriculture production
3. Promotion of Wetting Method for konzo control	\$10.00	Community sensitization campaign
4. School-based deworming	\$0.08	School-based deworming distribution
5. School-based promotion of good hygiene	\$1.18	School-based hygiene education campaign
6. WASH	\$32.97	Infrastructure provision, technical assistance and community behavior change communication programming

Note: n.a. = not applicable.

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 the DRC. 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 the DRC, 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 (for example, number of visits to a health center) (e.g., in Bhutta et al. 2013). 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 coverage⁴
- 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 saved, (2) number of lives saved, (3) cases of childhood stunting averted, and (4) increased program coverage. To calculate the number of DALYs, 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 2010a). 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* (2012b). 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 included all ten interventions to calculate the number DALYs saved. However, because of the methodological limitations of the LiST tool, the calculation for the number of lives saved is based on only six of the ten interventions,⁵ and cases of childhood stunting averted is based on only four of the ten.⁶ 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 cost-effectiveness of nutrition-specific interventions are calculated in terms of *cost per DALY saved*, *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 saved is based on the categorization used by WHO-CHOICE (Choosing Interventions that are Cost-Effective):⁷ an intervention is considered to be “very cost-effective” if the range for the cost per DALY averted is less than GDP per capita;⁸ it is

⁴ *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.

⁵ The six interventions are community nutrition programs for growth promotion, vitamin A supplementation, therapeutic zinc supplementation with ORS, 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.

⁶ 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.

⁷ Information on the cost-effectiveness thresholds used by WHO-CHOICE can be found at http://www.who.int/choice/costs/CER_levels/en/.

⁸ The DRC’s GDP per capita in current U.S. dollars was \$454 in 2013 (World Bank 2014).

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 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 the DRC 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 saved.

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 the DRC. 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 province
- Scenario 2: Prioritize scale up by intervention
- Scenario 3: Prioritize scale up by province and by intervention

Within each of the above scenarios, we consider multiple variations and analyze their cost-effectiveness in terms of cost per DALY saved, 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 at the national level in the DRC is estimated to be \$371 million annually (Table 5). This cost includes the additional cost of scaling up all 10 interventions across the entire country from current levels (\$378 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 (estimated at \$42 million). Of this total amount, part of the costs for iron fortification, multiple micronutrient powders, salt iodization, and complementary food (\$49 million) would be covered by private households with incomes above the poverty line, resulting in an annual financing gap of \$371 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)
Community nutrition programs for growth promotion in children	79.1
Vitamin A supplementation for children	1.6
Therapeutic zinc supplement with ORS for children	12.6
Micronutrient powders for children	12.9
Deworming for children	0.3
Iron-folic acid supplementation for pregnant women	3.9
Iron fortification of staples for general population	17.1
Salt iodization for general population	1.9
Public provision of complementary food for prevention of moderate acute malnutrition in children	124.9
Community-based management of severe acute malnutrition in children	124.2
Total cost for scaling up all 10 interventions	378.4
Capacity development for program delivery	34.1
Monitoring and evaluation, operations research, and technical support for program delivery	7.6
Household contributions	(49.4)
ANNUAL PUBLIC INVESTMENT REQUIRED	370.6

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

Reaching full national coverage for all 10 interventions nationwide is estimated to cost \$1.04 billion over five years. These figures (Table 6) are based on specific scale-up assumptions and are provided as an example in order to demonstrate how interventions can be scaled up progressively in the context of a five-year strategic plan. The five-year scale-up assumes that capacity building and system strengthening costs will be front-loaded, with coverage increasing steadily by 20 percent of the target population each year.

Table 6. Scale-Up of All 10 Interventions over Five Years (US\$, millions)

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
80.9	144.8	205.3	272.7	340.0	1,044

The expected benefits from scaling up these 10 nutrition-specific interventions to full national coverage are enormous (Table 7). Almost 5.5 million DALYs and over 76,000 lives would be saved annually, while more than 1 million cases of stunting among children under five would be averted. Program coverage is assumed to increase to cover the following beneficiaries:

- The families of 15.8 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 2.5 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 13.6 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 3.6 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 3.8 million children 12–59 months of age would receive deworming medication
- 1.9 million pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 85.5 million people would be able to consume staple foods fortified with iron
- 35.4 million people who do not currently use iodized salt would be able to obtain it
- 687,000 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices
- 3.1 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 7. Estimated Annual Benefits for Scaling Up 10 Nutrition-Specific Interventions to Full Coverage

Intervention	Beneficiaries covered	DALYs saved^a	Lives saved	Cases of stunting averted
Community nutrition programs for growth promotion in children	15,810,078	3,848,339	39,417	416,626
Vitamin A supplementation for children	2,493,463	65,743	1,240	25,350
Therapeutic zinc supplementation with ORS for children	13,623,502	160,211	12,606	—
Micronutrient powders for children	3,648,100	197,578	—	—
Deworming for children	3,843,900	13,702	—	—
Iron-folic acid supplementation for pregnant women	1,921,138	73,717 ^b	473	2,204
Iron fortification of staples for general population	85,459,883	—	—	—
Salt iodization for general population	35,380,391	—	—	—
Public provision of complementary food for prevention of moderate acute malnutrition in children	3,103,231	68,427	7,397	772,632
Community-based management of severe acute malnutrition in children	687,147	1,004,572	32,325	—
Total when all interventions implemented simultaneously^c	n/a	5,432,289	76,767	1,027,237

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 saved at \$70, the total cost per life saved at \$4,929, and the total cost per case of child stunting averted at \$368 (Table 8). Variation in cost among the interventions is high and, as a result, some interventions have a lower estimated cost per DALY saved (\$21 for community nutrition programs), whereas others have much higher costs (\$1,825 for the public provision of complementary foods). Overall, these cost estimates translate into an increase in annual public resource requirements of \$23 per child, which compares favorably with the cost of \$30 per child found in the global costing exercise (World Bank 2010).

Nine of the 10 nutrition-specific interventions are very cost-effective according to the WHO-CHOICE criteria (WHO 2014). The exception is the public provision of complementary food for the prevention of moderate acute malnutrition, with a cost per DALY of \$1,825, which exceeds three times the GDP per capita of \$454. Therefore, in a country like the DRC where fiscal and capacity constraints will limit scale-up, certain expensive interventions—such as the public provision of complementary foods—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 foods.

Table 8. Cost-Effectiveness of Scaling Up 10 Nutrition Interventions to Full Coverage, (US\$)

Intervention	Cost/DALY saved		Cost/life saved	Cost/case of stunting averted
	DRC	Global		
Community nutrition programs for growth promotion in children	21 ^a	53–153	2,005	190
Vitamin A supplementation of children	24 ^a	3–16	1,266	62
Therapeutic zinc supplementation with ORS for children	78 ^a	73	996	n/a
Micronutrient powders for children	65 ^a	12.2	—	—
Deworming for children	19 ^a	—	—	—
Iron-folic acid supplementation for pregnant women	5 ^a	66–115	8,313	1,784
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	1,825	500–1,000	16,886	162
Community-based management of severe acute malnutrition in children	124 ^a	41	3,842	—
TOTAL	70	—	4,929	368

Source: Authors' calculations for the DRC; 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 Province

Table 9 shows the estimated costs and benefits of scaling up the 10 nutrition-specific interventions according to the stunting burden found in each province. Significant disparities in malnutrition rates exist, with stunting rates exceeding 45 percent in five of eleven provinces. These are the *highest-burden provinces* in the table and they would disproportionately benefit from scaling-up nutrition interventions, as demonstrated by high expected benefits in terms of DALYs saved and lives saved. The *middle-burden provinces* have stunting rates between 40 and 45 percent *or* severe stunting between 20 and 25 percent, and the *lowest-burden provinces* have stunting rates less than 40 percent and severe stunting less than 20 percent.

Table 9. Scenario 1: Costs and Benefits of Scaling Up 10 Nutrition-Specific Interventions by Province

Province	Annual public investment (US\$, millions)	Annual benefits	
		DALYs saved	Lives saved
Highest-burden provinces:^a Stunting rates greater than 45% AND severe stunting greater than 25%	\$135	1,874,869	26,707
Middle-burden provinces:^b Stunting rates between 40 and 45% OR severe stunting between 20 and 25%	\$119	1,810,155	25,039
Lowest-burden provinces:^c stunting rates less than 40% AND severe stunting less than 20%	\$117	1,747,265	25,021
TOTAL	\$371	5,432,289	76,767

Note: Cells in red indicate recommended interventions under this scenario.

a. Bas-Congo, Kasai-Occidental, Kasai-Oriental, Nord-Kivu, Sud-Kivu.

b. Katanga, Maniema, Orientale.

c. Kinshasa, Équateur, Bandundu.

Given the high burden of stunting in Bas-Congo, the two Kasais, and the two Kivus, the preferred scenario (Scenario 1) is to scale up interventions in these provinces, with an annual public investment of \$135 million. This scenario would save almost 1.9 million DALYs and over 26,000 lives. It would also increase program coverage as follows:

- The families of 5.5 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 911,000 children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 4.7 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 1.1 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 1.6 million children 12–59 months of age would receive deworming medication

- 714,500 pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 29.6 million people would be able to consume staple foods fortified with iron
- 13.5 million people who do not currently use iodized salt would be able to obtain it
- 246,000 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices;
- 1.3 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

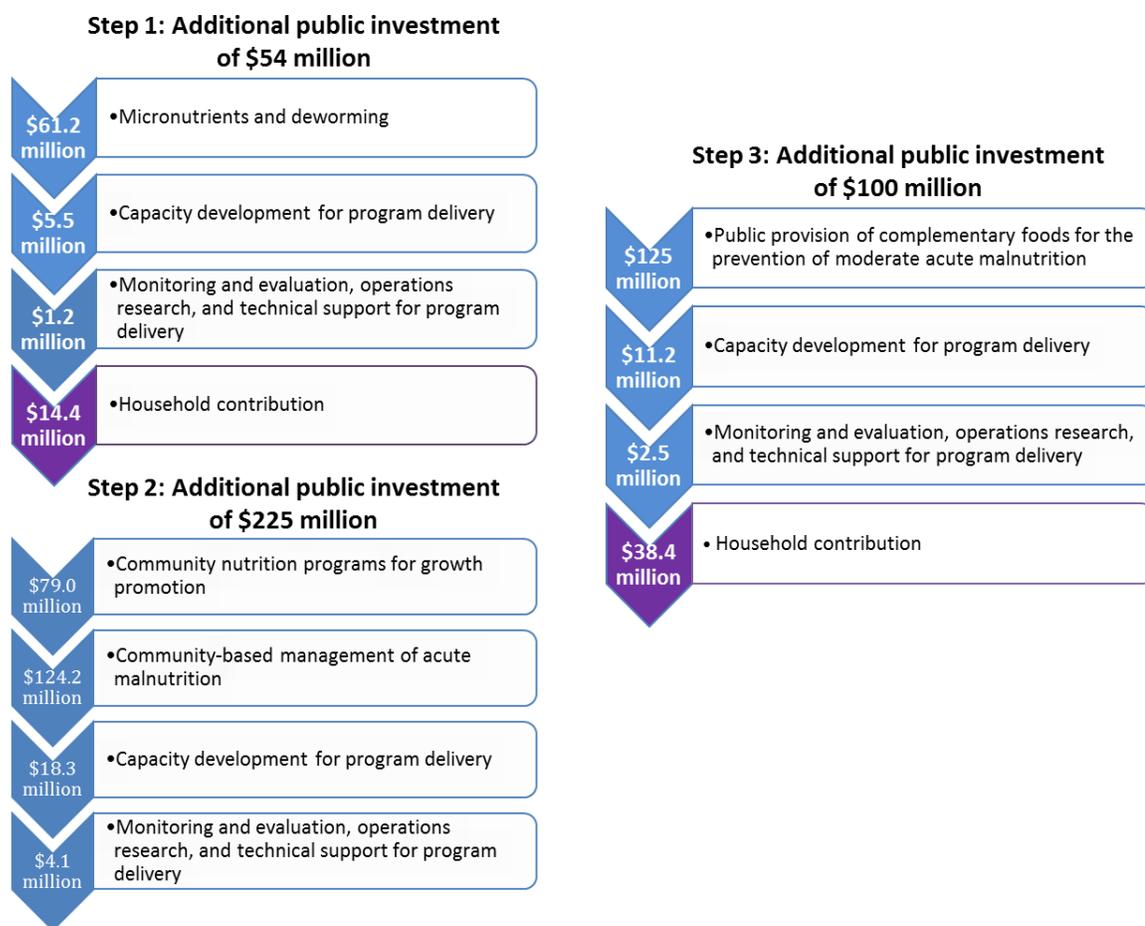
Scenario 2: Scaling Up by Intervention

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 6.

- **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 to full national coverage is \$61.2 million (this cost assumes no scale-up of the public provision of complementary foods; for an alternative scenario, see footnote 9). An additional \$6.7 million for capacity development for program delivery, and for monitoring and evaluation, operations research, and technical support brings the total cost of Step 1 to \$67.9 million. Once the costs covered by households above the poverty line (\$14.4 million) are deducted, the total public investment required for Step 1 is estimated at **\$54 million**.⁹
- **Step 2** includes the costs of a full scale-up of community nutrition programs for behavior change communication, in addition to the scale up of community-based management of acute malnutrition programming to 80 percent national coverage. The estimated cost of this scale-up is \$203 million. We also include an additional \$22 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 **\$225 million**.
- **Step 3** scales up the public provision of complementary foods for the prevention of moderate malnutrition to full national coverage. This intervention requires an investment of \$125 million in addition to the \$14 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 \$38 million, leaving a total public investment required of **\$100 million**.

⁹ If complementary foods are provided, children who are moderately malnourished or at risk of becoming moderately malnourished would receive complementary foods rather than micronutrient powders. In this case, Step 1 interventions would cost \$50.2 million, with \$5.5 million for capacity development for program delivery, and for monitoring and evaluation, operations research, and technical support for program delivery; and \$11 million covered by households above the poverty line, bringing the total public investment required to \$44.7 million.

Figure 6. Scenario 2: Step-Wise Scale-Up by Intervention



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

The public provision of complementary food (Step 3) is assigned the lowest priority for the following reasons: (1) the 2013 *Lancet* nutrition series concluded that there are no additional benefits of public provision of complementary foods beyond those provided by dietary counseling and education; (2) at \$1,825 per DALY saved, the cost-effectiveness of the public provision of complementary foods 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 the DRC. 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 2 interventions, requiring an annual public investment of \$279 million (Table 10). This scenario would save over 5.3 million DALYs and at least 66,000 lives. It would also provide the following program benefits:

- The families of 15 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 2.9 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 13.7 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 6.8 million children 6–23 months would receive vitamins and minerals through multiple micronutrient powders
- 4.3 million children 12–59 months of age would receive deworming medication
- 2 million pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 85.5 million people would be able to consume staple foods fortified with iron
- 37.9 million people who do not currently use iodized salt would be able to obtain it
- 728,000 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices

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

Intervention	Annual public investment (US\$, millions)	Annual benefits	
		DALYs saved	Lives saved
Step 1 interventions: All micronutrient and deworming interventions	\$54	497,249	14,072
Step 2 interventions: Community nutrition programs and community-based management of severe acute malnutrition	\$225	4,852,911	60,295
SUBTOTAL when Step 1 and 2 interventions are implemented simultaneously^a	\$279	5,350,160	66,264
Step 3 interventions: Public provision of complementary food for prevention of moderate acute malnutrition	\$100	68,427	7,397
Total when implemented simultaneously^a	\$371	5,432,289	76,767

Note: Cells in red indicate recommended interventions under this scenario.

a. 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.

Scenario 3: Scaling Up by Province and by Intervention

Scenario 3 proposes scaling up certain interventions according to geographic targeting criteria based on the prevalence of child stunting in each province. The public resource requirements for each variation under this scenario are shown in Table 11.

Table 11. Scenario 3: Cost of Scaling Up 10 Nutrition-Specific Interventions by Province and Intervention (US\$, millions)

Intervention/Province	Highest-burden provinces ^a	Middle-burden provinces ^b	Lowest-burden provinces ^c
Step 1 Interventions: Micronutrient and Deworming Interventions	19	18	16
Step 2 interventions: Community nutrition programs and community-based management of severe acute malnutrition	78	70	78
Step 3 interventions: Public provision of complementary food for prevention of moderate acute malnutrition	41	34	25

Note: Cells in red indicate recommended interventions under this scenario.

a. Bas-Congo, Kasai-Occidental, Kasai-Oriental, Nord-Kivu, Sud-Kivu.

b. Katanga, Maniema, Orientale.

c. Kinshasa, Équateur, Bandundu.

The first recommended scenario (**Scenario 3a**) is to scale up Step 1 and Step 2 interventions in provinces with stunting rates above 40 percent (highest- and middle-burden provinces),¹⁰ requiring an annual public investment of \$185 million. Scenario 3a would save over 3.6 million DALYs and over 44,000 lives (Table 12). Scenario 3a would provide the following program benefits:

- The families of 10.9 million children 0–59 months of age would be reached by community nutrition programs for growth promotion
- 2 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 9.4 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 4.6 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
- 1.4 million pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 58.8 million people would be able to consume staple foods fortified with iron
- 28.7 million people who do not currently use iodized salt would be able to obtain it
- 454,600 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices

A second scenario (**Scenario 3b**) under Scenario 3 would scale up Step 1 and Step 2 interventions in the five provinces where stunting rates are higher than 45 percent and severe stunting rates

¹⁰ The highest-burden provinces are Bas-Congo, Kasai-Occidental, Kasai-Oriental, Nord-Kivu, and Sud-Kivu; the middle-burden provinces are Katanga, Maniema, and Orientale.

exceed 25 percent (highest-burden provinces).¹¹ Scenario 3b would require an annual public investment of \$97 million and would save over 1.8 million DALYs and 22,000 lives. Furthermore, Scenario 3b would provide the following program benefits:

- The families of 4.9 million children 0–59 months would be reached by community programs for behavior change
- 774,000 children 6–59 months would receive twice-yearly doses of life-saving vitamin A supplementation
- 4.2 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 2.1 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 953,000 children 12–59 months of age would receive deworming medication
- 521,000 pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 26.7 million people would be able to consume staple foods fortified with iron
- 9.2 million people who do not currently use iodized salt would be able to obtain it
- 274,000 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices

The final scenario proposed under Scenario 3 (**Scenario 3c**) would scale up micronutrient and deworming interventions in all 11 provinces. In addition, Scenario 3c would target the scale-up of community nutrition programs to the five highest-burden provinces, while also increasing the reach of community-based management of severe acute malnutrition in the six provinces with global acute malnutrition rates over 10 percent (Bandundu, Bas-Congo, the two Kasais, Équateur, and Orientale). Scenario 3c would require an annual public investment of \$222 million and save over 3.8 million DALYs and 48,000 lives. The beneficiaries of Scenario 3c would be distributed as follows:

- The families of 5.5 million children 0–59 months of age would be reached by community programs for behavior change
- 2.9 million children 6–59 months of age would receive twice-yearly doses of life-saving vitamin A supplementation
- 13.7 million children 6–59 months of age would receive zinc supplementation as part of diarrhea management
- 6.8 million children 6–23 months of age would receive vitamins and minerals through multiple micronutrient powders
- 4.3 million children 12–59 months of age would receive deworming medication
- 2 million pregnant women would receive iron-folic acid tablets as part of their antenatal care
- 85.5 million people would be able to consume staple foods fortified with iron
- 37.9 million people who do not currently use iodized salt would be able to obtain it

¹¹ The highest-burden provinces are Bas-Congo, Kasai-Occidental, Kasai-Oriental, Nord-Kivu, and Sud-Kivu.

- 246,000 children 6–59 months of age would be treated for severe acute malnutrition using community-based management practices

Table 12. Scenarios Considered Under Scenario 3

Scenario	Annual public investment (US\$, millions)	Annual benefits	
		DALYs saved	Lives saved
3a: Micronutrient and deworming, community nutrition programs, and community-based management of severe acute malnutrition in highest- and middle-burden provinces	185	3,621,804	44,350
3b: Micronutrients, deworming, community nutrition programs, and community-based management of severe acute malnutrition in highest-burden provinces	97	1,841,859	22,722
3c: Micronutrients and deworming interventions in all provinces, community nutrition programs in highest-burden provinces, and community-based management of severe acute malnutrition in provinces with global acute malnutrition rates above 10%	222	3,870,168	48,461

COST-BENEFIT ANALYSIS OF THE SCALE-UP SCENARIOS

When considered in terms of cost-effectiveness (cost per DALY/life saved/case of stunting averted), all scenarios promise significant value for money. Table 13 presents a comparison of all five scenarios, and shows that full national coverage and Scenarios 1 and 3c feature some of the highest costs per DALY saved and life saved. Overall, Scenarios 2, 3a, and 3b stand out as the most cost-effective, with a cost per DALY saved of \$48–50.

Table 13. Costs and Benefits by Scenario

Scenario	Annual benefits	Cost per benefit unit (US\$)
----------	-----------------	------------------------------

	Annual public investment (US\$, millions)	DALYs saved	Lives saved	Cases of stunting averted	DALY saved	Life saved	Case of stunting averted
Full national coverage	\$371	5,432,289	76,767	1,027,237	\$70	\$4,929	\$368
Scenario 1	\$135	1,874,869	26,707	—	\$73	\$5,152	—
Scenario 2	\$279	5,350,160	66,264	—	\$49	\$3,991	—
Scenario 3a	\$185	3,621,804	44,350	—	\$48	\$3,953	—
Scenario 3b	\$97	1,841,859	22,722	—	\$50	\$4,023	—
Scenario 3c	\$222	3,870,168	48,461	—	\$55	\$4,401	—

Note: Cells in red indicate recommended scenarios. — = not available.

Scenarios 3a and 3b maximize cost-effectiveness while also minimizing resource requirements. Of these two scenarios, Scenario 3a offers the greatest cost-effectiveness at half the cost of scaling up nationwide, while Scenario 3b also maintains significant cost-effectiveness at just a quarter of the cost of reaching full national scale. One important aspect of both Scenarios 3a and 3b is that they both target the most highly burdened provinces rather than the nationwide population. Another attractive choice is Scenario 2; it is equally cost-effective (\$49 per DALY saved) and would provide interventions nationwide, although this scenario would require more public resources (\$279 million per year).

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 over five years for each scenario. Scenarios 3a and 3b require the fewest resources over five years as compared with 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 14). 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 14. Cost for Scale-Up of All Scenarios over Five Years (US\$, millions)

Scenario	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
Scale up of all 10 interventions nationwide	81	145	205	273	340	1,044
Scenario 1	29	53	75	99	124	380
Scenario 2	61	109	156	207	258	790
Scenario 3a	40	72	103	137	171	523
Scenario 3b	21	38	54	72	90	275
Scenario 3c	48	87	124	164	205	629

Note: Cells in red indicate recommended scenarios.

A high burden of malnutrition negatively impacts a nation’s human capital. Therefore an investment in improving nutrition outcomes among the DRC’s children is also an investment in the country’s economic future. The two main ways through 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. We estimate that a five-year scale-up plan that brings all 10 interventions to full national coverage in the DRC could produce \$591 million annual increase in national economic productivity over the productive lives of the children affected (Table 15).

These estimates of economic benefits are based on a highly conservative methodology that does not necessarily account for all of the potential benefits associated with improving nutrition outcomes among Congolese children. For example, these figures do not account for future growth in GDP per capita that 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 the DRC because productivity among the poor would benefit the most from improved nutritional outcome. However, these estimates clearly demonstrate that the opportunity costs of *not* scaling up nutrition interventions are at least \$591 million per year.

Our analyses also show that the nutrition interventions are excellent economic investments at a range of possible discount rates (Table 15). 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. At the 3 percent discount rate, the net present value of the interventions would be \$7,268 million and have a benefit-cost ratio of 8.7. At the 5 percent discount rate, the net present value would be \$3,837 million with a benefit-cost ratio of 5.4. At the 7 percent discount rate, the net present value would be \$2,005 million with a benefit-cost ratio of 3.4. These results show that, even at the most conservative discount rate of 7 percent, the interventions are an excellent economic investment. In addition, the investment yields a highly positive internal rate of return of 13.6 percent, another indicator that it is an excellent economic investment.

Table 15. Economic Benefits of Full Scale-Up of 10 Interventions

Economic measure	Impact of full scale-up of all 10 interventions nationwide		
	Annual increase in economic productivity ^a	\$591 million	
Internal rate of return	13.6%		
	Discount rate		
	3%	5%	7%
Net present value	\$7,268 million	\$3,837 million	\$2,005 million
Benefit-cost ratio	8.7	5.4	3.4

a. The annual increase in productivity is \$591 million annually over the productive lives of the children affected.

FINANCING CURRENT AND PROPOSED NUTRITION INTERVENTIONS

Current government funding is very limited and covers only salaries for some staff who provide nutrition services in Kinshasa and a few provinces (MOB 2014). Overall government financing for health care also remains low at just \$2 per capita per year. Between 2006 and 2010, national health expenditures from domestic resources amounted to approximately 4 percent of the budget; and out of a total of \$14 per person/per year, the government provides just \$2, much of which is used to pay salaries for the staff noted above.

In addition to out-of-pocket household expenditures, development partners are the main source of financing for health and nutrition interventions in the DRC. In 2011, financing from development partners represented 47 percent of total health expenditures, with donors responsible for financing everything from essential drugs to the salaries of health care workers. Development partners often “adopt” a health zone and ensure the provision of a package of interventions in that area. However, partner resources are insufficient to cover a country the size of the DRC. This has left much of the population either lacking access to health services or unable to afford the user fees charged by underfunded clinics (World Bank 2014b).

Total donor financing for nutrition interventions is also low in the DRC, but it has gradually increased from about \$20 million annually in 2007 to about \$25 million in 2012 (Figure 7).¹² The majority of these funds have been for humanitarian assistance—mainly the treatment of severe acute malnutrition—targeted to a few provinces in the east of the country, leaving other parts of the country underserved. Furthermore, current aid for nutrition is heavily weighted toward addressing wasting, despite the fact that wasting levels are low relative to stunting, and most current donor funding supports supply-side interventions such as nutrition supplements and community-based treatment of severe acute malnutrition. Efforts to expand donor funding to incorporate demand-side interventions, such as behavior change campaigns that change the choices households make for good nutrition, are needed.

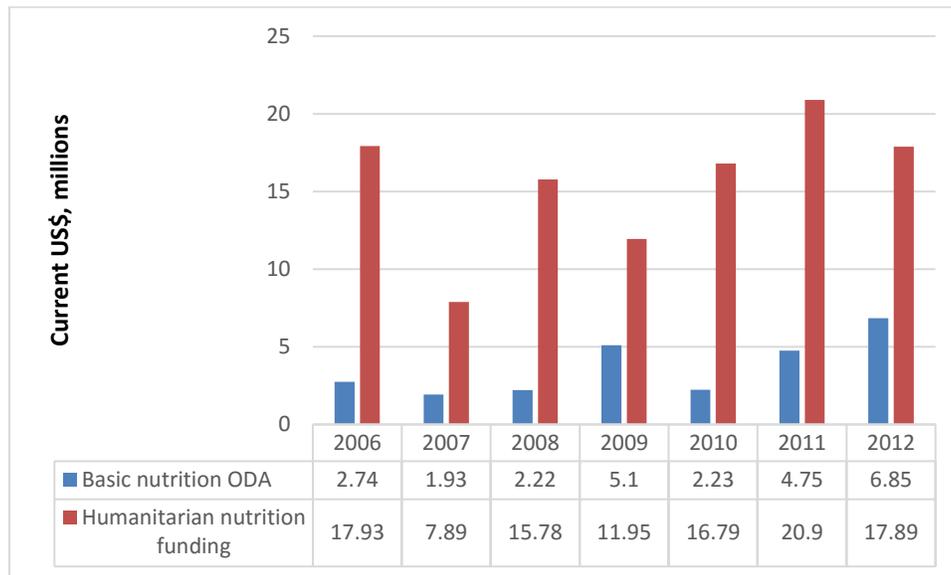
Although no comprehensive information is available on current and planned donor funding for nutrition, both the World Bank Group/IDA and DFID are supporting nutrition projects in the DRC. The World Bank/IDA approved a project of \$226.5 million in December 2014 to fund government health programming from 2015 through 2020, \$16.4 million of which is allocated to nutrition (World Bank 2014b). The project will include, as part of the basic health care package, indicators that will be “purchased” using performance-based financing. In addition to indicators (for antenatal care visits for pregnant women, immunization for children, etc.) that will have an impact on maternal and child nutrition, the project also has an indicator for “children 6–23 months receiving preventive nutrition services.” This will be centered on growth promotion, along with counseling and referral. Importantly, the quality checklist of the performance-based financing system will also focus on the quality of the nutrition services, and household visits will provide a mechanism for enabling the counseling to take place as well as enabling the monitoring of the growth of young children. The project is also innovative in that it will introduce household visits (performance-based financing projects typically focus on service delivery in facilities) that will be conducted using a protocol intended to promote healthy behaviors at the household level, including behaviors that have an impact on nutritional status. The project will finance service delivery in 140 health zones in the following four provinces: Équateur, Bandundu, Maniema, and Katanga. DFID recently partnered with UNICEF to provide \$7.3 million to fund direct nutrition interventions from 2013 to 2015 (DFID 2013).

Other development assistance includes USAID funding on the order of \$30 million per year in development food assistance programs that work to prevent chronic malnutrition through a multisectoral response; this funding is expected to continue through 2021. USAID also supports emergency food and nutritional assistance to the WFP, UNICEF, and NGOs, and although the annual total varies year to year,¹³ it is estimated that about \$10 million per year is allocated to the treatment of acute malnutrition (USAID 2015). Other donors that provide nutrition assistance include ECHO, which also supports emergency nutrition response; the Government of Belgium, which supports stunting prevention and nutrition interventions among refugees from the Central African Republic; and the Government of Japan, which supports the community-based management of severe acute malnutrition.

¹² More recent data are not available.

¹³ For example, in 2014 it was \$73 million (USAID 2015).

Figure 7. Trends in Donor Funding for Nutrition, 2006–2012



Sources: OECD 2014; UN OCHA 2014.

A critical next step will be to identify sources of financing for the large financing gap between what is currently being invested in nutrition interventions and the most modest of the scale-up scenarios proposed here. As discussed above, public budget allocations to nutrition interventions are currently negligible and, to date, the bulk of financing comes from international aid of about \$25 million per year. Given that the most modest of the scenarios presented here would require an additional \$97 million in annual investment, a priority is to identify supplementary sources of funding. The planned World Bank funding will cover only a modest part of these financing needs. Additional resources are needed to cover the key interventions identified here and to move from a humanitarian approach to a more development-focused approach that addresses both undernutrition and the social context in which it occurs.

UNCERTAINTIES AND SENSITIVITY ANALYSES

Because actual unit costs may differ from our estimates, it is important to consider the effects of either an increase or 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. In the DRC, 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 six nutrition-sensitive interventions delivered through the agriculture, education, and water and sanitation sectors: biofortification of cassava; aflatoxin reduction through biocontrol interventions; konzo control via the wetting method; school-based deworming; school-based promotion of good hygiene practices; and investments in increasing access to improved water, sanitation and hygiene (WASH) infrastructure. Table 16 summarizes the cost of scaling up these interventions and, when available, the estimated DALYs saved and cost per DALYs saved. Biofortification of cassava, school-based deworming, and WASH interventions are considered to be cost-effective scenarios in the DRC. Costs per DALY saved are not available for konzo control or school-based promotion of good hygiene.

Table 16. Preliminary Results for Costing Nutrition-Sensitive Interventions

Intervention	Annual cost (US\$, millions)	DALYs saved	Cost/DALY saved (US\$)
Biofortification of cassava	12.8 (total cost) ^a	—	0.40–1.00 ^a
Aflatoxin control in maize and groundnuts using biocontrol	31.4 ^b	8,260-14,868	2,114–3,806 ^b
Promotion of the wetting method for konzo control	4.8	—	—
School-based deworming	1.8 ^c	—	4.55 ^c
School-based promotion of good hygiene	12.7	—	—
WASH	1,037 (total, excluding sustaining costs)	1–2.7 million ^d	382–1,036 ^d

Note: When data are not available for the DRC, estimates from countries with similar circumstances are used (see specific notes below); — = not available.

a. Biofortification cost comes from an ex-ante evaluation in Meenakshi et al. (2010); cost per DALY saved comes from the preliminary results of an ex-ante evaluation in Birol et al. (2014).

b. Aflatoxin control costs are based on per hectare estimates for biocontrol using aflasafe™ in Nigeria. DALYs saved estimates are from authors' calculations based on the methodology found in Khlangwiset and Wu 2011.

c. Unit cost estimate is from Ghana (Guyatt 2003); cost/DALY saved estimate is from Kenya (J-PAL 2012).

d. Calculated using impact estimates from DFID (2012) and DALY estimates from IHME's *Global Burden of Disease* (2010b).

BIOFORTIFICATION OF CASSAVA

The projected total cost of scaling up biofortification of yellow cassava is estimated to be \$12.8 million (Meenakshi et al. 2010).¹⁴ This includes the costs of research and development, adaptive breeding, maintenance breeding, release, and dissemination components of the intervention. It is estimated that the DRC loses approximately 390,000 DALYs annually to vitamin A deficiency, and that the successful adoption of yellow cassava would save between a pessimistic 3 percent and an optimistic 32 percent of these lost DALYs each year (Meenakshi et al. 2010). Birol et al. (2014) have provided some preliminary results of updated cost and DALY calculations for biofortified cassava in the DRC with an estimated cost per DALY saved of between \$0.40 and \$1.00, depending on the assumed reduction in DALYs lost to vitamin A deficiency. Unfortunately, no estimations are currently possible for the number of lives saved as a result of the biofortification of yellow cassava.

AFLATOXIN REDUCTION THROUGH BIOCONTROL

The total cost of scaling up aflatoxin reduction through biocontrol is estimated to be \$31.43 million. The cost calculation uses the unit cost of aflasafe™ biocontrol developed by the International Institute for Tropical Agriculture and tested in Nigeria, with a cost per hectare of approximately \$15.6, including material and distribution costs (Bandyopadhyay 2013). The crop area calculation is based on the FAO's 2012 projections of DRC maize and groundnut planting area, which are estimated at 1.54 million and 477,000 hectares, respectively. For the purposes of this exercise, it is assumed that aflasafe™ will be applied to all maize and groundnut fields.¹⁵

The cost per DALY saved for biocontrol in the DRC is between \$3,806 and \$2,114, which is not considered to be cost-effective. However, biocontrol is considered the most cost-effective method for aflatoxin control when compared with other agricultural interventions. The estimated DALYs saved annually is between 8,260 and 14,868, depending on the assumed efficacy of the biocontrol method (between 50 percent and 90 percent).¹⁶ Because of a lack of evidence, it was not possible to estimate the impact of biocontrol on stunting prevalence.

PROMOTION OF THE WETTING METHOD FOR KONZO CONTROL

In order to control outbreaks of konzo in the four provinces in which it remains prevalent (Bandundu, the two Kasais, and Sud-Kivu), the cost of scaling up the promotion of the wetting method is estimated to be \$4.8 million. This calculation is based on a unit cost of \$10.00, which was derived from information on pilot projects in Australian National University (2014). The

¹⁴ This figure is the present value of costs distributed over a 30-year horizon and discounted at a 3 percent rate.

¹⁵ Most maize is for human consumption in the DRC but some is also for other purposes. We were not able to estimate how many hectares produce maize for human consumption versus other purposes.

¹⁶ DALY calculations are based on methodology derived from Khlangwiset and Wu (2011), liver cancer incidence data from IARC (2015), and country-specific DALY estimates from the IHME's *Global Burden of Disease* (2010a). DALYs are assumed to lag investment by five years and are discounted at a 3 percent rate.

target population for this intervention is assumed to be food-insecure households living in the four provinces where konzo is found.¹⁷

SCHOOL-BASED DEWORMING

The cost of scaling up school-based deworming is estimated to be \$1.8 million annually. Because data for the DRC are not available, the unit cost (\$0.08) used in the calculation is obtained from regional estimates of delivery cost in schools for Ghana (Guyatt 2003), assuming treatment twice a year. These estimates compare well with recent regional bottom-up cost analysis, based on neglected tropical disease national plans from 36 Sub-Saharan Africa countries (Seddoh et al. 2013), which estimates the unit cost of preventive chemotherapy of five neglected tropical diseases (lymphatic filariasis, onchocerciasis, schistosomiasis, trachoma, and soil-transmitted helminthiasis) in the Africa region at \$0.26. The major cost components for deworming are human resources, surveillance and mapping, non-donated drugs, advocacy, infrastructure and logistics, and implementation and management. The target population is school-aged children (6 to 19 years old) enrolled in primary and secondary schools, and current coverage is assumed to be negligible.

SCHOOL-BASED PROMOTION OF GOOD HYGIENE

The annual cost of scaling up school-based promotion of handwashing and good hygiene behavior is estimated to be \$12.7 million. Although promoting WASH in schools normally includes sustainable, safe water supply points, handwashing stands, and sanitation facilities, the costing of this intervention includes only the hygiene education component. The unit cost is obtained from a Ministry of Public Health report on the *Programme Villages et Écoles Assainis* (MOH 2013), and the unit cost for hygiene education component is estimated to be \$1.18 per student and includes the cost of capacity building, monitoring, advocacy, and social mobilization. The target population is school-age children and the current coverage is assumed to be approximately 4 percent, based on programmatic coverage data from the Ministry of Health (2013).

WATER, SANITATION AND HYGIENE (WASH)

The total cost of providing adequate water, sanitation, and hygiene for all households in the DRC is estimated to be \$1 billion. This high price tag reflects the overwhelming lack of WASH infrastructure in the DRC, where an estimated 34 million people (the target population used) live without access to clean drinking water (MOH 2013). This cost estimate is based on a unit cost of \$33 and program coverage of 7 percent, derived from data on the DRC *Villages Assainis* (Healthy Villages) program in the Ministry of Health (2013). Finally, the estimated number of DALYs saved through WASH interventions is based on the assumption that they can save between 21 and 57 percent of DALYs attributable to diarrheal diseases (DFID 2012) and DALY estimates from

¹⁷ The number of food-insecure households is derived from population data available in <http://foodsecuritycluster.net/sites/default/files/Rapport%20final%209%C3%A8me%20Cycle%20IPC%20DRC%20VF.pdf>.

the *Global Burden of Disease* (IHME 2010b). Importantly, these cost estimates do not include financing for sustaining costs in communities that have already been certified to be *assainis* (healthy) through the program.

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 saved, 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 saved, or cases of stunting averted) given available resources.

Reaching full national coverage of the 10 nutrition-specific interventions would require \$371 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. Therefore, our 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 attractive scenario (3a) would scale up key interventions in provinces with stunting rates above 40 percent at a cost per DALY saved of \$48. Scenario 3a would require an annual public investment of \$185 million and would save at least 3.6 million DALYs and 44,000 lives. Scenario 3b is also attractive because it would require fewer resources (\$97 million), while also providing a cost per DALY saved of \$49.

Recognizing the challenges of scaling to full coverage in one year, we estimate the investment required to scale up over five years to be \$523 million for Scenario 3a and \$275 million for Scenario 3b. These total costs for five years are significantly less than the \$1.04 billion needed for the full coverage scenario, but they still represent a significant increase over current spending on nutrition in the DRC. An important next step will be the identification of sources of funding for these key nutrition interventions.

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. Another limitation of the analysis is that it does not capture differences in costs across provinces. In a large country such as the DRC, 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 a selected number of nutrition-sensitive interventions implemented outside of the health sector. This report explores costs and benefits for six nutrition-sensitive interventions implemented outside of the health sector. However, the analysis presented here is only a starting point 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 the DRC. Key next steps are for the Government of the DRC and its partners to develop a road map of key actions and to identify milestones in addressing undernutrition in DRC.

APPENDICES

APPENDIX 1: MAP OF THE DEMOCRATIC REPUBLIC OF CONGO



Source: World Bank Group, internal map, 2009.

APPENDIX 2: TARGET POPULATION SIZE

Province	Children 6–59 months not covered by vitamin A supplementation (1)	Children 12–59 months not covered by deworming (2)	Families of children under 5 not covered by behavior change communication interventions (3)	Severely malnourished children not covered by community-based management of acute malnutrition programming (4)	Moderately malnourished children 6–23 months not covered by public provision of complementary food (5)	Children 6–23 months not receiving micronutrients or targeted for public provision of complementary foods (6)	Pregnant women not receiving iron-folic acid supplementation (7)	Total population not consuming iodized salt (8)	Total population not consuming flour fortified with iron (9)	Children 6–59 months not receiving zinc supplementation with oral rehydration salts for management of diarrhea (10)
Bandundu	96,638	182,495	1,544,802	115,934	333,794	325,878	196,733	2,304,677	8,350,279	1,351,568
Bas-Congo	44,361	117,580	645,488	23,303	150,500	125,141	84,576	914,150	3,489,123	568,727
Equateur	467,484	454,937	1,894,930	191,330	313,964	495,222	229,850	4,978,032	10,242,865	1,551,046
Kasai-Occidental	373,963	572,506	1,526,749	131,919	397,697	254,266	192,783	3,243,309	8,252,695	1,329,047
Kasai-Oriental	269,980	590,563	1,761,028	173,333	385,027	366,979	207,516	7,034,592	9,519,069	1,506,612
Katanga	465,661	657,218	2,318,029	133,460	401,884	587,977	306,230	9,648,013	12,529,886	2,032,160
Kinshasa	210,022	315,361	1,499,173	45,935	70,421	569,767	94,650	1,863,837	8,103,637	1,311,647
Maniema	555,237	618,787	1,933,058	82,735	526,649	298,819	307,617	4,346,768	10,448,961	1,703,181
Nord-Kivu	38,841	88,117	415,880	1,300	76,009	101,583	49,096	501,304	2,248,000	364,592
Oriental	147,988	385,795	1,150,421	58,222	198,469	292,791	116,410	1,243,698	6,218,489	1,005,505
Sud-Kivu	183,632	265,600	1,120,522	837	248,817	229,677	180,495	1,798,893	6,056,878	930,009
National	2,853,806	4,248,960	15,810,078	918,942	3,103,231	3,648,100	1,965,957	37,877,272	85,459,883	13,654,093

Sources: **Column 1:** INS Population Projections 2013 (children 6–59 months), MICS/ELIM 2010; **Column 2:** INS Population Projections 2013 (children 12–59 months), MICS/ELIM 2010; **Column 3:** INS Population Projections 2013 (children 0–59 months), MICS/ELIM 2010; **Column 4:** INS Population Projections 2013, incidence of severe acute malnutrition calculated based on MICS/ELIM 2010 and coverage of community-based management of acute malnutrition, programming from UN OCHA 2013; **Column 5:** INS Population Projections 2013 (children 6–23 months), % WAZ <–2 MICS/ELIM 2010; **Column 6:** INS Population Projections 2013 (children 6–23 months), MICS/ELIM 2010; **Column 7:** UNICEF 2013 (number of pregnant women), (number of women attending four or more antenatal clinics), MICS/ELIM 2010; **Column 8:** INS Population Projections 2013 (total population), % families consuming adequately iodized salt, MICS/ELIM 2010; **Column 9:** INS Population Projections 2013 (total population), MICS/ELIM 2010; **Column 10:** INS Population Projections 2013 (children 6–23 months), MICS/ELIM 2010 (coverage of zinc for treatment of diarrhea).

APPENDIX 3: DATA SOURCES AND RELEVANT ASSUMPTIONS

Intervention	Costed delivery platform	Cost estimate	Source	Assumptions
<i>Behavior change interventions</i>				
Breastfeeding promotion	Community nutrition programs	Included in community nutrition programs \$5.00 per child under five	Unit cost estimate from Nigeria (World Bank 2014c)	Infant and young child nutrition and Growth monitoring and promotion together costs \$5.00 per child under five costs \$5.00 per child under five
Education on appropriate complementary feeding practices (excluding provision of food)	Community nutrition programs	Included in community nutrition programs	n.a.	Assume zero additional cost as it is included in behavior change communication.
Handwashing	Community nutrition programs	Included in community nutrition programs	n.a.	Assume zero additional cost as it is included in behavior change communication.
<i>Micronutrients and deworming interventions</i>				
Vitamin A supplementation	Mass campaigns	\$0.55 per child per year	PRONANUT 2013; UNICEF 2013	Supplements are distributed through biannual national campaigns; overhead is shared with deworming. For children aged 6–11 months, each child receives one 1,000 international unit supplement twice per year. For children aged 12–59 months, each child receives one 2,000u supplement twice per year. A 1,000u capsule costs \$0.02; a 2,000u capsule costs \$0.03, which includes international shipping costs (equal to 15% of capsule costs). Programmatic costs (personnel, transportation, supervision, etc.) are \$0.51 per child for two campaigns a year.

Therapeutic zinc supplementation with ORS	Community nutrition programs	\$0.92 per child per year	UNICEF 2013	Each child is assumed to have 3.3 episodes of diarrhea per year, with an average of 10 tablets needed to treat one episode. Delivered as part of Kits PCIME (community nutrition programs). Each capsule costs \$0.0149, plus \$0.00373 in transport costs (25%), which comes to \$0.0186 per capsule per child. Add \$0.31 per child for distribution of Kits, identification of beneficiaries, establishment of community health structures, and supervision, shared with micronutrient powders.
Micronutrient powders	Community nutrition programs	\$3.54 per child 6–23 months per year	UNICEF 2013	A box of 30 packets of micronutrient Sprinkles costs \$0.86 and each child receives 90 packets per year. Add 25% for transportation costs. Add \$0.31 per child for distribution of Kits, identification of beneficiaries, establishment of community health structures, and supervision
Deworming	Mass campaigns	\$0.06 per child 12–59 months of age per year	PRONANUT 2013; UNICEF 2013	Assume one tablet of mebendazole per child 12–59 months of age twice per year (\$0.03 per mebendazole tablet). Programmatic costs (personnel, transportation, supervision, etc.) are already included in the cost of vitamin A supplementation.
Iron-folic acid supplementation for pregnant women	Primary health care	\$2.00 per pregnancy	World Bank 2014c	Based on unit cost data from Nigeria. No specific information on the DRC is available.
Iron fortification of staple foods	Market-based delivery systems	\$0.20 per person per year (flour fortification)	World Bank 2010; World Bank 2014c; UNICEF 2013	Global estimate is used. No specific information on the DRC is available.

Salt iodization	Market-based delivery systems	\$0.05 per person per year	World Bank 2010.	Global estimate is used. No specific information on the DRC is available.
<i>Complementary and therapeutic feeding interventions</i>				
Treatment of severe acute malnutrition using a community-based approach	Primary health care and community nutrition programs	\$162 per severely malnourished child per episode	UNICEF 2013	Food and supplies cost about \$55.82 per treatment. Transport costs about \$41.30. Personnel costs are approximately \$35. Other operational costs are \$30.
Public provision of complementary food for the prevention/treatment of moderate malnutrition	Community nutrition programs or primary health care system	\$40.25 per moderately malnourished child per year	WFP 2013	Plumpy'Sup costs \$27.26 per child per year. Personnel costs are \$7.06/child/year and transport costs are \$5.92/child/year. Based on the assumption that Plumpy'Sup costs \$3,495/metric ton, with children receiving approximately 24 grams/day for an average of 325 days each year.

Note: n.a. = not applicable.

APPENDIX 4: METHODOLOGY FOR ESTIMATING COSTS FOR THE DRC

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 the DRC, 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.

APPENDIX 5: METHODOLOGY FOR ESTIMATING DALYs FOR DRC

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 2012b). GHE 2012 morbidity and mortality estimates were used in combination with country-specific population attributable fractions (PAF) from the *Global Burden of Disease* (IHME 2010a). 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.

$$\text{YLL per 100,000} = (\text{U-5_cause_total_YLL} * \text{YLL_PAF} * 100,000) / \text{U-5_population}$$

$$\text{YLD per 100,000} = (\text{U-5_cause_total_YLD} * \text{YLD_PAF} * 100,000) / \text{U-5_population}$$

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:

$$\text{YLL} = \text{U-5_population_intervention_year} * \text{current_coverage} * \text{intervention_mortality_reduction} * \text{YLL_rate}$$

$$\text{YLD} = \text{U-5_population_intervention_year} * \text{current_coverage} * \text{intervention_morbidity_reduction} * \text{YLL_rate}$$

$$\text{DALY_current} = \text{YLL} + \text{YLD}$$

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:

$$\text{YLL} = \text{U-5_population_intervention_year} * \text{intervention_coverage} * \text{intervention_mortality_reduction} * \text{YLL_rate}$$

$$\text{YLD} = \text{U-5_population_intervention_year} * \text{intervention_coverage} * \text{intervention_morbidity_reduction} * \text{YLL_rate}$$

$$\text{DALY_intervention} = \text{YLL} + \text{YLD}$$

5. Calculate net DALYs averted

The potential net DALYs averted by the intervention is:

$$\text{DALYs averted} = \text{DALY_intervention} - \text{DALY_current}$$

APPENDIX 6: METHODOLOGY FOR DRC 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 DRC LiST estimates.

Table 5.1: DRC LiST Estimates: Data Sources

DRC LiST estimates	Data sources
<i>Demographic data</i>	
First year population	UN DESA 2012; applied household population distribution from MICS/ELIM 2010
Sex ratio at birth	UN DESA 2012
Life expectancy	LiST projection
<i>Family planning</i>	
Unmet need	Bradley et al. 2012.
Total fertility rate	UN DESA 2012
Age-specific fertility rate	UN DESA 2012
<i>Health, mortality, economic status</i>	
Vitamin A deficiency	MICS/ELIM 2010
Zinc deficiency	Wessells and Brown 2012
Diarrhea incidence	Fishcher Walker et al. 2012
Severe Pneumonia incidence	Fishcher Walker et al. 2013
Malaria exposure (women)	Guerra et al. 2008
Stunting distribution	LiST default; data have been calculated using DHS and MICS/ELIM datasets
Wasting distribution	LiST default; data have been calculated using DHS and MICS/ELIM datasets
Neonatal mortality	You et al. 2013
Infant mortality	MICS/ELIM 2010
Child mortality	MICS/ELIM 2010
Distribution of causes of death	Liu et al. 2012
Maternal mortality ratio	WHO 2013

Household poverty status	World Bank low-income country estimate: Poverty headcount ratio at \$1.25 a day (PPP) (% of population). World Bank 2012b, accessed 2014
Household size	MICS/ELIM 2010

Once the demographic and health data have been updated, the coverage and scale-up plan for each intervention is introduced into LiST. LiST can use either a sequential method to calculate the impact of individual interventions or LiST can calculate the simultaneous impact of a set of interventions implemented at the same time. The second, simultaneous method is like 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 in the “full coverage” scenario (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 a 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 the benefits 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 are an underestimate of 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 includes 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.¹⁸

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).¹⁹ 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 49, which is equivalent to life expectancy at birth in Mali. 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.

¹⁸ 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.

¹⁹ 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.

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

$$1. \text{ Present value of reduced mortality} = (\text{lives saved attributable to intervention scale-up}) \\ * (\text{GNI per capita}) * LDF$$

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

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
GDP per capita	\$400	World Bank 2013
Life expectancy at birth	49 years	World Bank 2011
Per capita income	\$180	AFDB 2013
Coefficient of deficit (stunting)	0.66	Hoddinott 2011
Actual gains realized	90%	Hoddinott 2013

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

$$NPV = \sum_{c=1}^5 (PV \text{ of reduced mortality})_c + (PV \text{ of reduced morbidity})_c - \sum_{t=1}^5 \frac{1}{(1+r)^t} (\text{investment cost})_t$$

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.

APPENDIX 8: SENSITIVITY ANALYSIS

Assumption change	Effect on total cost
Iron fortification of staples costs double	Increase from \$371 million to \$384 million
All micronutrient and deworming unit cost doubles	Increase from \$371 million to \$415 million
Community nutrition program unit cost doubles	Increase from \$371 million to \$458 million
Public provision of complementary food unit cost doubles	Increase from \$371 million to \$471 million
Community-based management of severe acute malnutrition unit cost doubles	Increase from \$371 million to \$509 million
Iron fortification of staples costs reduced by 50%	Decrease from \$371 million to \$364 million
All micronutrient and deworming unit cost reduced by 50%	Decrease from \$371 million to \$348 million
Community nutrition program unit cost reduced by 50%	Decrease from \$371 million to \$327 million
Public provision of complementary food unit cost reduced by 50%	Decrease from \$371 million to \$321 million
Community-based management of severe acute malnutrition unit cost reduced by 50%	Decrease from \$371 million to \$302 million

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This paper builds on global experience and the DRC's specific context to identify an effective nutrition approach along with costs and benefits 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 provinces of the DRC would require a yearly public investment of \$371 million. The expected benefits are enormous: annually over 5.4 million DALYs and over 76,000 lives would be saved, while at least 1 million cases of stunting among children under five would be averted. Economic productivity could potentially increase by \$591 million annually over the productive lives of the beneficiaries, with an impressive internal rate of return of 13.6 percent. However, because it is unlikely that the Government of the DRC or its partners will find the \$371 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 provinces with the highest rates of stunting and would cost between \$97 and \$185 million depending on how many provinces are covered. We then identify and cost six nutrition-sensitive interventions relevant to the DRC and for which there are 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 the DRC.

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