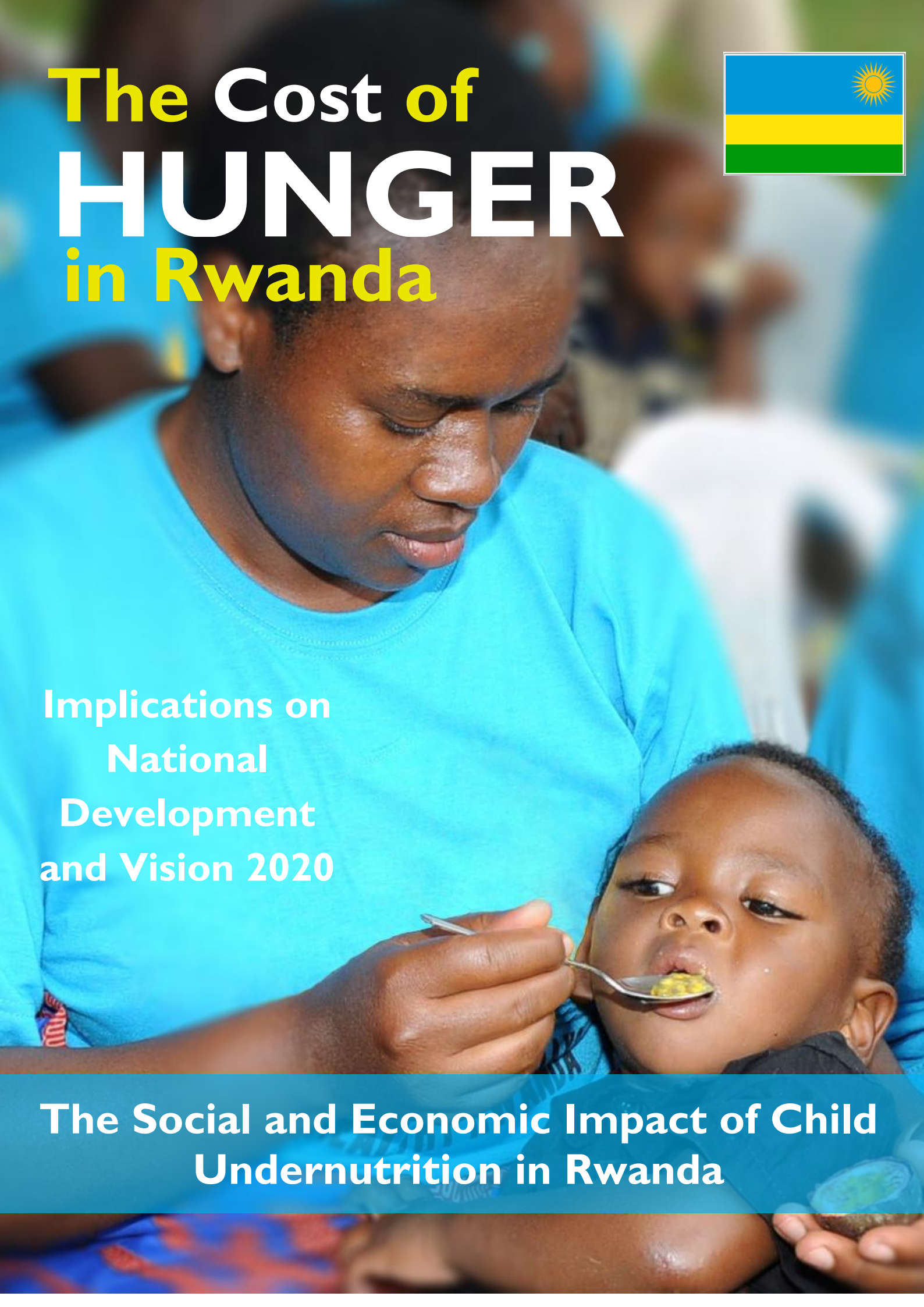
The Cost of HUNGER in Rwanda



Implications on National Development and Vision 2020

The Social and Economic Impact of Child Undernutrition in Rwanda

Initial Funding Provided by

The Cost of HUNGER In Rwanda

Social and Economic Impacts of Child Undernutrition in Rwanda

Implications on National Development and Vision 2020


When a child is undernourished, the negative consequences follow that child for his/her entire life. These negative consequences also have grave effects on the economies where s/he lives, learns and works.

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Foreword

Chronic child undernutrition can no longer be considered a sectoral issue, as both its causes and solutions are linked to social policies across numerous sectors. It requires active interventions from health, education, social protection and social infrastructure perspectives. Our mission in addressing these socio-economic issues invests in the future of Rwandan children and the nation. Malnutrition goes beyond a lack of food consumption. The interconnectivity between all of these elements has promoted a necessity for further investigations regarding the causes and effects of food deprivation.

This study comes at an important time for Rwanda. Now more than ever, it is evident that malnutrition, in all its forms, needs to be addressed as a national priority. This analysis is demonstrating that Rwanda has been able to make important progress in reducing the number of underweight children. However, it is also evidencing that there is room to improve in reducing the number of stunted children, who are still not receiving the proper nutrients to develop from a physical and cognitive standpoint.

We are at an important crossroad in our development process, and the time to take action is now. Our policies need to be enhanced and a new emphasis needs to be given to reducing stunting in Rwanda. As the Cost of Hunger study demonstrates, this will have an impact on improving our health, educational outcomes and improve productivity, as we prepare for the new development challenges that will be addressed in the post-MDG Agenda.

We welcome the contribution from the African Union Commission and its NEPAD programme, to bring this issue at the forefront of the development agenda, beyond the health and agriculture sectors. The partnership with the UN Economic Commission for Africa and the World Food Programme to support a Multisectoral national team of experts and partner institutions, including the Ministry of Health, the Ministry of Agriculture and Animal Resources, the Ministry of Finance and Economic Planning, the National Institute of Statistics Rwanda (NISR), the Ministry of Education, the Ministry of Foreign Affairs and Cooperation, the Ministry of Local Government, WFP and REACH to carry-out this study, demonstrates a good example of collaboration and capacity strengthening in advocacy and evidenced-based policy making.

Together we can initiate a path that will renew our efforts to eliminate hunger and child malnutrition in Rwanda, to realize the Vision 2020 that has been proposed for our development.

Honourable Dr. Agnes Binagwaho
Minister of Health, Republic of Rwanda

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Special recognition has to be given to the National Implementation Team (NIT) in Rwanda, as they were responsible for collecting, processing and presenting results. The NIT composed of Dr Victor Mivumbi, Mr Leopold Kazungu, and Mr Alexis Mucumbitsi from the Ministry of Health (MINISANTE, Chair), Mr. Claude Bizimana from the Ministry of Agriculture and Animal Resources (MINAGRI, Co-chair), Ms Yvonne Umulisa from the Ministry of Finance and Economic Planning (MINECOFIN), Mr Fabien Mpayimana from the National Institute of Statistics Rwanda (NISR), Ms Claudine Mukagahima from the Ministry of Education (MINEDUC), Mr Samuel Munyakayanza from the Ministry of Foreign Affairs and Cooperation (MINAFFET), Mr Védaste Hakizimana from the Ministry of Local Government (MINALOC), Ms Franklina Mantilla, REACH facilitator, and Ms Dong-eun Kim from WFP.

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The design and implementation of the study was directed by a Steering Committee jointly led by Menghestab Haile (WFP), Janet Byaruhanga from the Health, Nutrition and Population Division of the Social Affairs Department at the AUC and Boitshepo Bibi Giyose from NEPAD.

Acronyms

ACS	African Centre for Statistics
ADFNS	Africa Day for Food and Nutrition
ADS	Acute Diarrheal Syndrome
ARI	Acute Respiratory Infection
ARNS	Africa Regional Nutrition Strategy
ATYS-VMD	Africa Ten Year Strategy for the Reduction of Vitamin and Mineral Deficiencies
AUC	Africa Union Commission
CAADP	The Comprehensive Africa Agriculture Development Programme
COHA	Cost of Hunger in Africa
DHS	Demographic and Health Survey
ECLAC	Economic Commission for Latin America and the Caribbean
EDPRS	Economic Development and Poverty Reduction Strategy
EICV	Integrated Household Living Conditions Survey
FAFS	Framework for African Food Security
FAO	Food and Agriculture Organization
FTF	Feed the Future
GDP	Gross Domestic Product
GNI	Gross National Income
ICU	Intensive Care Unit
ILO	International Labour Organization
IUGR	Intra Uterine Growth Retardation
LBW	Low Birth Weight
MDGs	Millennium Development Goals
MINAFFET	Ministry of Foreign Affairs and Cooperation
MINEDUC	Ministry of Education
MINAGRI	Ministry of Agriculture and Animal Resource
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and Economic Planning
MINISANTE	Ministry of Health
NCHS	National Centre for Health Statistics
NISR	National Institute of Statistics of Rwanda
NEPAD	The New Partnership for Africa's Development
NIT	National Implementation Team
NPCA	NEPAD Planning and Coordinating Agency
OECD	Organization for Economic Cooperation and Development
PANI	Pan- African Nutrition Initiative
P4P	Purchase for Progress
REACH	Renewed Efforts Against Child Hunger
SAM	Severe Acute Malnutrition
SUN	Scaling Up Nutrition
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
RWF	Rwandan Franc
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization

Executive Summary

The Cost of Hunger in Africa (COHA) is an African Union Commission (AUC) led initiative through which countries are able to estimate the social and economic impact of child undernutrition in a given year. Twelve countries are initially participating in the study. Rwanda is part of the four second-phase countries, the first to carry out the study and present results.

The COHA study illustrates that child undernutrition is not only a social, but also an economic issue, as countries are losing significant sums of money as a result of current and past child undernutrition. To that end, in March 2012 the regional COHA study was presented to African Ministers of Finance, Planning and Economic Development who met in Addis Ababa, Ethiopia. The Ministers issued a resolution confirming the importance of the study and recommending it continue beyond the initial stage.

The COHA study in Rwanda is led by National Implementation Team (NIT). The NIT composed of Dr Victor Mivumbi, Mr Leopold Kazungu, and Mr Alexis Mucumbitsi from the Ministry of Health (MINISANTE, Chair), Mr Claude Bizimana from the Ministry of Agriculture and Animal Resources (MINAGRI, Co-chair), Ms. Yvonne Umulisa from the Ministry of Finance and Economic Planning (MINECOFIN), Mr Fabien Mpayimana from the National Institute of Statistics Rwanda (NISR), Ms. Claudine Mukagahima from the Ministry of Education (MINEDUC), Mr Samuel Munyakayanza from the Ministry of Foreign Affairs and Cooperation (MINAFFET), Mr Védaste Hakizimana from the Ministry of Local Government (MINALOC), Ms Franklina Mantilla, REACH facilitator, and Ms Dong-eun Kim from WFP.

During the process, all data for the study were collected from National Institute of Statistics of Rwanda (NISR), Demographic and Household Survey (DHS) 2010, National Institute of Statistics of Rwanda, Statistical Yearbook 2012, budget execution report 2011-2012, Ministry of Economic Planning and Finance, Ministry of Health (MOH), ICF International 2012, UN Population Division, as well as primary data collection.

Methodology

The COHA model is used to estimate the additional cases of morbidity, mortality, school repetitions, school dropouts and reduced physical capacity that can be directly associated to a person's undernutrition status before the age of five. In order to estimate these social impacts for a single year, the model focuses on the current[1] population, identifies the percentage of that population who were undernourished before the age of five, and then estimates the associated negative impacts experienced by the population in the current year. Using this information and the economic data provided by the Rwanda National Implementation Team (NIT), the model then estimates the associated economic losses incurred by the economy in health, education and in potential productivity in a single year.

Trends in child stunting

Rwanda has made progress in reducing stunting in children; nevertheless, stunting rates still remain high. The model estimated that 3.0 million adults in the working-age population suffered from growth retardation before reaching five years. In 2012 this represented 49.20 % of the population aged 15-64 who were in a disadvantaged position as compared to those who were not undernourished as children. Additionally the prevalence of underweight children has also improved according to the 2010/2011 Demographic and Health Survey (DHS), approximately 44 percent of Rwandan children under the age of 5 were suffering from low height for their age (stunting), which is a slight reduction from the 47 percent reported by DHS in 2005. The prevalence of underweight children has also improved from 18.0 percent to 12 percent. For that same period, the level of low birth weight prevalence in children has also remained steady, at around 6 percent.

[1] The model set 2009 as the base year, given the availability of data for that year and in order to insure the continuity of the study. As it is the most recent possible study year, it is referred to as "current" in this report.

Initial Results: the social and economic cost of child undernutrition in Rwanda

Overall results in Rwanda show that an estimated 503.6 billion Rwandan francs (RWF) were lost in the year 2012 as a result of child undernutrition. This is equivalent to 11.5% of GDP.

- For 2012, there were an estimated 280,385 additional clinical episodes associated to undernutrition in children under five, which incurred a cost of an estimated 65.1 billion RWF. Cases of diarrhoea, fever, respiratory infections and anaemia totalled 47,064episodes in addition to the 233,322 cases of underweight children. According to the estimated data, only one out of every five of all episodes received proper health attention.
- Undernutrition was associated to 21.9% of all child mortalities, which represented over 53,849 child deaths in 2012 and over 121,023 for the period from 1998 to 2007.
- Stunted children have a higher grade repetition rate at 12.7%, compared to non-stunted children at 9.4%. This incremental risk of 3.3 which generated 44,255 additional cases of grade repetition in 2012, during which the education system and families incurred a cost of 2.37 million RWF.
- Stunted children in Rwanda are also more likely to drop out of school. Based on the information from the NIT2010-2011, the model estimated that for 2012 the average schooling achievement for a person who was stunted as a child is 1.1 years lower than that of a person who was never undernourished. The resulted disadvantage in the labour market is estimated to have generated private costs of 794 million RWF in potential productivity loss for that single year.
- 49.2 percent of adults in Rwanda suffered from stunting as children. This represented more than 3 million people of working age who were not able to achieve their potential as a consequence of child undernutrition. In rural Rwanda, where most people are engaged in manual activities, it is estimated that in 2012 alone, 40.4 billion RWF were not produced due to a lower capacity of this group.
- Lastly, an estimated 922 million working hours were lost in 2012 due to absenteeism from the workforce as a result of nutrition-related mortalities. This represents 309 billion RWF, which is equivalent to 7.1% of the country's GDP.

Analysis of scenarios

In addition to calculating a retrospective cost for 2012, the model also can highlight potential savings, based on three scenarios. The three scenarios are described by the chart and graph below. These scenarios are constructed based on the estimated net present value of the costs of the children born in each year, from 2012 to 2025. The methodology follows each group of children and, based on each scenario, estimates a progressive path towards its achievement.

Scenario	**Baseline:** The Cost of Inaction by 2025	**Scenario #1:** Halving the Prevalence of Child Undernutrition by 2025	**Scenario #2.** The 'Goal'Scenario: "10 and 5 by 2025"
Description	Prevalence of stunted and underweight children stops at the level recorded in 2012 (44.2% and 11.4% respectively)	Prevalence of stunted and underweight children is reduced to half of 2012 (22.1% and 5.7% respectively)	Prevalence of stunted children is reduced to 10% and underweight children of less than five years of age, to 5%
Implications	No increase or decrease in percentage points but an increase in total number of stunted children and a higher burden on the society	A constant annual reduction of 1.7% points in the prevalence of stunting is required	A constant annual reduction of 2.63% points in the prevalence of stuntingis required
Estimated Change in period	Cost increase of up to 44% by 2025 compared to the values in 2012	Accumulated savings of 91.5 billion RWF for the period from 2012 to 2025	Accumulated savings of 112.5 billion RWF for the period from 2012 to 2025
Annual Average Savings	none	7,041million RWF ($US11.5 million)	8,653 million RWF ($US14.1 million)

Summary of conclusions and recommendations

The Government of Rwanda has put forth Vision 2020, where roadmap proposed to "to transform Rwanda into a middle-income nation in which Rwandans are healthier, educated and generally more prosperous". This vision, which was constructed though an extensive participative process, 6 pillars where identified and key indicators and targets where defined that would serve as evidence of growth both in economic and social terms. The Cost of Hunger in Rwanda presents an opportunity to better understand the role that child nutrition can play as a catalyst for the achievement of Vision 2020.

An overarching conclusion of this study is that chronic child undernutrition can no longer be considered a sectoral issue, as both its causes and solutions are linked to social policies across numerous sectors. As such, stunting reduction will require interventions from the health, education, social protection and social infrastructure perspectives and its improvement would evidence a step forward in the right direction for the inclusive development in a country, towards achieving growth with equity.

The multisectoral National Implementation Team, development partners and civil society have made some recommendation regarding the study. In which it was suggested that including the goal of stunting in the strategic planning to achieve meaningful socioeconomic transformation, EDPRS2 should include stunting as a high level indicator within its goal. Subsequently, the other key element recommended was improving coordination; a comprehensive multisectoral policy must be put in place, with strong political commitment and allocation of adequate resources for its implementation. The other suggestion was on the promotion of awareness about nutrition which remain limited across the whole population. To eliminate this setback heads of households and mothers should be targeted to reduce stunting.

Moreover, the promotion of the consumption of fortified complementary food is vital for population affected by micronutrient deficiencies and stunting. This falls under educating mothers on how to use the right nutrition for their children who are above 6 month of age. And also instalment of commission against child undernutrition by attracting experts from different fields such as nutrition, health, etc. Such a commission would be in the position to speak strongly with one voice while urging to put in place different programmes that address child undernutrition. The final implication made was regarding the improvement of monitoring and evaluation system that focus on child undernutrition which should target children before 2 years of age.

Section I: Brief Socio-Economic Background

I Brief Socio-Economic and Nutritional Background

The Republic of Rwanda (hereafter referred to as Rwanda) is the most densely populated country in Africa. Rwanda has a Gross Domestic Product (GDP) estimated at RWF 4,363 billion (US$ 7.103) (2012) and a per capita Gross National Income (GNI) of approximately US$ 644[1], which has grown considerably in the last decade. There are also high levels of inequality (with a GINI index of 0.49 and food insecurity (with a Global Hunger Index categorized at "serious") due to undernourishment, child undernutrition and child mortality, which presented important challenges for the country's development. However, Rwanda was one of the ten countries with most improved food security in since 1990, according to the Global Hunger Index.

Despite recent improvements, poverty remains a continuous challenge for Rwandans. In 2011, the poverty headcount ratio at national was 44.9 percent. The incidence of poverty is higher in rural areas where approximately 48.7 percent of the population lives below the poverty line, as compared to 22.1 percent in urban areas.[2] This illustrates a higher burden of poverty on rural communities. Further, Rwanda reports low unemployment, with only 0.9 percent of people reported as being unemployed and only 1.6 percent of youth 16-24 in 2011.[3]

TABLE 1.1
SOCIO-ECONOMIC INDICATORS

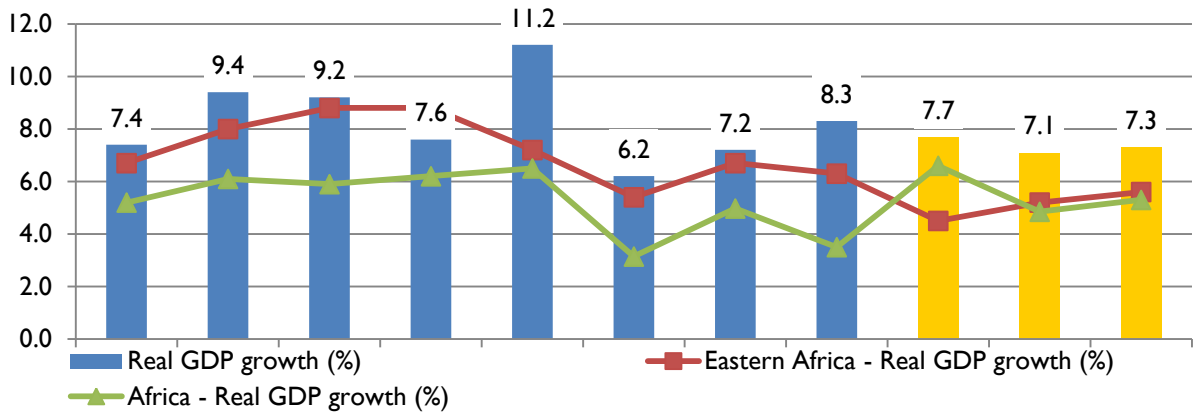
Indicators	2000-2002	2005-2007	2010-2012
Total population, in millions	8.8	9.7	11.1
GDP, total in billions of RWF	742	1,716	4.363
GNI per capita (atlas method current US$)	210	300	570
Poverty headcount ratio at national poverty line (% of the Population)	58.9	56.7	44.9
GINI Index	…	53.1	50.8
Unemployment, % of total labour force [a/]	1.6	1.9	1.6
Unemployment, youth total (% of total labour force ages 16-24)[a/]	2.4	2.4	1.7
Population growth (annual %)	2.6	2.4	2.8
Life expectancy at birth, total (years)	50.4	60.0	62.9

Source if not otherwise noted: World Development Indicators, The World Bank.
[a/] Republic of Rwanda, National Institute of Statistics of Rwanda, Statistical Yearbook 2012, p. 22. The official definition in Rwanda for unemployment is working less than 1 hour a week

From an economic perspective, Rwanda has experienced an important period of economic expansion in the last decade, with average growth rates higher than those reported for Sub-Saharan Africa. According to estimates from the African Economic Outlook, the real GDP growth rates will range from 7.1 percent to 7.3 percent in the next two years.

[2]World Development Indicators, The World Bank.
[3] Idem

FIGURE 1.1
TRENDS IN REAL GDP GROWTH, 2003-2013
(In Percentages)



Source: "World Economic Outlook Database October 2012, October 2013
Figures for 2012 are estimates; for 2013and later are projections.

Public investment in the social sector has also been maintained in the last decade, but is still below the average, by proportion, compared to the Sub-Saharan region. Public spending in education is estimated at 4.8 percent, which ranks above the regional average of 4.3 percent. Health expenditures from a per capita perspective are low compared to the rest of the region, but high as a proportion of GDP and percentage of total health expenditure.[4]

TABLE 1.2
SOCIAL INVESTMENT INDICATORS

Indicators	2000-2001	2006-2007	2010-2011	Sub-Saharan Africa*
Public spending on education, total (% of gov. exp.)	25.6	19.0	17.2	16.2
Public spending on education, total (% of GDP)	5.7	4.3	4.8	4.3
Health expenditure per capita (current US$)	9	36	63	94
Health expenditure, total (% of GDP)	4.4	9.4	10.8	6.5
Health expenditure, public (% of total health expenditure)	48.9	47.3	56.7	44.9

Source: World Development Indicators, The World Bank. Most recent year available
* Latest data available – Developing countries only

More specifically, for the year 2012, the government of Rwanda allocated the following budget to the respective fields of health, education and social affairs:

TABLE 1.3
GOVERNMENT EXPENDITURE, 2011-2012
(In Millions of RWF)

Health Expenditure	Education expenditure	Social Expenditure
64,690.62	169,492.76	37,263.26

Source: Budget execution report 2011-2012, Ministry of Economic Planning and Finance

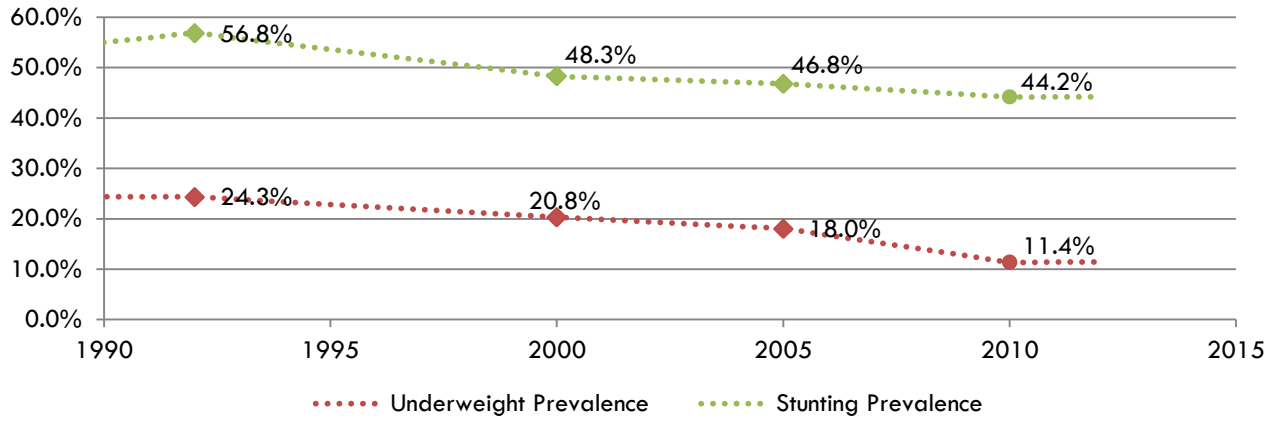
[4]World Development Indicators, The World Bank.

The recent improvement in poverty rates has been accompanied by a reduction in child undernutrition, particularly in stunting.

According to the 2010/2011 Demographic and Health Survey (DHS), approximately 44 percent of Rwandan children under the age of 5 were suffering from low height for their age (stunting), which is a slight reduction from the 47 percent reported by DHS in 2005. The prevalence of underweight children has also improved from 18.0 percent to 12 percent. For that same period, the level of low birth weight prevalence in children has also remained steady, at around 6 percent.[5]

An important element to note is the widening gap between the stunted children and the underweight children. It would seem that the interventions are targeted at reducing the lack of calorie intake of children, however the low progress rate of reduction in the stunted children might indicate the further efforts most be done in improving the quality of intake and improve the elements that determine absorption capacity of nutrients.

FIGURE 1.2
ESTIMATED UNDERNUTRITION TRENDS IN CHILDREN UNDER-FIVE, 1990-2010
(In Percentages)



Source: Prepared in-house based on information from DHS 2010, 2005, 2000 and national data from 1992 and 1976.
Data prior to 2006, has been updated in line with new Child Growth Standards[16] introduced by WHO in 2006 to replace the 1977 International Growth Reference, formulated by the National Centre for Health Statistics (NCHS).

The current levels of child undernutrition illustrate the continuing challenges for reduction of child hunger. It is estimated that 848,688 of the 1,976,470 children under the age of five in Rwanda were affected by stunting in 2012 and almost 224,441 children were underweight. This situation is especially critical for children between 12 and 59 months, where almost half of all children are affected by stunting.

TABLE 1.4
POPULATION AND CHILD UNDERNUTRITION, 2012

		Low Birth Weight		Underweight		Stunting	
Age groups	Population size (2012)[a/]	Population affected (2012)	Prevalence (2012)[b]	Population affected (2012)	Underweight prevalence (2012)[b/]	Population affected (2012)	Stunting prevalence (2012)[b/]
Newborn (IUGR)[a]		26,961	6.2%				
0 to 11 months	434,850			38,637	8.9%	86,100	19.8%
12 to 23 months	411,073			53,548	13.0%	201,837	49.1%
24 to 59 months	1,130,547			132,256	11.7%	560,751	49.6%
Total	1,976,470	26,961	6.2%	224,441	11.4%	848,688	44.2%

Source: Estimated based on DHS surveys 2010 and demographic projections
[a/] In a given year, the new-born population is the same as the 0-11 month's age group.
[b/] Estimated on the basis of the equation of De Onis et al, 2003.
[/c]Prevalences adjusted to those reported at DHS 2010.

[5]National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], andICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA:NISR, MOH, and ICF International

Section II: Cost of Hunger in Africa Methodology

II Cost of Hunger in Africa Methodology

A. Why is Child Undernutrition Important?

Recently, Africa has been experiencing a steady economic growth that has positioned the continent as a key region for global investment and trade. The pace of real GDP growth on the continent has doubled in the last decade and six of the world's fastest growing economies are in Africa.[6]

While this growth has been recorded despite some of the highest rates of child undernutrition in the world, the continent is still short of its full potential.

Human capital is the foundation of economic development. Improved nutritional status of people has a direct impact on economic performance through increased productivity and enhanced national comparative advantage. In order for Africa to maximize its present and future economic growth opportunities, increased efforts are needed for cost-effective interventions that address the nutritional situation of the most vulnerable members of the society.

Achieving nutrition and food security would generate immediate impact on the achievement of the Millennium Development Goals (MDGs). If child undernutrition were reduced, there would be a direct improvement in child mortality rates, as undernutrition is the single most important contributor to child mortality.[7] If girls were not undernourished, they would be less likely to bear underweight children. Further, healthy children would be more productive as adults and would have a higher chance of breaking the cycle of poverty for their families.

Undernutrition leads to a significant loss in human and economic potential. The World Bank estimates that undernourished children are at risk of losing more than 10 per cent of their lifetime earning potential, affecting thus national productivity. Recently, a panel of expert economists at a Copenhagen Consensus Conference concluded that fighting malnourishment should be the top priority for policy makers and philanthropists.[8] At that conference, Nobel Laureate Economist, Vernon Smith declared that, "One of the most compelling investments is to get nutrients to the worlds undernourished. The benefits from doing so – in terms of increased health, schooling, and productivity – are tremendous."[9] Improving the nutrition status is therefore a priority area that needs urgent policy attention to accelerate socio-economic progress and development in Africa.

However, despite a compelling economic case for nutrition interventions, investments with apparent shorter term returns are prioritized in social budgets. Hence, stronger efforts are required to sensitize the general population, policy makers and development partners on the high cost of undernutrition, in order to strengthen national and international political and financial commitments and to ensure that young children do not continue to suffer from undernourishment in Africa.

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[6] "World Economic Outlook Database October 2012", World Economic Outlook Database October 2012, October 2012, http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/index.aspx.

[7] Robert E. Black et al., "Maternal and child undernutrition: global and regional exposures and health consequences," *The Lancet* 371, No. 9608, 2008, doi: 10.1016/S0140-6736(07)61690-0.

[8] Copenhagen Consensus 2012, *Top economists identify the smartest investments for policy-makers and philanthropists,* 14 May 2012, http://www.copenhagenconsensus.com/Default.aspx?ID=1637.

[9] *Idem.*

Positioning nutrition interventions as a top priority for development and poverty reduction is often difficult, partly due to the lack of credible country-specific data on short-term returns. There is not enough country-specific evidence to demonstrate how improved nutrition would have a direct impact on school performance and eventually in improving opportunities in the labour market and physical work. Additionally, nutrition is often looked at as a health issue, without considering the rippling social impact that it has on other areas of development.

Despite the aforementioned challenges, efforts continue, both at continental and global levels, to address the issues of undernutrition and hunger. At the regional level, these efforts include initiatives and strategies such as the *African Regional Nutrition Strategy*, the *Comprehensive Africa Agriculture Development Programme* (CAADP), especially CAADP Pillar III, which focuses on reducing hunger and improving food and nutrition security, the *Pan African Nutrition Initiative* (PANI), *Framework for African Food Security* (FAFS), *Africa Ten Year Strategy for the Reduction of Vitamin and Mineral Deficiencies* (ATYS-VMD), and African Day for Food and Nutrition Security (ADFNS). At the global level, initiatives include *REACH*, *Purchase for Progress* (P4P), *Scaling Up Nutrition* (SUN), *Feed the Future* (FTF), the "1,000 Days" partnership, as well as the *Abuja Food Security Summit* of 2006. All these efforts are designed to reduce hunger, malnutrition and vulnerability, in a bid to also achieve the MDGs.

Within the framework of the African Regional Nutrition Strategy (2005-2015)[10], the objectives of the African Task Force on Food and Nutrition Development[11] and CAADP, the African Union and the New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency (NPCA), the United Nations Economic Commission for Africa (UNECA), and the World Food Programme (WFP) undertook efforts to conduct the *Cost of Hunger Study on the Social and Economic Impact of Child Undernutrition in Africa*. This study is built on a model developed by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC). Through a South-South collaboration agreement, ECLAC has supported the adaptation of the model to the African context.

This study aims at generating evidence to inform key decision makers and the general public about the cost African societies are already paying for not addressing the problem of child undernutrition. The results provide compelling evidence to guide policy dialogue and advocacy around the importance of preventing child undernutrition. Ultimately, it is expected that the study will encourage revision of current allocation practices in each participating country to ensure provision of the human and financial resources needed to effectively combat child undernutrition, specifically during the first 1,000 days of life when most of the damage occurs.

[10]African Regional Nutrition Strategy (2005-2015). Objectives I-III: I. To increase awareness among governments of the region, regional and international development partners and the community on the nature and magnitude of nutrition problems in Africa and their implications for the development of the continent and advocate for additional resources for nutrition. II. To advocate for renewed focus, attention, commitment and a redoubling of efforts by member states, in the wake of the worsening nutrition status of vulnerable groups. III. To stimulate action at the national and regional level that lead to improved nutrition outcome, by providing guidance on strategic areas of focus.

[11]African Union, "CAHM5 Moves into gear with meeting on food and nutrition development", 14 April 2011, http://www.au.int/en/sites/default/files/task%20force%20on%20food%20and%20nutrition%20development.pdf

B. Brief description of the model

i. Conceptual framework

Hunger is caused and affected by a set of contextual factors. "Hunger" is an overarching term that reflects an individual's food and nutrition insecurity. Food and nutrition insecurity occur when part of the population does not have assured physical, social and economic access to safe and nutritional food to satisfy dietary needs.

DEFINITION OF TERMS FOR COHA MODEL

1. Chronic Hunger: The status of people, whose food intake regularly provides less than their minimum energy requirements leading to undernutrition.[12]
2. Child Undernutrition: The result of prolonged low levels of food intake (hunger) and/or low absorption of food consumed. It is generally applied to energy or protein deficiency, but it may also relate to vitamin and mineral deficiencies. Anthropometric measurements (stunting, underweight and wasting) are the most widely used indicators of undernutrition.[13]
3. Malnutrition: A broad term for a range of conditions that hinder good health caused by inadequate or unbalanced food intake or from poor absorption of food consumed. It refers to both undernutrition (food deprivation) and over nutrition (excessive food intake in relation to energy requirements.[14]
4. Food insecurity: Exists when people lack access to sufficient amounts of safe and nutritious food, and therefore are not consuming enough for an active and healthy life. This may be due to the unavailability of food, inadequate purchasing power or inappropriate utilization at household level.[15]
5. Food vulnerability: Reflects the probability of an acute decline in food access or consumption, often in reference to some critical value that defines minimum levels of human wellbeing.[16]

Nutrition security therefore, depends on a person's food security or insecurity. Specifically, nutrition security can be described as, the "appropriate quantity and combination of food, nutrition, health services and care taker's time needed to ensure adequate nutrition status for an active and healthy life at all times for all people."[17] A direct and measurable consequence of nutrition insecurity is low birth weight, underweight and/or lower than normal height-for-age.

Levels of nutrition security in a country are related to epidemiological and nutritional transitions, which can be evaluated to assess the population's nutritional situation. Further, a person's nutritional situation is part of a process that is expressed differently depending on the stage of the life cycle: intrauterine and neonatal life, infancy and pre-school, school years or adult life. This is because the nutrient requirements and the needs are different for each stage[18].

Below is the discussion of the central elements, considered in the model, to estimate the effects and costs of child undernutrition based on the concepts mentioned above, along with a brief description of the causes and consequences of undernutrition. The discussion also describes the dimension of analysis and the principal methodological aspects used to interpret the results.[19]

ii. Causes of undernutrition

[12]"Hunger statistics", FAO Hunger Portal, Undernourishment or Chronic Hunger, FAO, accessed March 14, 2013, http://www.fao.org/hunger/en/.

[13]*Ibid*

[14]*Ibid.*

[15]*Ibid.*

[16] WFP, *VAM Standard analytical framework*, World Food Programme, 2002.

[17] USAID, *USAID Commodities reference guide*, Annex I: Definitions, January 2006, http://transition.usaid.gov/our_work/humanitarian_assistance/ffp/crg/annex-I.htm.

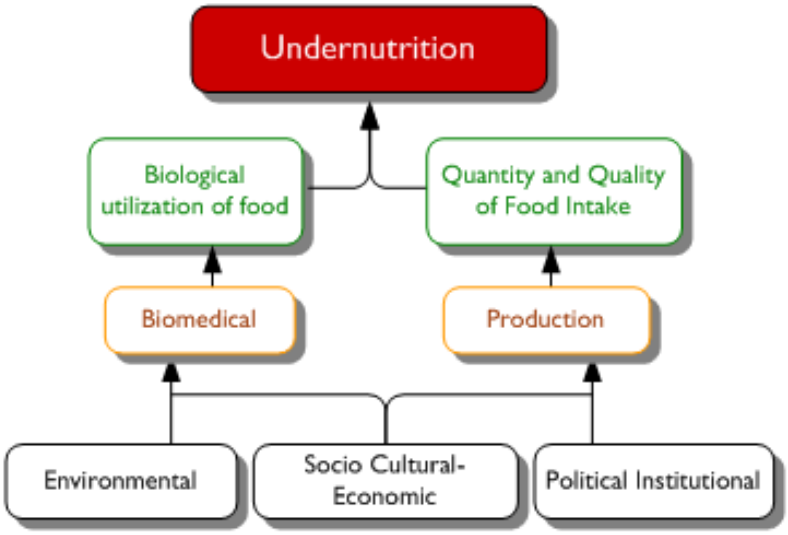
[18]Rodrigo Martínez and Andrés Fernández, *Model for analysing the social and economic impact of child undernutrition in Latin America,* Naciones Unidas, CEPAL, Social Development Division, Santiago De Chile, 2007.

[19]A summarized version of the theoretical background and the basic characteristics considered in the model of analysis are presented. For a more detailed discussion of the model, see Rodrigo Martínez and Andrés Fernández, *Model for analysing the social and economic impact of child undernutrition in Latin America,* Naciones Unidas, CEPAL, Social Development Division, Santiago De Chile, 2007.

The main factors associated with undernutrition, as a public health problem, can be grouped into the following: environmental (natural or entropic causes), sociocultural-economic (linked to poverty and inequality) and political-institutional. Together, these factors increase or decrease biomedical and productivity vulnerabilities, through which they determine the quantity and quality of dietary intake and the absorption capacity, which constitute the elements of undernutrition.[20]

Each of these factors helps increase or decrease the likelihood of a person to suffer from undernutrition (see Figure II.I). Further, the importance of each of these factors depends on the level of the country's demographic and epidemiological transition as well as on the person's current stage in the life cycle. Together these factors determine the intensity of the resulting vulnerability to undernutrition.

FIGURE II.1
CAUSES OF UNDERNUTRTION



Source: Mofified from Rodrigo Martinez and Andrés Fernández, *Model for analysing the social and economic impact of child undernutrition in Latin America* (see footnote) based on consultations carried out by authors.[1]

Environmental factors define the surroundings in which the subject and his or her family live, including the risks stemming from the natural environment itself and its cycles (from floods, droughts, frosts, earthquakes, and other phenomena), and those produced by humans themselves (such as the contamination of water, air, and food, the expansion of agriculture into new territories, etc.). The socio-cultural-economic determinants include elements associated with poverty and equality, education and cultural norms, employment and wages, access to social security, and coverage of aid programmes. The political-institutional factors encompass government policies and programmes aimed specifically at solving the population's food and nutritional problems.

Production factors include those directly associated with the production of food, as well as the access that the at-risk population has to them. The availability and autonomy of each country's dietary energy supply depend directly on the characteristics of production processes, the degree to which they utilize natural resources, and the extent to which these processes mitigate or aggravate environmental risks.

Finally, biomedical factors take into account the individual's susceptibility to undernutrition, insofar as deficiencies in certain elements limit the capacity to make biological use of the food consumed (regardless of quantity and quality).

iii. Consequences of undernutrition

Child undernutrition has long-term negative effects on a person's life[21], most notably in the aspects of health, education, and productivity (see Figure II.2).These elements are quantifiable as costs and expenditures to both the public sector and to individuals. Consequently, these effects exacerbate problems in social integration and increase or intensify poverty. A vicious cycle is perpetuated as vulnerability to undernutrition grows.

[20]Rodrigo Martínez and Andrés Fernández, *Model for analysing the social and economic impact of child undernutrition in Latin America,* Naciones Unidas, CEPAL, Social Development Division, Santiago De Chile, 2007.

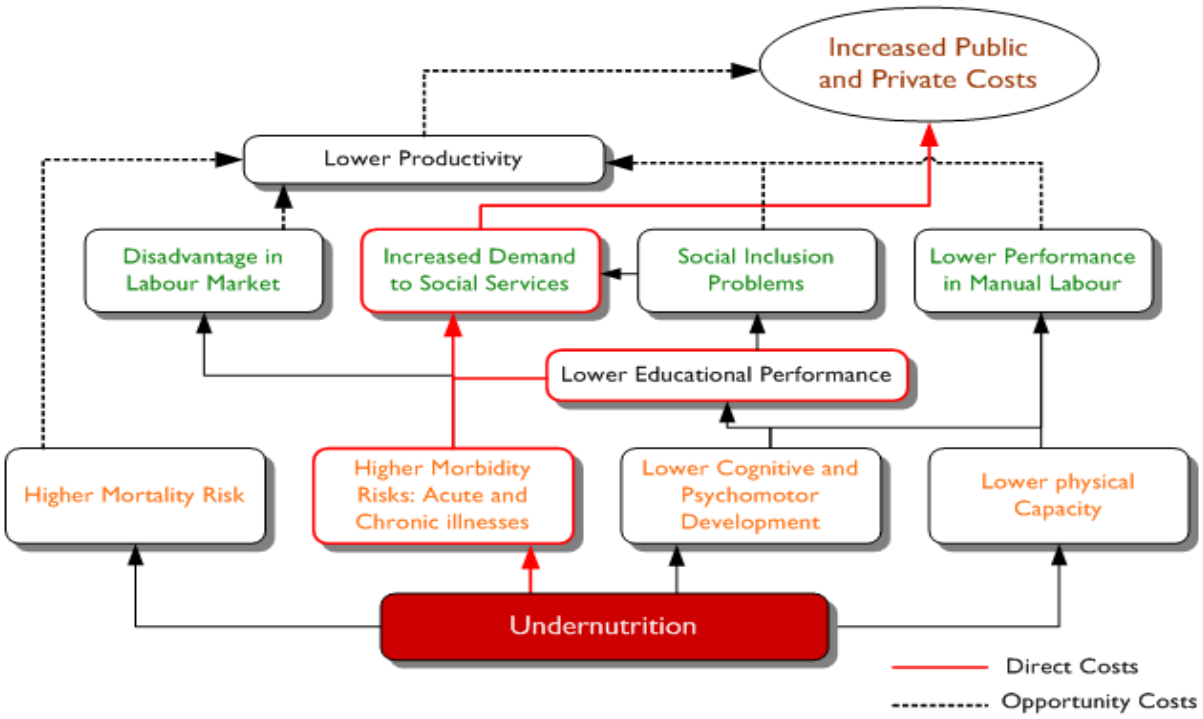
[21]Alderman H., et al., "Long-term consequences of early childhood malnutrition", FCND Discussion Paper No. 168, IFPRI, 2003.

Undernutrition may have immediate or evolving impacts throughout a person's lifetime, although individuals who suffered from undernutrition during early years of their life cycle (including intrauterine) are more likely to be undernourished later in life. Health studies have shown that undernutrition leads to increased appearance or intensified severity of specific pathologies, and increases the chance of death during specific stages of the life cycle.[22] The nature and intensity of the impact of undernutrition on pathologies depends on the epidemiological profile of a given country.

In education, undernutrition affects student performance through disease-related weaknesses and results in limited learning capacity associated with deficient cognitive development.[23] This translates into a greater probability of starting school at a later age, repeating grades, dropping out of school and ultimately obtaining a lower level of education.

Later in life, individuals may experience lower physical capacity in manual labour as a result of stunting.[24] Stunting, which is caused by food deprivation and nutrient deficiencies, is established by low height-for-age measurements during childhood. In adulthood, it leads to an overall reduced body mass when compared to the full adult potential.

FIGURE II.2
CONSEQUENCES OF UNDERNUTRITION



Source: Rodrigo Martinez and Andrés Fernández, *Model for analysing the social and economic impact of child undernutrition in Latin America* (see footnote) based on consultations carried out by authors.[1]

Undernutrition and each of its negative impacts on health, education and productivity, as described above, lead to a social, as well as an economic, loss to the individual and society as a whole (see Figure II.2). Thus, the total cost of undernutrition (TC^U) is a function of higher health-care spending (HC^U), inefficiencies in education (EC^U) and lower productivity (PC^U). As a result, to account for the total cost (TC^U), the function can be written as:

$$TC^U = f(HC^U, EC^U, PC^U)$$

In the area of health, the high probability resulting from the epidemiological profile of individuals suffering from undernutrition proportionally increases the costs in the health care sector (HSC^U). In aggregate, this is equal to the sum of the interactions between the probability of undernutrition in each age group, the probability that a particular group will suffer from the diseases because of undernutrition, and the costs of treating the pathology (HSC^U) that typically includes diagnosis, treatment and

[22] Amy L. Rice et al., "Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries," *Bulletin of the World Health Organization* 78, No. 2000, 2000.

[23] Melissa C. Daniels and Linda S. Adair, "Growth in young Filipino children predicts schooling trajectories through high school," *The Journal of Nutrition*, March 22, 2004, Jn.nutrition.org.

[24] Lawrence J. Haddad and Howarth E. Bouis, "The impact of nutritional status on agricultural productivity: wage evidence from the Philippines," *Oxford Bulletin of Economics and Statistics* 53, No. 1, February 1991, doi:10.1111/j.1468-0084.1991.mp53001004.x.

control. To these are added the costs paid by individuals and their families as a result of lost time and quality of life (IHC^U). Thus, to study the variables associated with the health cost (HC^U) the formula is:

$$HC^U = f\,(HSC^U, IHC^U)$$

In education, the reduced attention and learning capacity of those who have suffered from child undernutrition increase costs to the educational system (ESC^U). Repeating one or more grades commensurately increases the demand that the educational system must meet, with the resulting extra costs in infrastructure, equipment, human resources and educational inputs. In addition, the private costs (incurred by students and their families) derived from the larger quantity of inputs, external educational supplementation and more time devoted to solving or mitigating low performance problems (IEC^U) are added to the above costs. Thus, in the case of the education cost (EC^U), the formula is:

$$EC^U = f\,(ESC^U, IEC^U)$$

The productivity cost associated with undernutrition is equal to the loss in human capital (HK) incurred by a society, stemming from a lower educational level achieved by malnourished individuals (ELC^U), a lower productivity in manual labour experienced by individuals who suffered from stunting (MLC^U) and the loss of productive capacity resulting from a higher number of deaths caused by undernutrition (MMC^U). In the model these costs are reflected as losses in potential productivity (PC^U). Thus:

$$PC^U = f\,(ELC^U, MLC^U, MMC^U)$$

As a result, in order to comprehensively analyse the phenomenon of undernutrition, the model considers its consequences on health, education and productivity by translating them into costs.

iv. Dimensions of analysis

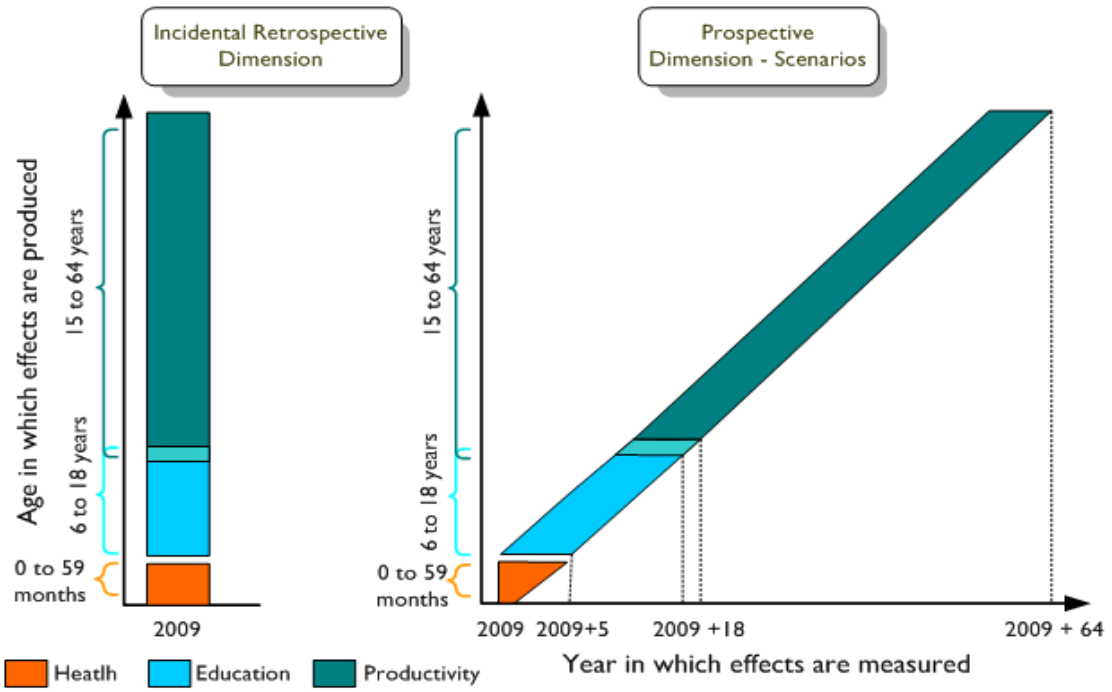
Considering that a country's undernutrition situation and the consequences thereof reflect a specific epidemiological and nutritional transition process, a comprehensive analysis involves estimates of the current situation extrapolated from previous transitional stages as well as estimates of the future to predict potential cost and saving scenarios based on prospective interventions to control or eradicate the problem.

On this basis, a two-dimensional analysis model was developed to estimate the costs arising from the consequences of child undernutrition in health, education and productivity:

1. ***Incidental retrospective dimension*** focuses on the population in the study year, including mortality cases of those who would have been alive in the study year. The retrospective dimension estimates the nutritional situation of individuals under the age of five to identify the related economic costs in the study year. Thus, it is possible to estimate the health costs of pre-school boys and girls who suffer from undernutrition during the year of analysis, the education costs stemming from the children currently in school who suffered from undernutrition during the first five years of life, and the economic costs due to lost productivity by working-age individuals who were exposed to undernutrition before the age of five.
2. ***Prospective, or potential savings, dimension***. This dimension focuses on children under five in a given year and allows analysis of the present and future losses incurred as a result of medical treatment, repetition of grades in school and lower productivity. Based on this analysis, potential savings derived from actions taken to achieve nutritional objectives can be estimated.

As shown in Figure II.3, the incidental retrospective dimension includes the social and economic consequences of undernutrition in a specific year (for the purposes of this report 2009 was set as the base year) for cohorts that have been affected (0 to 4 years of age for health, 6 to 18 years for education and 15 to 64 years for productivity). The prospective dimension on the other hand, projects the costs and effects of undernutrition recorded in the reference year of the study. These are based on the number of children born during the period selected in the analysis and, with the application of a discount rate, on the present value estimates of future costs to be incurred due to the consequences of undernutrition. The prospective dimension is the basis for establishing scenarios to estimate the economic and social savings of an improved nutritional situation.

FIGURE II.3
DIMENSIONS OF ANALYSIS BY POPULATION AGE AND YEAR WHEN EFFECTS OCCUR



Source: Rodrigo Martinez and Andrés Fernández, *Model for analysing the social and economic impact of child undernutrition in Latin America* (see footnote) based on consultations carried out by authors.[1]

v. Methodological aspects

The analysis focuses on undernutrition during the initial stages of the life cycle and its consequences throughout life. This limits the study to the health of the foetus, the infant and the pre-schooler, i.e. those aged 0 to 59 months.[25] Similarly, the effects on education and productivity are analysed in the other demographic groups, i.e. 6-18 years old and 15-64 years old, respectively.

The population of children suffering from undernutrition was divided into sub-cohorts (0 to 28 days, 1 to 11 months, 12 to 23 months and 24 to 59 months) in order to highlight the specificity of certain effects during each stage of the life cycle.

The study uses undernutrition indicators that are measurable and appropriate to the different stages of an individual's life cycle. For intrauterine undernutrition, low birth weight (LBW) due to intrauterine growth restriction (IUGR, defined as a weight below the tenth percentile for gestational age) is estimated. For the pre-school stage, moderate and severe stunting categories (weight-for-height scores below -2 standard deviations) are used, with reference, where possible, to the World Health Organization (WHO) distribution for comparison purpose.[26]

Estimates of the impacts of undernutrition on health, education and productivity are based on the concept of the relative (or differential) risk run by individuals who suffer from undernutrition during the first stages of life as compared to a healthy child. This is valid both for the incidental-retrospective analysis and for the prospective-savings analysis; however, as its application has specific characteristics in each case, they are detailed separately in this document.

To estimate the costs for the incidental retrospective dimension, the values occurring in the year of analysis are totalled based on estimates of differential risks undergone by the different cohorts of the population. In the prospective analysis on the other hand, a future cost flow is estimated and updated (to present value).

The methodological approach presented here considers the most detailed and complete set of causes and effects of child undernutrition. Further, consideration has been made to ensure that certain causes and effects are not overemphasized or double counted. The methodological framework is based on strong research as well as institutional support from international organizations, and has been deemed a strong basis for the purpose of the research described in this report.

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[25] In the original design, the idea of analyzing direct information on the nutritional and health situation of pregnant women was considered, but the lack of reliable information on the incidence of undernutrition led to its exclusion from the analysis.

[26] In the estimation of stunting, a complementary analysis is done based on NCHS Standard in order to estimate the relative risk of lower productivity.

Section III: Effects and Costs of Child Undernutrition

III Effects and Costs of Child Undernutrition

Undernutrition is mainly characterized by wasting - a low weight-for-height, stunting - low height-for-age and underweight - low weight-for-age. In early childhood, undernutrition has negative life-long and intergenerational consequences; undernourished children are more likely to require medical care as a result of undernutrition-related diseases and deficiencies. This increases the burden on public social services and health costs incurred by the government and the affected families. Without proper care, underweight and wasting in children results in a higher risk of mortality. During schooling years, stunted children are more likely to repeat grades and drop out of school, reducing thus, their income-earning capability later in life. Furthermore, adults who were stunted as children are less likely to achieve their expected physical and cognitive development, thereby impacting on their productivity.

A. Social and economic cost of child undernutrition in the health sector

Undernutrition at an early age predisposes children to higher morbidity and mortality risks. The risk of becoming ill due to undernutrition has been estimated using probability differentials, as described in the methodology. Specifically, the study has examined medical costs associated with treating low birth weight (LBW), underweight, anaemia, acute respiratory infections (ARI), acute diarrheal syndrome (ADS) and fever/malaria associated with undernutrition in children under the age of five.

i. Effects on morbidity

Undernourished children are more susceptible to recurring illness.[27] Based on the differential probability analysis undertaken with DHS data in Rwanda, underweight children under 5 years have an increased risk of anaemia (increased risk equal to 6.7 percentage points), an increased risk of diarrhoea (increased risk equal to 3.2 percentage points), an increased risk of respiratory infection (increased risk equal to 3.3 percentage points in the age-group of 28 days to 11 months), and an increased risk of fever/malaria (increased risk equal to 5.7 percentage points).

The study estimated that in Rwanda in 2012, there were 47,064 incremental episodes of illness related to diseases associated with underweight. In addition, pathologies related to calorie and protein deficiencies and low birth weight associated with intrauterine growth restriction (IUGR), totalled 233,322 episodes in 2012.

[27] Idem

TABLE 2.5
MORBIDITIES FOR CHILDREN UNDER-FIVE ASSOCIATED WITH UNDERWEIGHT, BY PATHOLOGY, 2012

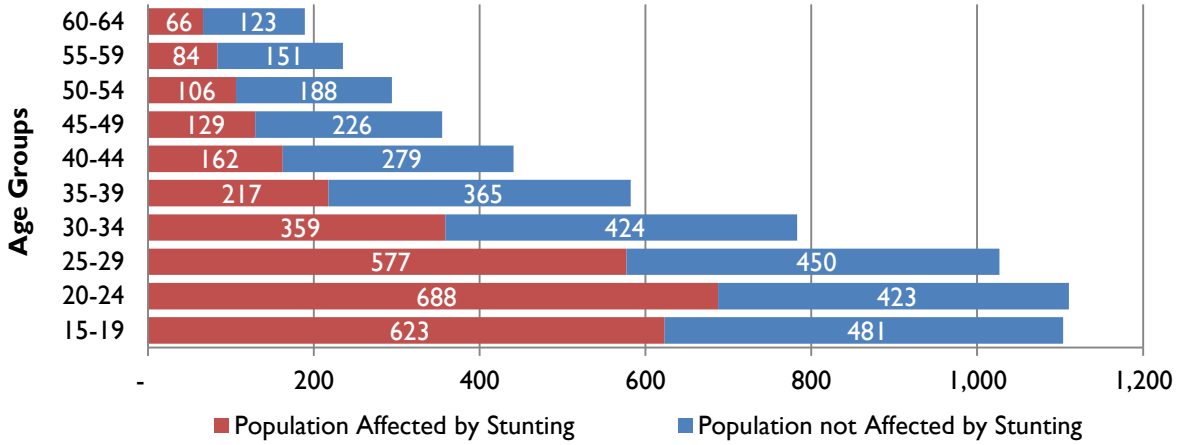
Pathology	Number of Episodes	Distribution of Episodes
Anaemia	15,743	33%
ADS	22,874	49%
ARI	718	2%
Fever/Malaria	7,729	16%
Subtotal	**47,064**	
LBW	8,880	4%
Underweight	224,441	96%
Subtotal	**233,322**	
Total	**280,385**	

Source: Model estimations based on DHS 2010, and demographic information

ii. Stunting levels of the working age population

Undernutrition leads to stunting in children, which can impact on their productivity at later stages in life.[28] Rwanda has made progress in reducing stunting in children; nevertheless, stunting rates still remain high. As illustrated in Figure 2.3, the model estimated that 3.0 million adults in the working-age population suffered from growth retardation before reaching five years. In 2012 this represented 49.20 % of the population aged 15-64 who were in a disadvantaged position as compared to those who were not undernourished as children.

FIGURE 2.3
WORKING AGE POPULATION AFFECTED BY CHILDHOOD STUNTING, BY AGE
(In Thousands of people)



Source: Model estimations based on demographic information and WHO/NCHS/DHS nutritional surveys.

iii. Effects on mortality

Child undernutrition can lead to increased cases of mortality most often associated with incidences of diarrhoea, pneumonia, fever and malaria.[29]Nevertheless, when the cause of death is determined, it is rarely attributed to the nutritional deficit of the child, but rather to the related illnesses. Given this limitation in attribution, the model utilizes relative risk factors[30]to estimate

[28]H. Alderman, "Long Term Consequences of Early Childhood Malnutrition," Oxford Economic Papers 58, no. 3 (May 03, 2006), doi:10.1093/oep /gpl008.
[29]Robert E. Black et al., "Maternal and child undernutrition: global and regional exposures and health consequences," The Lancet 371, No. 9608, 2008, doi:10.1016/S0140-6736(07)61690-0
[30]Idem

the risk of increased child mortality as a result of child undernutrition. Mortality risk associated with undernutrtion was calculated using these relative risk factors, historical survival and mortality rates,[31] and historical nutrition information.

In the last 5 years alone, it is estimated that 53,843 child deaths in Rwanda were directly associated with undernutrition. These deaths represent 21.9 percent of all child mortalities for this period. Thus, it is evident that undernutrition significantly exacerbates the rates of death among children and limits the country's capacity to achieve the MDGs, especially the goal to reduce child mortality.

TABLE 2.6
IMPACT OF UNDERNUTRITION ON CHILD MORTALITY, ADJUSTED BY SURVIVAL RATE, 1948-2012
(In Number of mortalities)

Period	Number of child mortalities associated to undernutrition
1948-1997	573,327
1998-2007	121,023
2008-2012	53,843
Total	748,193

Source: ECA on the basis of life tables provided by UN Population Division

These historical mortality rates will also have an impact on national productivity. The model estimates that an equivalent of 9.4 percent of the current workforce has been lost due to the impact of undernutrition in increasing child mortality rates. This represents 573,327 people who would have between 15-64 years old, and part of the working age population of the country.

iv. Estimation of public and private health costs

The treatment of undernutrition and related illness is a critical recurrent cost for the health system. Treating a severely the treatment of undernutrition and related illnesses is a critical recurrent cost for the health system. Treating a severely underweight child for example, requires a comprehensive protocol[32] that is often more costly than the monetary value and effort needed to prevent undernutrition. The economic cost of each episode is often increased by inefficiencies when such cases are treated without proper guidance from a health-care professional or due to lack of access to proper health services. These costs generate a significant important burden not just to the public sector but to society as a whole. It is estimated that 280,385 clinical episodes (Table 2.5) in Rwanda in 2012, were associated with the higher risk present in underweight children. As indicated in Table 2.7, these episodes generated an estimated cost of RWF 65,107 million.

TABLE 2.7
HEALTH COSTS OF UNDERNUTRITION-RELATED PATHOLOGIES, 2012

Pathology	% of episodes	Cost in Millions (RWF)	Cost in thousands (US$)	% of Cost
Underweight	80%	57,836.2	13,255.0	89%
LBW/IUGR	3%	3,222.2	738.5	5%
Anemia	6%	894.3	205.0	1%
ADS	8%	1,994.3	457.0	3%
ARI	0%	148.3	34.0	0%
Fever	3%	1,012.0	231.9	2%
Total Cost		**65,107.3**	**1,666.4**	

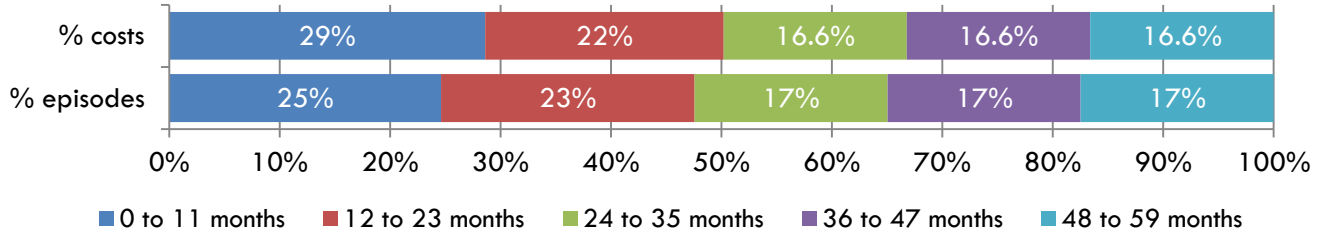
Source: Model estimations based on DHS 2010

Most of these costs incurred were associated with the protocol required to bring an underweight child back to a proper nutritional status, which often requires therapeutic feeding. An important element to highlight is the particular costs generated by the treatment of low birth weight children. These cases represented 3 percent of all the episodes but generated 5 percent of the total cost. This is due to the special management protocol required by LBW children which often includes hospitalization and time in intensive care.

[31] Data provided by the UN Population Division, http://www.un.org/esa/population/unpop.htm
[32] WHO, Management of severe malnutrition: a manual for physicians and other senior health workers ISBN 92 4 154511 9, NLM Classification: WD 101, 1999.

As shown in figure 2.4, more than half of the costs and episodes occur during the first 1,000 day of life of the child, particularly before the child turns 2 years old, in coherence with the window of opportunity to prevent and address child malnutrition[33].

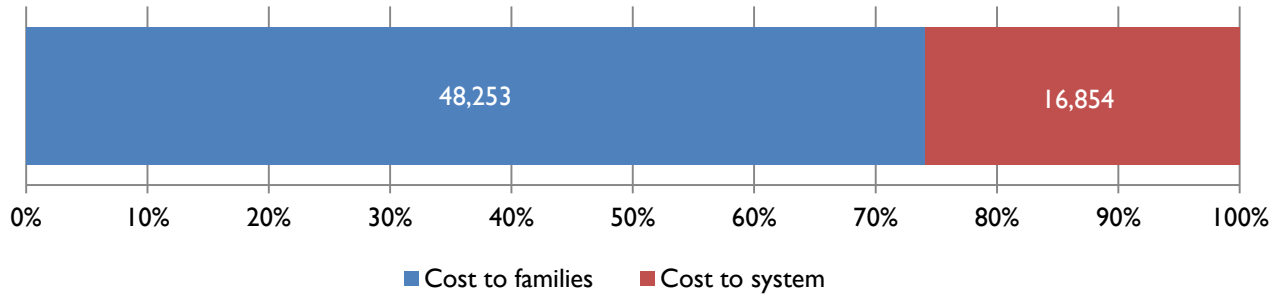
FIGURE 2.4
DISTRUBUTION OF INCREMENTAL EPISODES AND COSTS OF ILLNESS ASSOCIATED WITH UNDERNUTRITION BY AGE GROUP



Source: Model estimations based on DHS 2010, and demographic information

A large proportion of costs related to undernutrition are borne by families as these children are often not provided with proper health care. Based on the information collected by the NIT, The model estimated that only 28.2percent these episodes presented receive proper health care. As explained in the methodology section of this report, medical costs incurred in a treatment facility are used as shadow costs to estimate the burden borne by families. Figure 2.5 summarizes the institutional (public system) and costs to caretakers of treating pathologies associated with undernutrition. In Rwanda, it is estimated that families bear around 74.1 percent of the costs associated with undernutrition, while the cost to the health system was 25.9 percent.

FIGURE 2.5
DISTRIBUTION OF PRIVATE AND PUBLIC COSTS
(In Percentages and millions of RWF)



Source: Model estimations based on demographic information and WHO/DHS nutritional surveys.

Although the families of undernourished children incur most of the health costs related to undernutrition, the burden of this phenomenon is still an important expenditure component in the public sector. In 2012, the annual estimated cost to the public sector was equivalent to 26.1 percent of the total budget allocated to health. On the whole, the economic impact of undernutrition in health-related aspects was equivalent to 1.5 percent of the GDP of that year.

[33]http://www.thousanddays.org/

B. Social and economic cost of child undernutrition in education

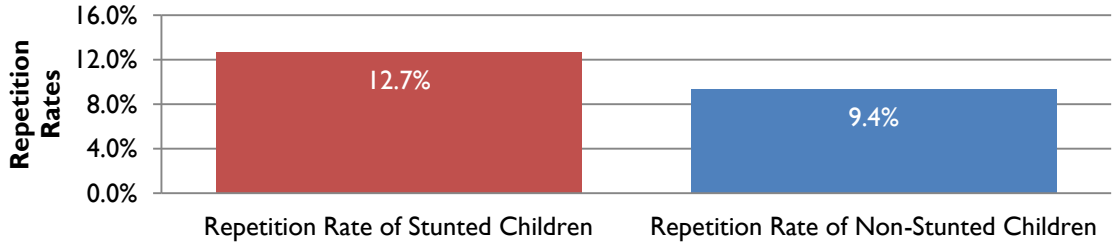
There is no single cause for repetition and dropout; however, there is substantive research that shows that students who were stunted before the age of 5 are more likely to underperform in school.[34] The number of repetition and dropout cases considered in this section result from applying a differential risk factor associated to stunted children to the official government information on grade repetition and dropouts in 2012. The cost estimations are based on information provided by the Ministry of Education on the average cost of a child to attend primary and secondary school in Rwanda in 2012, as well as estimations of costs incurred by families to support schooling.

i. Effects on repetition

Children who suffered from undernutrition before 5 years of age are more likely to repeat grades, compared to those were not afflicted by undernutrition.[35] In Rwanda in 2012, net enrolment rates were relatively high in primary education at 96.5 percent but rather low in secondary education was at only 21 percent and 25.4% in higher secondary[36].

Based on official information provided by the National Implementation Team from the Ministry of Education, 327,500 children repeated grades in 2012. Using data on increased risk of repetition among stunted students, the model estimated that the repetition rate for stunted children was 12.7 percent, while the repetition rate for non-stunted children was 9.4 percent. Given this incremental differential risk of 3.3 percentage points, the model estimates that 44,255 students or 13.5 percent of all repetitions in 2012 were associated with stunting.

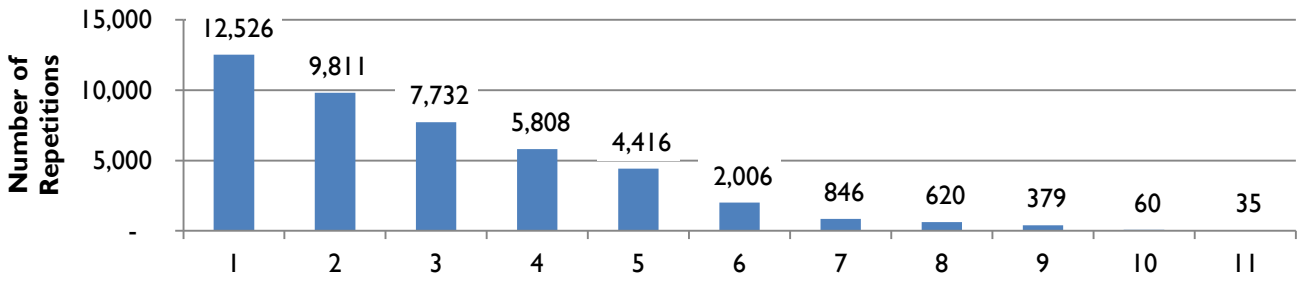
FIGURE 2.6
REPETITION RATES IN EDUCATION BY NUTRITIONAL STATUS, 2012
(In Percentages)



Source: Model eestimations based on data provided by Ministry of Education and relative risk factors.

As shown in Figure 2.7, most of these grade repetitions happen during the primary and preparatory school. There are far fewer children who repeat grades during secondary school; this largely due to the fact that many underperforming students would have dropped out of school before reaching secondary education.

FIGURE 2.7
GRADE REPETITION OF STUNTED CHILDREN, BY GRADE, 2012



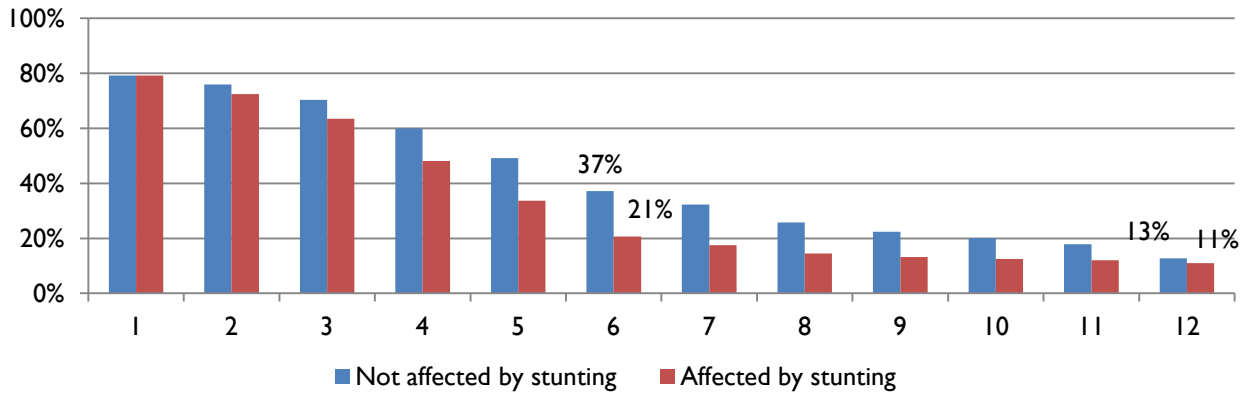
Source: Estimations based on data from Ministry of Education.

[34]Melissa C. Daniels and Linda S. Adair, "Growth in young Filipino children predicts schooling trajectories through high school," The journal of Nutrition, March 22, 2004, pp. 1439-1446, accessed September 11, 2012, Jn.nutrition.org
[35]Idem
[36]Ministry of Education. Rwanda. 2012 Education Statistics Yearbook. February 2013.

ii. Effects on retention

Research shows that students who were stunted as children are more likely to drop out of school.[37]According to available data and taking into account relative risks relating to the consequences of stunting on educational performance, the working age population who suffered of stunting would be expected to have lower educational attainment. It can be estimated that only 21 percent of stunted people (of working age) in Rwanda completed primary school compared to 37 percent of those who were never stunted. For school completion, the differential between the stunted and non-stunted children would be reduced, to 13% for the non-stunted and 11% for the stunted, as other factors not related to the nutritional situation of the population would be more relevant in acting as barriers for school completion.

FIGURE 2.8
GRADE ACHIVEMENT BY NUTRITIONAL STATUS, 2012
(In percentages)



Source: Model estimations based onRwanda Demographic and Health Survey 2010 and the relative risk factors.

The costs associated with school dropouts are reflected in the productivity losses experienced by individuals searching for opportunities in the labour market. As such, the impact is not reflected in the school age population, but in the working-age population. Hence, in order to assess the social and economic costs in 2012, the analysis focuses on the differential in schooling levels achieved by the working age population who suffered from stunting as children and the schooling levels of the population who was never stunted.

iii. Estimation of public and private education costs

Repetition in schooling has direct cost implications for families and the school system. Students who repeat grades generate an incremental cost to the education system, as they require twice as many resources to repeat the year. In addition, the caretakers also have to pay for an additional year of education.

In 2012, the 44,255 students who repeated grades (and whose repetitions are considered to be associated with undernutrition) incurred a cost of RWF 2.37 million. The largest proportion of repetitions occurred during primary school, where the cost burden falls mostly on the public education system. The following chart summarizes the public and private education costs associated with stunting.

[37]Data provided to COHA from the Ministry of Education (using the Education Management Information System for 2009)

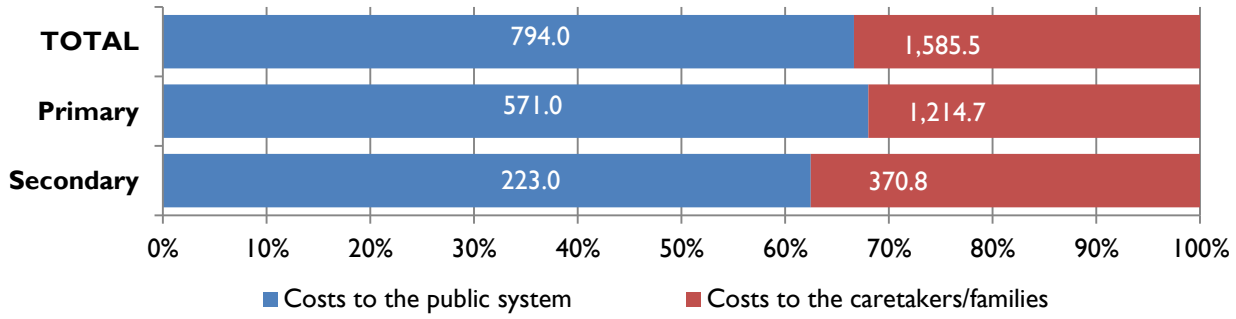
TABLE 2.8
COSTS OF GRADE REPETITIONS ASSOCIATED WITH STUNTING
(In RWF)

	Primary		Secondary		Total	
	In RWF	In USD	In RWF	In USD	In RWF	In USD
Number of repetitions associated with stunting	42,299		1,956		44,255	
Public Costs per student	28,718	46.75	189,589	308.63		
Total Public Costs (in Millions)	1,214.7	1.98	370.8	0.60	1,585.5	2.58
Private Costs per student	13,500	21.98	114,000	185.58		
Total Private Costs (in Millions)	571.0	0.93	223.0	0.36	794.0	1.29
Total Costs	**1,785.8**	**2.9**	**593.7**	**1.0**	**2,379.5**	**3.9**
% Social expenditure on education					1.40%	

Source: Model estimations based on costing data from the Ministry of Education
[/a] Values adjusted to 2012, based on a compound inflation rate

As in the case of health, the social cost of undernutrition in education is shared between the public sector and the families. Of the overall costs, a total of RWF 7.9 billion (33.4 percent) is being covered by the education system, while RWF 1.5 billion (66.6 percent) is borne by the families and caretakers. Nevertheless, the distribution of this cost varies depending on whether the child repeated grades in primary or secondary education. In primary education, the families cover 32 percent of the associated costs of repeating a year, where as in secondary the burden on the families is increased to 38 percent. In both cases, the government covers a larger proportion of the burden.

FIGURE 2.9
DISTRIBUTION OF COSTS IN EDUCATION
(In percentages and millionsof RWF)



Source: Estimations based of data provided by NIT

C. The social and economic cost of child undernutrition in productivity

As described in the health section of the report, the model estimated that 49.2 percent of the working-age population in Rwanda were stunted as children. Research shows that adults who suffered from stunting as children are less productive than non-stunted workers and are less able to contribute to the economy. This represents 3,010,751 people whose potential productivity is affected by undernutrition.

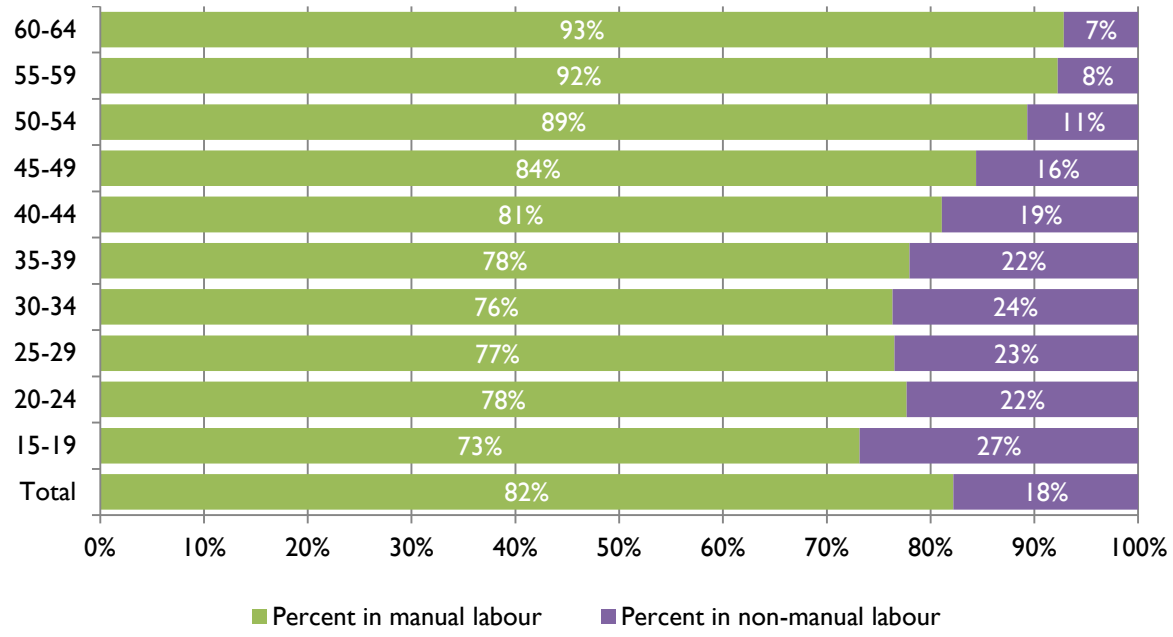
National productivity is significantly affected by historical rates of child undernutrition. Firstly, stunted people, on average, have achieved fewer years of schooling than non-stunted people.[38] In non-manual activities, higher academic achievement is directly correlated with higher income.[39] Research shows that stunted workers engaged in manual activities tend to have less lean body mass[40] and are more likely to be less productive in manual activities than those who were never affected by growth retardation.[41] Finally, the population lost due to child mortality hinders economic growth, as they could have been healthy productive members of the society.

The model utilizes historical nutritional information, in-country demographic projections and adjusted mortality rates, to estimate the proportion of the population who was affected by childhood nutrition and productivity can be compromised.

The cost estimates in labour productivity were estimated by identifying differential income associated with lower schooling in non-manual activities, as well as the lower productivity associated with stunted people in manual work, such as agriculture. The opportunity cost of productivity due to mortality is based on the expected income that a healthy person would have been earning, had he or she been part of the workforce in 2012.

The distribution of the labour market is an important contextual element in determining the impact of undernutrition on national productivity. As shown in Figure 2.10, 79 percent of the working age population is engaged in manual activities. The trend of manual labour seems to be lower for the younger group from 15 to 24, indicating that more non-manual jobs are becoming available for the youth in Rwanda.

FIGURE 2.10
MANUAL AND NON-MANUAL LABOUR DISTRIBUTION, BY AGE, 2012
(In Percentages)



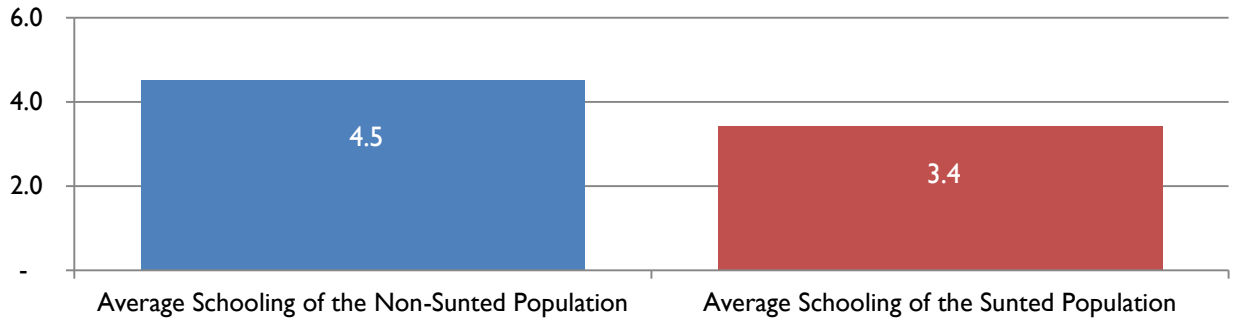
Source: Model Estimations based on the "Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11

[38]Melissa C. Daniels and Linda S. Adair, "Growth in young Filipino children predicts schooling trajectories through high school," The journal of Nutrition, March 22, 2004, pp. 1439-1446, accessed September 11, 2012, Jn.nutrition.org
[39]Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11
[40]C. Nascimento et al., Stunted Children gain Less Lean Body Mass and More Fat Mass than Their Non-stunted Counterparts: A Prospective Study., report (Sao Paulo: Federal University of Sao Paulo, 2004).
[41] Lawrence J. Haddad and Howarth E. Bouis, "The impact of nutritional status on agricultural productivity: wage evidence from the Philippines," Oxford Bulletin of Economics and Statistics 53, No. 1, February 1991, doi: 10.1111/j.1468-0084.1991.mp53001004.x.

i. Losses from non-manual activities due to reduced schooling

As described in the education section of this report, students who were undernourished as children complete, on average, fewer years of schooling than students who were adequately nourished as children.[42] This loss in educational years has particular impact for people who are engaged in non-manual activities, in which a higher academic education represents a higher income.

FIGURE 2.11
AVERAGE SCHOOLING YEARS
FOR STUNTED AND NON-STUNTED POPULATION
(In Years of education)



Source: Model calculations based on data from DHS 2010

The lower educational achievement of the stunted population has an impact on the expected level of income a person would earn as an adult. As presented in Table 2.9, the model estimates that 722,887 people engaged in non-manual activities suffered from childhood stunting. This represents 11.8 percent of the country's labour force that is currently less productive due to lower schooling levels associated to stunting. The estimated annual losses in productivity for this group are RWF 40.4 billion (US$ 65 million) equivalent to 0.93 percent of the GDP in 2012.

TABLE 2.9
REDUCED INCOME IN NON-MANUAL ACTIVITIES
DUE TO STUNTING, 2012

Age in 2012	Population working in non-manual sectors who were stunted as children	Income losses in non-manual labour	
		millions of RWF	millions of USD
15-19	179,787	4,307.4	7.0
20-24	162,836	14,403.7	23.4
25-29	144,673	9,336.9	15.2
30-34	93,701	5,645.5	9.2
35-39	55,454	2,852.1	4.6
40-44	35,718	1,738.9	2.8
45-49	23,689	1,077.8	1.8
50-54	13,451	500.5	0.8
55-59	7,791	287.2	0.5
60-64	5,785	222.6	0.4
Total	722,887	40,373	65.7
% GDP		0.93%	

Source: Model Estimations based on "Third Integrated Household Living Conditions Survey (EICV3)" and DHS.

ii. Losses in manual intensive activities

[42]Melissa C. Daniels and Linda S. Adair, "Growth in young Filipino children predicts schooling trajectories through high school," The Journal of Nutrition, March 22, 2004, pp. 1439–1446, accessed September 11, 2012, Jn.nutrition.org

Manual activities are mainly observed in the agricultural, forestry and fishing subsectors, employing more than 82 percent of the Rwandan population. Research shows that stunted workers engaged in manual activities tend to have less lean body mass[43] and are more likely to be less productive in manual activities than those who were never affected by growth retardation.[44]The model estimated that 4.82 million Rwandans are engaged in manual activities, of which 2.58 million were stunted as children. This represented an annual loss in potential income that surpasses RWF 86,513 billion (US$ 140.83million), equivalent to 1.98 percent of the GDP in potential income lost due to lower productivity.

TABLE 2.10
LOSSES IN POTENTIAL PRODUCTIVITY IN MANUAL ACTIVITIES DUE TO STUNTING, 2012

Age in 2012	Population working in manual labour who were stunted as children	Income losses in manual labour	
		millions of RWF	millions of USD
15-19	490,325	17,404	28.33
20-24	567,274	21,681	35.29
25-29	471,728	15,855	25.81
30-34	302,380	9,914	16.14
35-39	196,183	8,581	13.97
40-44	153,004	4,099	6.67
45-49	128,096	3,378	5.50
50-54	112,484	2,049	3.34
55-59	92,728	1,970	3.21
60-64	75,062	1,582	2.57
Total	**2,589,265**	**86,513**	**140.83**
% GDP		1.98%	

Source: Model Estimations based on "Third Integrated Household Living Conditions Survey (EICV3)"

iii. Opportunity cost due to mortality

As indicated in the health section of this report, there is an increased risk of child mortality associated with undernutrition.[45]The model estimated that 573,327 people of working age were absent from Rwanda's workforce in 2012 due to child mortality associated with undernutrition. This represents a 9.37 percent reduction in the current workforce.

[43] C. Nascimento et al., Stunted Children gain Less Lean Body Mass and More Fat Mass than Their Non-stunted Counterparts: A Prospective Study, report (Sao Paulo: Federal University of Sao Paulo, 2004).
[44] Lawrence J. Haddad and Howarth E. Bouis, "The impact of nutritional status on agricultural productivity: wage evidence from the Philippines," Oxford Bulletin of Economics and Statistics 53, No. 1, February 1991, doi: 10.1111/j.1468-0084.1991.mp53001004.x.
[45]Robert E. Black et al., "Maternal and child undernutrition: global and regional exposures and health consequences," The Lancet 371, No. 9608, 2008,
doi:10.1016/S0140-6736(07)61690-0

TABLE 2.11
LOSSES IN POTENTIAL PRODUCTIVITY DUE TO MORTALITY ASSOCIATES WITH UNDERNUTRITION, 2012

Age in 2012	Working Hours Lost due to Higher mortality of underweight children (in Millions of hours)	Income losses due to mortality	
		Millions of RWF	Millions of USD
15-19	120.3	49,326.3	80.3
20-24	148.4	65,847.0	107.2
25-29	131.1	47,404.7	77.2
30-34	112.6	35,050.3	57.1
35-39	98.9	36,880.4	60.0
40-44	84.3	19,722.3	32.1
45-49	68.8	18,171.7	29.6
50-54	62.9	12,132.3	19.7
55-59	48.8	12,482.7	20.3
60-64	46.2	12,202.3	19.9
Total	922.5	309,219.9	503.4
% GDP		7.1%	

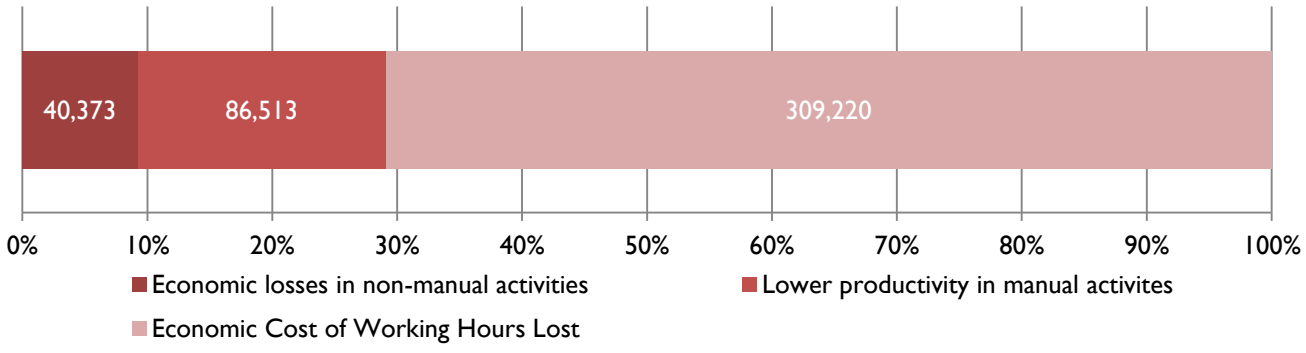
Source: Model Estimations based on "Third Integrated Household Living Conditions Survey (EICV3)"

Considering the productive levels of the population, by their age and sector of labour, the model estimated that in 2012, the economic losses (measured by working hours lost due to undernutrition-related child mortality) were RWF 309,219.4 billion, which represented 7.1 percent of the country's GDP.

iv. Overall productivity losses

The total losses in productivity for 2012 are estimated at approximately RWF 436.10 billion (US$ 7,099,232,066), which is equivalent to 10 percent of Rwanda's GDP. As presented in Figure 2.12, the largest share of productivity loss is due to reduced productivity due to undernutrtion-related mortality which represents 70.9 percent of the total cost. The lost productivity in non-manual activities represents 9.3 percent of the costs. The income differential in manual labour, due to the lower physical and cognitive capacity of people who suffered from growth retardation as children represents 19.8 percent of the total costs.

FIGURE 2.12
DISTRIBUTION OF LOSSES IN PRODUCTIVITY
(In millions of RWF)



Source: Compiled in-house, based on model estimations,

D. Summary of effects and costs

The methodology is used to analyse the impact of child undernutrition in different stages of the life cycle, without generating overlaps. As a result, the individual sectoral costs can be aggregated to establish a total social and economic cost of child undernutrition. For Rwanda, the total losses associated with undernutrition are estimated at RWF 504 billion or US$ 820 million for the year 2012. These losses are equivalent to 11.5 percent of GDP of that year. The highest element in this cost is the loss in potential productivity as a result of undernutrition-related mortalities.

TABLE 2.12
SUMMARY OF COSTS, 2012

	Episodes	Cost in Millions of RWF	Cost in Millions of Dollars	Percentage of GDP
Heath Costs				
LBW and Underweight	233,322	61,058	99.4	
Increased Morbidity	47,064	4,049	6.6	
Total for Health	280,385	65,107	106	1.5%
Education Cost				
Increased Repetition - Primary	42,299	1,786	2.9	
Increased Repetition - Secondary	1,956	594	1.0	
Total for Education	44,255	2,380	3.9	0.05%
Productivity Costs				
Lower Productivity - Non-Manual Activities	722,887	40,373	65.7	
Lower Productivity - Manual Activities	2,589,265	86,513	140.8	
Lower Productivity - Mortality	309,220	309,220	503.4	
Total for Productivity	3,621,372	436,106	710	10.0%
TOTAL COSTS		**503,593**	**820**	**11.5%**

Source: Model estimations

Section IV: Analysis of Scenarios

IV Analysis of Scenarios

The previous chapter showed the social and economic costs that affected Rwanda in 2012 due to high historical trends of child undernutrition. Most of these costs are already cemented in the society and policies must be put in place to improve the lives of those already affected by childhood undernutrition. Nevertheless, there is still room to prevent these costs in the future. Currently, one out of every three children under the age of five in Rwanda is stunted.

This section analyses the impact that a reduction in child undernutrition could have on the socio-economic context of the country. The results presented in this section project the additional costs to the health and education sectors as well as losses in productivity that Rwanda n children would bear in the future. They also indicate potential savings to be achieved. This is a call for action to take preventive measures and reduce the number of undernourished children to avoid large future costs to the society.

The model generates a baseline that allows development of various scenarios based on nutritional goals established in each country using the prospective dimension. The generated outcomes can be used to advocate for increased investments in proven nutritional interventions. These scenarios are constructed based on the estimated net present value of the costs of children born in each year between 2012 and 2025. The methodology follows each group of children and, based on each scenario, estimates a progressive path towards achieving the set nutritional goals.

The scenarios developed for this report are as follows:

1. **Baseline: The Cost of Inaction. Progress in reduction of stunting and underweight child stops.**

   For the baseline, the progress of reduction of the prevalence of undernutrition stops at the levels achieved in 2012. It also assumes that the population growth would maintain the pace reported in the year of the analysis, hence increasing the number of undernourished children and the estimated cost. As this scenario is highly unlikely, its main purpose is to establish a baseline, to which any improvements in the nutritional situation are compared in order to determine the potential savings in economic costs.

2. **Scenario #1: Cutting by half the prevalence of child undernutrition by 2025.**

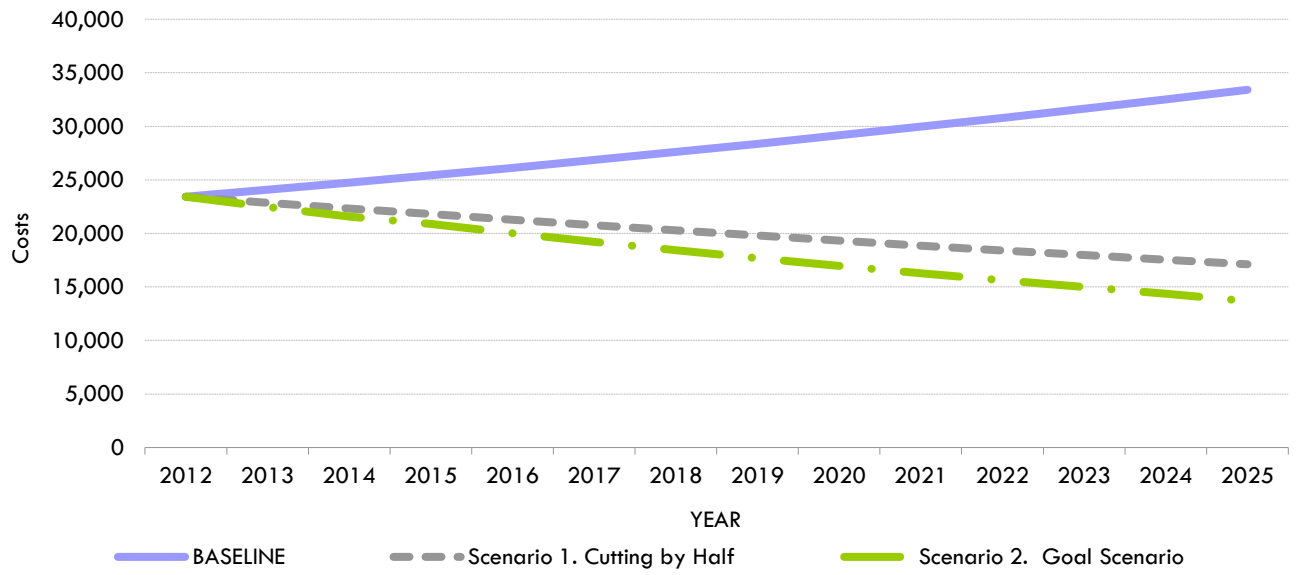
   In this scenario, the prevalence of underweight and stunted children would be reduced to half of the 2012 values corresponding to the reference year. In the case of Rwanda this would mean a constant reduction of 1.7% points annually in the stunting rate from 44.2% (estimate for 2012) to 22.1% in 2025. A strong effort has to be carried-out to complete this scenario that would require a revision of the effectiveness of on-going interventions for the reduction of stunting as the average rate of reduction for stunting between 2005 and 2010 was estimated at 0.52%. This is however an improvement from the previous measurement, where from the year 2000 to 2005, the average annual rate of progress in the reduction of stunting was only 0.3%.

3. **Scenario #2: The 'Goal' Scenario. Reduce stunting to 10% and underweight children to 5% by 2025.**

   In this scenario, the prevalence of stunted children would be reduced to 10% and the prevalence of underweight children under the age of five, to 5%. Currently, the global stunting rate is estimated at 26%, with Africa having the highest prevalence at 36%. This Goal Scenario would require a true call for action and would represent an important regional challenge, in which countries of the region could collaborate jointly in its achievement. The progress rate required to achieve this scenario would be 2.63% annual reduction for a period of 13 years, from 2012 to 2025.

As shown in Figure IV.1, the progressive reduction of child undernutrition generates a similar reduction in the costs associated to it. The distances between the trend lines would indicate the savings that would be achieved in each scenario.

FIGURE IV.1
TRENDS OF ESTIMATED COSTS OF CHILD UNDERNUTRITION, 2009-2025
(In millions of RWF)



In the baseline, where the progress of reduction of child undernutrition would stop at the levels of 2012, the total cost would increase by 44%, from 37 to 53billion RWF, during the period leading to 2025. Nevertheless, in the Scenario 1, in which a reduction by half of the current prevalence is achieved, the total cost would reduce by 26% to 27 billion RWF. In the case of the Goal Scenario on the other hand, there would be a 38% reduction in the estimated total costs, amounting to 23 billion RWF.

TABLE IV.1
ESTIMATED TOTAL COSTS OF CHILD UNDERNUTRITION, BY SCENARIO, 2009
(In millions of RWF)[/a]

	2012	Scenarios for the Year 2025		
		Baseline. The Cost of Inaction	S1. Cutting by Half	S2. Goal Scenario
Heath Costs				
Increased Morbidity	19,494	28,258	14,681	13,016
Education Cost				
Increased Grade Repetition	88	126	60	26
Productivity Costs				
Lower Productivity in Non-Manual Activities	3,185	4,543	1,672	680
Lower Productivity in Manual Activities	2,199	3,137	1,492	647
Lower Productivity due to Mortality	12,041	17,176	9,503	8,432
Total Costs	**37,007**	**53,239.7**	**27,408.4**	**22,801.9**
Percentage Change from Baseline		44%	-26%	-38%

Source: Model estimations

The potential economic benefits of reducing undernutrition are a key element in making a case for nutrition investments. The reduction in clinical cases in the health system, lowered grade repetition and improved educational performance as well as physical capacity are elements that contribute directly to the national productivity.

As presented in Table IV.2, cutting undernutrition by half by 2025 would represent a reduction in costs of over 91.5 trillion RWF, equivalent to $US149 million for the period of 13 years, from 2012 to 2025. Although the tendency of savings would not be linear, as they would increase over time with the achieved progress, a simple average of the annual savings would represent $US11.5 million per year. In the case of the Goal Scenario, the savings would increase to 112.5 billion RWF, or $US183.1 billion, which represent a simple average of $US14.1 million per year.

TABLE IV.2
ESTIMATED SAVINGS FOR EACH SCENARIO, 2009
(In millions of RWF)

	Cutting Undernutrition by Half by 2025	Goal Scenario
Heath Costs		
Reduced Morbidity	47,792	54,644
Education Cost		
Reduced Grade Repetition	238	404
Productivity Costs		
Higher Productivity in Non-Manual Activities	10,706	16,184
Higher Productivity in Manual Activities	5,905	10,038
Increased Working Hours	26,910	31,242
Total Savings in RWF	**91,535.6**	**112,492.9**
Total Savings in millions of $US	149.0	183.1
Average Annual Savings[1] in RWF	**7,041.2**	**8,653.3**
Average Annual Savings[1] in US$	11.5	14.1

Source: Model estimations

[1] Simple Average of total savings divided by the years considered in the period from 2012 to 2025

Section V: Conclusions and Recommendations

V Conclusions and Recommendations

A. Conclusions

The Government of Rwanda has put forth Vision 2020, where roadmap proposed to "to transform Rwanda into a middle-income nation in which Rwandans are healthier, educated and generally more prosperous". This vision, which was constructed though an extensive participative process, 6 pillars where identified and key indicators and targets where defined that would serve as evidence of growth both in economic and social terms. The Cost of Hunger in Rwanda presents an opportunity to better understand the role that child nutrition can play as a catalyst for the achievement of Vision 2020.

From a health sector perspective the study estimates that child undernutrition generates health costs equivalent to 9.6% of the total public budget allocated to health. These costs are due to episodes directly associated with the incremental quantity and intensity of illnesses that affect underweight children and the protocols necessary for their treatment. It is also important to note that only 1 out of every 3 children is estimated to be receiving proper health attention. As the health coverage expands to rural areas, there will be an increase of people seeking medical attention; this can potentially affect the efficiency of the system to provide proper care services. This study illustrates that a reduction of child undernutrition could facilitate the effectiveness of this expansion by reducing the incremental burden generated by the health requirements of underweight children.

Further, the study estimates that 21.9 of all cases of child mortality are associated with the higher risk of undernutrition. Hence, a preventive approach to undernutrition can help reduce this incremental burden to the public sector, and also reduce the costs that are currently being covered by caretakers and families. A reduction of child undernutrition will have a direct impact on increasing the life expectancy level, and contribute to reaching and hopefully exceeding, the 55 year target set from 2020.

Increasing the educational level of the population, and maximizing the productive capacity of the population dividend, is a key element to increase competitiveness and innovation. This represents a particular opportunity in Rwanda where the population under 15 years is estimated to be 43% of the total population. These children and youth must be equipped with the skills necessary for competitive labour. Thus, the underlying causes for low school performance and early desertion must be addressed. As there is no single cause for this phenomenon, a comprehensive strategy that considers improving in the quality of education and the conditions required for school attendance must be put in place. This study demonstrates that stunting is one barrier to attendance and retention, and to effectively elevate the educational levels and improve individuals' labour opportunities in the future, this barrier must be removed.

The study estimated that children who were stunted experienced a 3.3% higher repetition rate in school. As a result, 16% of all grade repetitions in school were associated to the higher incidence of repetition that is experienced by stunted children. 96% of these grade repartitions occur in primary school, suggesting that a reduction in the stunting prevalence could also support an improvement in schooling results, as it would reduce preventable burdens to the education system. A reduction in the prevalence of stunted children can have an impact in improving performance, grade retention, hence enrolment and transitions rates, all of which are key indicators outlined in Vision 2020.

As outlined in Vision 2020, Rwanda must also consider the impact that an increasing rate of urbanization will have on employment and productivity. An important component to prepare for this shift is to ensure that the workforce is ready to make a transition towards a more skilled labour, and economies are able to produce new jobs to reduce youth unemployment. By preventing child stunting thus avoiding the associated loss in physical and cognitive capacity that hinders individual productivity, people can be provided with a more equal opportunity for success.

The study estimates that 49% of the current working age population in Rwanda suffered from stunting as a child. This population has achieved on average, lower schooling levels than those who did not experience growth retardation of 1.0 years of lower schooling. As the country continues to urbanize, and an increasing number of people participate in skilled employment, this loss

in human capital will be reflected in a reduced productive capacity of the population. Thus, it may be a particularly crucial time to address child undernutrition and prepare future youth for better employment by prioritizing the reduction of stunting in Africa's transformation agenda. Further, a reduction of stunting will also impact positively the productive levels of rural economies, as healthy workers in agricultural settings are expected to be more productive and earn better wages.

The COHA model also provides and important prospective analysis that sheds light on the potential economic benefits to be generated by a reduction in the prevalence of child undernutrition. The model estimates that in Rwanda, a reduction of the prevalence to half of the current levels of child undernutrition by the year 2025 can generate average annual savings of 7,041 RWF million (US$ 11.5million). An additional scenario shows that a reduction to 10% stunting and 5% underweight for that same period could yield annual average savings of 8,653.3 RWF billion (US$ 14.16million). This economic benefit that would result from a decrease in morbidities, lower repetition rates and an increase in manual and non-manual productivity, presents an important economic argument for the incremental investments in child nutrition.

An overarching conclusion of this study is that chronic child undernutrition can no longer be considered a sectoral issue, as both its causes and solutions are linked to social policies across numerous sectors. As such, stunting reduction will require interventions from the health, education, social protection and social infrastructure perspectives and its improvement would evidence a step forward in the right direction for the inclusive development in a country, towards achieving growth with equity.

B. The way Forward – Recommendations for Ending Child Stunting

This Cost of Hunger in Rwanda highlights both challenges and opportunities to the country regarding the reduction of child undernutrition. It sheds new light on the implications of child nutrition for development, and as such, it also an opportunity to renew commitments towards the eventual elimination of child malnutrition. However, this goal will require a new perspective on its implications, causes and consequences, accompanied by sense of urgency, in order to address the problem in a decisive and sustainable manner. Its achievement will require long-term commitment, increased national capacity and the implementation of a series of actions that can contribute to increasing the pace of reduction of stunting in Rwanda.

The results of this study encourage Rwanda not to be content with "acceptable" levels of stunting; equal opportunity should be the aspiration of every country on the continent. In this sense, it is **recommended that aggressive targets are set in Rwanda for the reduction of stunting that go beyond proportional reduction, to establish an absolute value as the goal at 10%**. More specifically, **investment should be increased in combating undernutrition during the first 1000 days of a child's life**, including through improved availability and access to nutrient-dense complementary foods for children aged 6 to 23 months old. As recommended actions, the multisectoral National Implementation Team, development partners and civil society met around the results presented in this study and recommended the following:

1. **Including stunting as a Goal indicator in strategic planning**. Vision 2020 and the Second Economic Development and Poverty Reduction Strategy (EDPRS2), outline Rwanda's plan to reach medium-term development over next five years (2013-2018), and are regarded as the main pillars to achieve sustainable development in the future. However, if the country is to achieve meaningful socioeconomic transformation, EDPRS2 should include stunting as a high level indicator within its goals. As one of the guiding principles of EDPRS2 is district-led development, the strategy should facilitate the dissemination of good methods and practices to reduce the levels of stunting from one district to the others.
2. **In order to address the multiple dimensions of child nutrition, a comprehensive response is needed with a focus on multiple determinants of child undernutrition.** A comprehensive multisectoral policy must be put in place, with strong political commitment and allocation of adequate resources for its implementation. This plan should look to identify and take action on which drivers determine the current state of child undernutrition in order to adequately shape and ensure effective programmes that address child undernutrition. These may include a lack of production, awareness, quality, availability, sanitation, fortification, social protection, water, family dynamics etc. Furthermore, it is recommended that the assessment of child nutrition also includes information that relates the nutritional status of the children to the livelihoods and economic activities of the households. This information can be used to ensure that interventions effectively reach these vulnerable families with appropriate incentives and innovative approaches within social protection schemes.
3. **Promotion of awareness of the entire population.** The government supports awareness activities through various sectors and mechanisms. Nutrition awareness remains limited across the whole population including the educated. The demonstrated impact of nutritional deficiencies in most parts of the country requires enhancing the awareness on the importance of nutrition especially in the first 1000 days of a child's life and the school-going age group that has be found to facilitate nutritional catch-up starting from the early childhood care and development centres. Therefore, in particular heads of households and mothers need to be targeted in order to bring the levels of stunting down.
4. **Promotion of the consumption of fortified complementary food especially in populations most affected**

by micronutrient deficiencies and stunting. This could include teaching mothers about the right nutrition for their children as well as exploring home fortification using Micronutrient powders as a strategy for improving the quality of complementary food for children above 6 months of age.

5. **Instalment of 'Commission against child undernutrition'**. Following the example of different actions taken in the past to address chronic hunger, the creation of a 'Commission against child undernutrition', under the auspices of the Prime Minister's Office, could shed a light on the negative impacts that child undernutrition has on social and economic development in Rwanda. Attracting experts from different fields such as nutrition, health, etc. such a commission would be in the position to speak strongly with one voice while urging to put in place different programmes that address child undernutrition.
6. **Improvement of monitoring and evaluation systems.** An important element that must be addressed to enhance the national capacity to address malnutrition is to improve the monitoring and evaluation systems. Currently, the assessments of the prevalence of child nutrition are carried-out with a periodicity of between 3 to 5 years. Nevertheless, in order to be able to measure short term results in the prevention of stunting, a more systematic approach with shorter periodicity is recommended, of 2 years between each assessment. As the focus on the prevention of child undernutrition should target children before 2 years of age, these results will provide information to policy makers and practitioners on the results being achieved in the implementation of social protection and nutrition programmes.

Section VI: Annexes

VI Annexes

Annex 1. Glossary of Terms

1. **Average number of days require for hospitalization:** The average number of days a child needs to stay in a hospital when hospitalized, to receive adequate care.
2. **Average number of days required for ICU:** The average number of days a child needs to stay in the ICU when put in ICU care, to receive adequate care.
3. **Average number of primary care visits per episode:** When a child experiences a given pathology, he/she may require medical care multiple times. This variable is the average number of primary (outpatient) medical care visits a child requires per episode.
4. **Average waiting time spent at primary care:** When a caretaker brings a child to a primary care facility, the time the parent and child spend at the facility for waiting and receiving care.
5. **Cost of medical inputs per event during hospitalization:** This variable includes the medical materials (medicines, procedures) that are covered by the hospital for treatment of each pathology case.
6. **Cost of medical inputs per event in ICU:** This variable includes the medical materials (medicines, procedures) that are covered by the hospital for treatment of each pathology case in ICU.
7. **Cost of medical inputs per event in primary care:** This variable includes the medical materials (medicines, procedures) that are covered by the health facility for treatment of each pathology case.
8. **Costs not covered by the health system:** This variable includes the value of the inputs (i.e. medications) that are paid for by the family.
9. **Daily cost of hospital bed during hospitalization:** This variable includes the total cost to the hospital calculated per day per patient staying in the hospital. This value includes the cost of staff, facilities and equipment, as a unit cost per patient.
10. **Daily cost of hospital bed in ICU:** This variable includes the total cost to the hospital calculated per day per patient staying in the ICU. This value includes the cost of staff, facilities and equipment, as a unit cost per patient.
11. **Daily hours lost due to hospitalization:** The number of hours the caretaker spends at the hospital each day with the child when he/she brings a child to a primary care facility.
12. **Differential Probability (DP):** Refers to the difference between the probability of occurrence of a consequence (i.e., disease, grade repetition and lower productivity) given a specific condition. The model uses this variable specifically to determine the risk among those suffering from undernutrition and those who are not (ECLAC).
13. **Discount rate:** The interest rate used to assess a present value of a future value by discounting (FAO). In the model it is utilized to obtain the present value in the scenario section.
14. **Dropout rate per grade:** Percentage of students who drop out of a grade in a given school year (UNESCO).

15. **Episodes:** It is the number of disease events occurring for a given pathology. In the model it is based on a 1 year period, i.e. the number of times a specific pathology occurs in 1 year (ECLAC).
16. **Food insecurity:** Exists when people lack access to sufficient amount of safe and nutritious food and therefore, are not consuming enough for an active and healthy life. This may be due to the unavailability of food, inadequate purchasing power or inappropriate utilization at household level (FAO).
17. **Food vulnerability:** Reflects the probability of an acute decline in food access or consumption, often in reference to some critical value that defines minimum levels of human wellbeing (WFP).
18. **Hunger:** The status of persons, whose food intake regularly provides less than their minimum energy requirements, i.e. about 1800 kcal per day. It is operationally expressed by the undernourishment indicator (FAO).
19. **Incidental retrospective dimension:** Used to estimate the cost of undernutrition in a country's population in a given year. The model applies it by looking at the health costs of pre-school children (0 to 5-year-olds) suffering from undernutrition, the education costs of school-age children (6 to 18-year-olds) and the economic costs resulting from lost productivity by working-age individuals (15 to 64-year-olds) (ECLAC).
20. **Intrauterine growth restriction (IUGR):** Refers to the foetal weight that is below the 10th percentile for gestational age (WHO). In the model, this is the only type of condition considered in the estimation of cost for low birth weight children.
21. **Low Birth Weight (LBW):** A newborn is considered to have low birth weight when he/she weighs less than 2,500 grams (WHO).
22. **Malnutrition:** A broad term for a range of conditions that hinder good health caused by inadequate or unbalanced food intake or by poor absorption of the food consumed. It refers to both undernutrition (food deprivation) and over nutrition (excessive food intake in relation to energy requirements) (FAO).
23. **Mortality rate:** The proportion of deaths per year in a given population, usually multiplied by a 10th population size so it is expressed as the number per 1,000, 10,000, 100,000, individuals per year.
24. **Percentage of cases that attend health services:** The proportion of episodes for which a caretaker brings a child to a primary health facility for treatment.
25. **Productivity/Labour productivity:** Measures the amount of goods and services produced by each member of the labour force or the output per unit of labour (ILO). In the model, it refers to the average contribution that an individual can make to the economy, measured by consumption or income, depending on data availability.
26. **Proportion of episodes requiring hospitalization:** When a child experiences pathology, he/she may require in-patient care. This variable identifies the proportion of the episodes by pathology, for which a child requires hospitalization.
27. **Proportion of episodes requiring ICU:** When a child experiences pathology, he/she may require care in an ICU facility. This variable identifies the proportion of the episodes by pathology, for which a child requires ICU care.
28. **Prospective or potential savings dimension:** This dimension makes it possible to project the present and future losses incurred as a result of medical treatment, repetition of grades in school and lower productivity caused by undernutrition among children under the age of five in each country, in a specific year (ECLAC).
29. **Public social spending:** Social expenditure is the provision by public (and private) institutions of benefits to, and financial contributions targeted at, households and individuals in order to provide support during circumstances, which adversely affect their welfare, provided that the provision of the benefits and financial contributions constitutes neither a direct payment for a particular good or service nor an individual contract or transfer (OECD).
30. **Relative risk:** Refers to the risk of an event occurring, given a specific condition. It is expressed as a ratio of the probability of the event occurring in the exposed group versus a non-exposed group. In the model it is used to establish the risk level of disease, lower educational performance or lower productivity relative to exposure to undernutrition.
31. **Repetition rate per grade:** Number of repeaters in a given grade in a given school year, expressed as a percentage of enrolment in that grade in the previous school year (UNESCO).
32. **Stunting:** Reflects shortness-for-age; an indicator of chronic malnutrition, calculated by comparing the height-for-age of a child with a reference population of well-nourished and healthy children (WFP). The model uses it as the indicator to analyse the impact on educational performance and productivity.

33. **Survival rate:** A rate calculated for a given geographic area that presents the likelihood of a person surviving in a given period of time.
34. **Undernourishment:** Food intake that is continuously insufficient to meet dietary energy requirements. This term is used interchangeably with chronic hunger, or, in this report, hunger (FAO).
35. **Undernutrition:** The result of prolonged low levels of food intake and/or low absorption of food consumed (undernourishment). It is generally applied to energy (or protein and energy) deficiency, but it may also relate to vitamin and mineral deficiencies (FAO).
36. **Underweight:** Measured by comparing the weight-for-age of a child with a reference population of well-nourished and healthy children (WFP). The model utilizes it to analyse the impact of child undernutrition on health.
37. **Unit cost per attention in primary care:** This variable includes the total cost to the health facility per attention, comprising the cost of staff, facilities and equipment, as a unit cost per patient.
38. **Wasting:** Reflects a recent and severe process that led to substantial weight loss, usually associated with starvation and/or disease. Wasting is calculated by comparing weight-for-height of a child with a reference population of well-nourished and healthy children (WFP).

Annex II. Methods and Assumptions

Indicator	Data and Sources
Economic data	
Gross Domestic Product	Source: IMF Database. Ministry of Finance Latest actual data: 2010 National accounts manual used: SNA 1993 GDP valuation: Market prices Start/end months of reporting year: January/December Base year: 2006 Chain-weighted: No Primary domestic currency: Rwanda francs Data last updated: 09/2012
$US exchange rate	World Bank database. Based on official government statistics, national accounts data have been revised for 1999 onward; the new base year is 2006. Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local)
Inflation, average consumer prices	International monetary fund data for 2009-2012. Based on official government statistics, national accounts data have been revised for 1999 onward; the new base year is 2006.
Social Expenditure	Budget execution report 2011-2012, Ministry of Economic Planning and Finance
Health Expenditure	Budget execution report 2011-2012, Ministry of Economic Planning and Finance.
Education Expenditure	Budget execution report 2011-2012, Ministry of Economic Planning and Finance
Average transport cost (two public transportation tickets in urban areas in local currency)	Key statistics information: transport of persons, 2011, Rwanda Utilities Regulatory Authority (RURA). Estimated at RWF 160
Minimum wage per hour	242.50 RWF Rwanda Source Manpower Survey, Ministry of Public Service and Labour
Average wage per hour	377.33 RWF Rwanda Source Manpower Survey, Ministry of Public Service and Labour
Average income per years of schooling	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11
Distribution of workers by Manual and Non-Manual Labour per age group	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11 **Manual Activities** include: 11.00 '11 Agriculture': 12.00 '12 Livestock'; 13.00 '13 Forestry'; 14.00 '14 Fishing & Hunting'; 21.00 '21 Mining'; 22.00 '22 Quarrying'; 31.00 '31 Food Manufacture'; 32.00 '32 Textile Manufacture" 33.00 '33 Wood Products Man.'; 34.00 '34 Paper Products Man.'; 35.00 '35 Chemical Industries'; 36.00 '36 Non-metallic Products. Man.'; 37.00 '37 Metal Manufacture'; 38.00 '38 Metal Products Man.'; 41.00 '41 Gas, Water & Electricity'; 51.00 '51 Construction Buildings"; 52.00 '52 Construction Roads'; 53.00 '53 Rural Reconstruction'. **Non-Manual activities** include 61.00 '61 Wholesale Trade' 62.00 '62 Retail Trade'; 63.00 '63 Other Trade'; 64.00 '64 Hotel & restaurants'; 65.00 '65 Import & Export'; 71.00 '71 Transport'; 72.00 '72 Warehousing'; 73.00 '73 Communications'; 81.00 '81 Banking'; 82.00 '82 Insurance'; 83.00 '83 Real Estate'; 84.00 '84 Business Services'; 91.00 '91 Government, Admin & Social Services'; 92.00 '92 Recreation & Tourism'
Annual average income related to productive work, manual intensive activities by age	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11. Household Expenditure is adjusted by Adult Equivalent Factor, and distributed on the household members by characteristics.
Annual average income related to productive work, NON manual intensive activities by highest educational level attained and age	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11. Household Expenditure is adjusted by Adult Equivalent Factor, and distributed on the household members by characteristics.
Average working hours per week	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11
Annual worked hours per age group	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11
Employment rate	Based on income data from the "Third Integrated Household Living Conditions Survey (EICV3)" National Institute of Statistics for Rwanda 2010/11

Indicator	Data and Sources
Demographic Data	
0 Years of Age - Total Population Projected from 1948-2012	United Nations Statistics Division – Demographic and Social statistics – Accessed November 2013. Processed with the Support of the African Centre for Statistics at ECA. Tesfaye G. (2013)
0 - 4 years total population Projected from 1948-2012	
Population in 2012 by age	
Mortality rate for children under 5 and Survival rate, projected from 1950 to 2050	Calculated from Abridged Life Tables provided by the UN Statistics Division – Demographic and Social statistics. Aseffa S. (2013). For detailed calculation process please review Rodrigo Martínez and Andrés Fernández, *Operational manual for the use of the model for analysing the Social and Economic impact of child undernutrition in Latin America*, Naciones Unidas, CEPAL, Social Development Division, Santiago De Chile, 2008, Pages 18-26.
Working age population (WAP) by educational level	Calculated from National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA: NISR, MOH, and ICF International. Variables: v106_Highest educational level; v107_Highest year of education. K. Asseffa (2013)
Health Data	
Underweight prevalence of children under 5 years old	Calculated from National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA: NISR, MOH, and ICF International
Stunting prevalence of children under 5 years old	
Stunting and Underweight mode prevalence	Calculated based on the highest prevalence register in the age groups surveyed in from National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA: NISR, MOH, and ICF International
Number of annual disease events (anaemia, ADS, ARI, Stunting, Underweight, Wasting) by Age group	2011 Annual National Quantification Report, the incidence rate of diarrhoea is 3 episodes per child per year. Additional Incidence Rates for the iCCM Interventions: Anaemia 1.00, ARS 0.28, Malaria 0.56. Focal Point. MIVUMBI N. Victor, MD,Mmed(OG) MDA/ Newborn health, MCH/MoH
Average number of primary care visits for each pathology (anaemia, ADS, ARI, Stunting, Underweight, Wasting) by Age group	Estimated by health specialists and experts through in-depth interview, on the following values Anaemia 1.0, ADS 2.3, ARI, 3.5, Underweight 4.0, Malaria 2.0. Visiting health centres. Primary Care: Kicukiro Health Centre;
Proportion of events of pathology (anaemia, ADS, ARI, Stunting, Underweight, Wasting) by Age group requiring hospitalization	Estimated by health specialists and experts through in-depth interview, on the following values Anaemia 1.3% (utilized the proportion of severe anaemia cases as proxy), ADS 30%, ARI 50%, Underweight 20% (utilized proportion of severe underweight as proxy), Malaria 50%. Field visits at Kibagabaga Hospital and CHUK (University Central Hospital of Kigali) Hospital
Average number of days of hospital treatment for each event (anaemia, ADS, ARI, Stunting, Underweight, Wasting) by Age group	Estimated by health specialists and experts through in-depth interview, on the following values (in days of hospitalization) Anaemia 7, ADS 2, ARI 3, Underweight 15, and Malaria 3. Field visits at Kibagabaga Hospital and CHUK (University Central Hospital of Kigali) Hospital
Average waiting time spent at primary care attention by pathology	Estimated by health specialists and experts through in-depth interview, on the following values (in hours) Anaemia 2, ADS 4, ARI 2, Underweight 2, and Malaria 3. Field visits at Kibagabaga Hospital and CHUK (University Central Hospital of Kigali) Hospital
Daily hours lost due to hospitalization by pathology	Estimated at 8 daily hours lost.

Indicator	Data and Sources
Average unit cost for attention in primary care by age group and pathology	Estimates based on hospital records and interviews with health specialists and experts. The unit cost for out-patient attention takes into account the overhead and direct costs associated to provision of medical consultation. As overhead costs were considered: the annual expenditure of water, electric power, fuel as well as the maintenance of the primary care facility. These overhead costs were divided by the annual number of patients. As direct costs were considered: the number and qualification (paediatricians, general practitioners, nurses) of medical staff and the time (in minutes) each of them dedicate to the patient. Based on their hourly salary the unit cost for attention is subsequently calculated. For a full overview of the average unit cost for attention per pathology please consult the Health Costing Guidelines.
Average cost of medical inputs for event in primary care by age group and pathology	Estimated by health specialists and experts through interviews. As medical inputs are considered: diagnosis scans and medicines for treatment. The costing of these inputs is done based on the hospital costing record. For a full overview of all the medical input and its cost per pathology please consult the Health Costing Guidelines.
Average unit cost for attention in hospital by age group and pathology	Estimates based on hospital records and interviews with health specialists and experts. The unit cost for in-patient attention takes into account the overhead and direct costs associated to provision of medical consultation. As overhead costs were considered: the annual expenditure of water, electric power, fuel and food as well as the maintenance of the hospital. These overhead costs were divided by the annual number of patients. As direct costs were considered: the number and qualification (paediatricians, general practitioners, nurses) of medical staff and the time (in minutes) each of them dedicate to the patient. Based on their hourly salary the unit cost for attention is subsequently calculated. For a full overview of the average unit cost for attention per pathology please consult the Health Costing Guidelines.
Average cost of medical inputs for event in hospital by age group and pathology	Estimated by health specialists and experts through interviews. As medical inputs are considered: diagnosis scans and medicines for treatment. The costing of these inputs is done based on the hospital costing record. For a full overview of all the medical input and its cost per pathology please consult the Health Costing Guidelines.
Average private cost of medical inputs for event by age group and pathology	Estimated by health specialists and experts through interview. To estimate the costs borne by the families a proxy of % of the total costs of medical input was used.
% of Cases who attend Health Services	Calculated from National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA: NISR, MOH, and ICF International, as follows: Low birth weight (68.9%/P.115);
Average travel time for ambulatory care.	Established at 2 hours for all cases and pathologies.
Percentage of low birth weight children	National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF International. 2012. Rwanda Demographic and Health Survey 2010. Calverton, Maryland, USA: NISR, MOH, and ICF International. Page 126. Table 10.1
Proportion of events of LBW requiring/access hospitalization	100% of cases of LBW would require hospitalization Estimated by health specialists and experts through in-depth interview.
Average number of days of hospital treatment for LBW	A Minimum of 5 days is recommended for LBW. Estimated by health specialists and experts through in-depth interview.
Morbidity differential probability for anaemia among healthy versus underweight children by age groups.	Calculated in-house at 6.7% for children under 5, from Rwanda Demographic Health Survey data, 2010, utilizing the prevalence of anaemia (moderate or severe) of underweight children and the prevalence of non-underweight children differentiated by age groups, with support. Assefa K. (2013)
Morbidity differential probability for ADS among healthy versus underweight children by age groups.	Calculated in-house at 3.2% for children under 5, from Rwanda Demographic Health Survey data, 2010, utilizing the prevalence of Acute Diarrheal Syndrome –ADS (reported diarrhoea in the last 2 weeks) of underweight children and the prevalence of non-underweight children differentiated by age groups, with support. Assefa K.(2013)
Morbidity differential probability for ARI among healthy versus underweight children by age groups.	Calculated in-house at -0.1% for children under 5, from Rwanda Demographic Health Survey data, 2010, utilizing the prevalence of Acute Respiratory Infection - ARI (data on children who were ill with a cough accompanied by rapid breathing) of underweight children and the prevalence of non-underweight children differentiated by age groups, with support. Assefa K. (2013)

Indicator	Data and Sources
Morbidity differential probability for Fever among healthy versus underweight children by age groups.	Calculated in-house at 5.7% for children under 5, from Rwanda Demographic Health Survey data, 2010, utilizing the prevalence of Acute Respiratory Infection - ARI (data on children who reported fever in last 2 weeks) of underweight children and the prevalence of non-underweight children differentiated by age groups, with support. Assefa K. (2013)
Hazard Ratio of child mortality associated with underweight	Estimated at 2.86, based on calculations by Acosta C., Martinez R. (2013) from Robert E. Black et al., "Maternal and child undernutrition: global and regional exposures and health consequences," The Lancet 371, No. 9608, 2008, doi:10.1016/S0140-6736(07)61690-0)
Hazard ratio for child mortality associated with stunting	Estimated at 2.33, based on calculations by Acosta C., Martinez R. (2013) from Robert E. Black et al., "Maternal and child undernutrition: global and regional exposures and health consequences," The Lancet 371, No. 9608, 2008, doi:10.1016/S0140-6736(07)61690-0
Education Data	
Enrolment by grade in Primary	Rwanda. Ministry of Education. 2012 Education Statistics Yearbook. February 2012. Data were obtained from Ministry of Education. Page 17, Table14,
Enrolment by grade in Secondary	Rwanda. Ministry of Education. 2012 Education Statistics Yearbook. February 2012. Data were obtained from Ministry of Education. Page 23, Table 25,
Number of passes by grade	Calculated by grade by the Ministry of Education with data for 2011. The rates were maintained constant and applied to 2012 enrolment data.
Number of population repeating grades by grade	Calculated by grade by the Ministry of Education with data for 2011. The rates were maintained constant and applied to 2012 enrolment data.
Annual Private/Public cost per student / year by educational level	Estimations by NIT in (RWF). Primary Education – Public Cost: 28,718; Cost to Families: 13,500. Secondary Education – Public Cost 189,589; Cost to Families: 114,000.
Relative Risk associated of grade repetition associated with stunting	Estimated at 1.35, based on calculations from Cebu Longitudinal Health and Nutrition Survey, with support from Melissa C. Daniels
Relative Risk associated of dropping out associated with stunting	Estimated at 1.61, based on calculations from Cebu Longitudinal Health and Nutrition Survey, with support from Melissa C. Daniels

Annex III. Brief Description the Data Collection and Validation Process

The data collection process was led by the members of the National Implementation Team, who developed a work plan and assigned responsibilities among the specialists. The process was initiated with a Capacity building workshop held in February 2012, where the National Implementation Team was sensitized on the methodology a work plan was developed to implement the studying Rwanda.

For analyzing the data on health, secondary data as well as primary data has been the source of information. The secondary data used are the Demographic Household Survey (DHS) of 2010 and the hospital records of Kikukiro Health Center, Kibagabaga Hospital and Universal Central Hospital of Kigali (CHUK), all in Kigali, Rwanda. In addition, primary data was collected by conducting surveys and interviews with health specialists in the aforementioned health facilities. These questionnaires included a template on medical inputs per pathology, created on the basis of WHO guidelines, in order to assess which medical input is used and which not or which additional medical input per pathology in general is also given to the patient of the respective pathology. Subsequently the costs of these medical inputs could be estimated on the basis of the hospital records. The questionnaire was also used to calculate the amount of time each staff member dedicates to a certain case of pathology. Based on the hospital records the unit cost of attention was accordingly calculated by taking into account the individual salary of each staff member involved and the time they spend on a pathology case. Finally, the hospital records also formed the basis to estimate the cost of a hospital bed which was calculated by dividing the annual overhead costs (which consists of the operational costs such as water, electricity, gas and staff) of the hospital by the annual number of in-patients.

A similar process was carried-out to obtain the data on labour productivity. In Rwanda, the Integrated Household Living Condition Survey is conducted every five years. This survey provides information related to income, expenditure, education among many other poverty and living condition related information. For analyzing the COHA data on productivity, the main source of information was the "Third Integrated Household Living Conditions Survey (EICV3) from the National Institute of Statistics for Rwanda carried out from 2010/2011. To process the calculation, the data on 14,308 household's expenditure was utilized, adjusting it to the adult equivalent factor, to obtain per capita estimations. These estimations were associated with the household members of working age, 15-64, considering their educational level. In the case of the data set for Rwanda, the data set provided limited information that associated age, education level and expenditure. In this sense, the missing values were estimated based on the average of the available data.

In December 2013, the Rwandan government organized a validation workshop in Kigali. The purpose of the workshop was to validate the results of the Cost of Hunger in Rwanda and produce recommendations for the future. During that workshop, the NITs identified possible solutions to the last gaps in data availability and defined action plans in order to continue the process, with the continuous support from the regional team.

This validation workshop was organized by AUC, ECA, and WFP to in collaboration with the Rwandan Government, with the participation of key government institutions namely the Ministry of Agriculture (Minagri), Ministry of Finance and Economic Planning (Minecofin), Ministry of Education (Minéduc), Ministry of Foreign Affairs and Cooperation (Minaffet), Ministry of Health (Minisanté)), Ministry of Local Government (Minoloc), the National Institute of Statistics of Rwanda (NISR) and the Rwanda Agricultural Board (RAB). Additionally, development partners namely Adventist Development and Relief Agency (ADRA), Catholic Relief Services (CRS),CARITAS, CONCERN, College of Science and Technology (COSTECH), ECA, EU, FAO, FEWS NET, Gardens for Health, Partners in Health (PIH), REACH, Rwanda Biomedical Center (RBC), Society for Family Health, USAID, WFP and World Relief were also contributing to the discussion.

The final report of the Cost of Hunger in Rwanda was submitted officially by the African Union Commission and accepted by the Government of Rwanda in February 2014.

Annex IV. Consulted Resources

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