Quantifying the Cost and Benefits of Ending Hunger and Undernutrition:
Examining the Differences among Alternative Approaches

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As part of the Sustainable Development Goals (SDGs), world leaders have committed to ending hunger by 2030. Yet despite unprecedented progress made in recent decades, the world is not on track to reach the goal. Current levels of spending to end hunger are inadequate.

THE COST OF ENDING HUNGER

How much would it cost to end chronic hunger globally? Many have tried to answer this question—the Food and Agriculture Organization of the United Nations (FAO) produced estimates as early as 1949. But estimating the cost is complicated by the multiple interrelated goals on the global agenda. While the end of hunger must be central to any vision of sustainable development, none of the SDGs can be achieved in isolation. Hunger (SDG2) and poverty (SDG1), while not synonymous, are both causes and consequences of each other.[1] Agriculture heavily impacts climate change and vice versa (SDG13).[2] And responsible production and consumption (SDG12) are critical for sustaining food security in a world of resource scarcity.[3] Indeed, policy makers must consider how investments and expenditures to end hunger would fit within efforts to achieve all SDGs and what kinds of trade-offs may present themselves.

Today, with advancements in multidisciplinary modeling and richer datasets, we can better approach an answer. This brief examines estimates produced by several recent model simulations and frameworks that focus on the cost of ending hunger as well as progress toward other development goals—estimates that range from US$7 billion to US$265 billion per year. The differences among these estimates are largely attributable to the different targeted objectives and policy questions of each modeling exercise, different investment strategies considered, and varying assumptions about the role of different sectors in reducing hunger.

A variety of investment strategies can contribute to ending hunger—including investments to end poverty, increase agricultural productivity, target hungry households, and address undernutrition—each associated with different costs, uncertainties, and economywide benefits. Examining the different impacts of these strategies, as these models do, presents an interesting opportunity to consider the policy pathways that could be followed toward ending hunger and more. New models of the benefits of ending hunger and of the costs of ending malnutrition in all its forms through investments to improve dietary diversity likewise contribute to our understanding of these pathways.

The models reviewed here also lead to different estimates because they are built with distinct targets—for example, most but not all use 2030 as the target year, in line with the SDGs. These models also use different measures of the end of hunger. Most consider a country to have achieved this goal when the share of undernourished people is less than 5 percent of the population—a prevalence seen currently in the United States and many countries in Western Europe. Others aim for zero hunger, with correspondingly higher costs.

DIFFERENT COSTING MODELS, DIFFERENT QUESTIONS, DIFFERENT OBJECTIVES

Four recent efforts have estimated the cost of ending hunger and undernutrition.[4] Each asks a different question and uses a different approach (Table 1).

The **Achieving Zero Hunger** approach[5] from FAO, the International Fund for Agricultural Development (IFAD), and the

World Food Programme (WFP) takes aim at hunger by way of ending poverty—thus the investments are focused on ensuring that people have adequate income and resources to get the food they need. To achieve this by 2030 would cost an additional US$265 billion per year for social protection and pro-poor investments and expenditures, public and private, in agriculture and rural development. To estimate the social protection expenditures required, the model calculates the transfers needed to raise all incomes to 40 percent above the poverty line of US$1.25 (PPP) a day, along with markups for administrative costs and leakages, leading to costs of US$67 billion per year. Unlike other models, Achieving Zero Hunger aims for absolute-zero levels of hunger by funding income transfers to the poor in perpetuity. However, the bulk of the costs in this approach come from investments designed to generate rural income—namely, investments in improving primary agriculture and natural resources; agroprocessing operations; infrastructure; institutional frameworks; and research, development, and extension. Achieving Zero Hunger assumes that over time these investments will raise incomes and thus reduce income transfers. Among those reviewed, this model produces the highest cost estimates.

IFPRI's **IMPACT** model asks a slightly different question—what are the effects of boosting agricultural productivity on food security and the environment? Climate change will increase the number of people at risk of hunger, thus partially offsetting gains that would be realized by investments in productivity in the absence of climate change. The IMPACT work provides a global-scale analysis,[6] with a focus on Africa,[7] where the impact of climate change is expected to be pronounced and where hunger is most prevalent. The analysis finds that increased global investments in agricultural research, resource management, and infrastructure to increase agricultural productivity—expected to reduce hunger through increased incomes and food availability—would cost an average of US$52 billion annually until 2030. The IMPACT model uses the 5 percent hunger threshold as a global goal, but even under this package of investments about 10 percent of people in Eastern and Central Africa would remain at risk of hunger. Among the studies reviewed in this brief, this is the only one that considers the future impact of climate change.

Ending Hunger: What Would It Cost—a joint project of IFPRI and the International Institute for Sustainable Development (IISD)—uses the **MIRAGRODEP** dynamic global model[8] to provide the most direct estimate: we can end hunger by 2030 with an additional US$11 billion, on average, invested annually from 2015 to 2030.[9] Under business-as-usual rates of progress, 73 countries would still find more than 5 percent of their populations hungry—the threshold for elimination of hunger used in this study—by 2030. For those countries, the model minimizes

the cost of ending hunger through new public expenditures in three categories of interventions: (1) social safety nets directly targeting consumers through cash transfers and food stamps; (2) farm support to expand production and increase farmers' incomes; and (3) rural development that reduces inefficiencies along the value chain and enhances rural productivity. Like Achieving Zero Hunger, MIRAGRODEP assumes that these investments will raise incomes and reduce income transfers. Because MIRAGRODEP combines a multicountry, multisectoral model with household surveys, it allows for including targeted interventions based on the precise characteristics of hungry households (instead of national averages, which are more commonly used). Because of this targeting approach, along with its exclusive focus on ending caloric hunger and no other development goals, MIRAGRODEP's cost estimate is among the lowest of all models reviewed. Indeed, it is the only study that targets ending hunger exclusively. With a clear focus on public interventions and the international donor community's role, this cost estimate does not include the private investments triggered directly or indirectly by public action.

The **Investment Framework for Nutrition** from the World Bank estimates the cost of improving nutrition outcomes and practices to move toward some of the World Health Assembly goals by 2025. The goals targeted in the analysis are: (1) reducing the number of stunted children by 40 percent; (2) reducing the number of women of reproductive age with anemia by 50 percent; (3) increasing the rate of exclusive breastfeeding up to 50 percent; and (4) reducing and maintaining child wasting to a level of less than 5 percent. According to this framework, it would cost an additional US$7 billion annually from 2015 to 2025 to reach these goals.[10] The package of investments includes targeted nutrition-specific interventions, such as micronutrient supplementation and promotion of good infant and young child nutrition and hygiene practices, and "low-hanging fruit" investments, such as staple food fortification. None of the interventions involves primary agricultural production or investments in rural development—necessary investments for eliminating hunger and undernutrition. Moreover, this approach does not aim to end hunger. As such, the estimated costs are the lowest among the models reviewed.

The Investment Framework also attempts to estimate the economic returns to these investments in nutrition in order to develop benefit-cost ratios (BCRs) for each target. To arrive at a global estimate of US$10.50 BCR from preventing stunting, the analysis uses a seminal micro study in Guatemala along with averted deaths; the estimated losses from not breastfeeding (BCR: $12.10); earnings gained via increased productivity from reduced anemia (BCR: $34.70); and economic benefits of reducing wasting based on estimated mortality reductions (BCR: $3.60).[11]

Table 1: Overview of four costing exercises

Model/ framework and institution(s)	Question asked and time frame	Investments included	Hunger target and key modeling factors included	Annual cost (US$)
Achieving Zero Hunger (FAO, IFAD, WFP)	What are the additional transfers and investments needed to end poverty and hunger in all countries by 2030?	Poverty gap transfers and pro-poor public investment in irrigation, genetic resources, mechanization, agroprocessing, infrastructure, institutions, and agricultural R&D	Zero hunger target	265 billion
IMPACT (IFPRI)	How much would hunger decrease given investments to achieve target yield increases by 2030?	Agricultural R&D, irrigation expansion, water use efficiency, soil management, and infrastructure	5% hunger target; effects of climate change included	52 billion
MIRAGRODEP (IFPRI-IISD)	What is the minimum cost to end hunger for vulnerable households in all countries by 2030?	Social safety nets, farm support, and rural development	5% hunger target; bottom up approach with household-level targeted interventions	11 billion
Investment Framework for Nutrition (World Bank)	What is the minimum cost to meet the World Health Assembly (WHA) goals on reducing undernutrition by 2025?	Targeted nutrition interventions (micronutrient and protein supplementation, promoting good health and hygiene, complementary foods) and select nutrition-sensitive interventions (staple food fortification and pro-breastfeeding policies)	40% reduction in child stunting; 50% reduction in anemia in women; 50% increase in exclusive breastfeeding rates; 5% child wasting	7 billion

Source: Adapted from D. Mason-D'Croz et al., "IMPACT Projections of Investments in Agriculture and Implications for Reducing Hunger in Africa by 2030: Results from the IMPACT Model, Version 3.3," project report, Washington, DC: IFPRI, 2016.

RESEARCH FRONTIERS

Modeling the benefits of ending hunger and malnutrition

Acknowledging that food security is a human right, the main benefit of eliminating hunger and malnutrition is ending unnecessary sources of human suffering. Moreover, living in a world free from hunger would have many other wide-ranging and important advantages. Several studies show that ending hunger and malnutrition leads to increased productivity and better health, more peaceful and stable communities and households, and improved educational attainment.[12] Some of these benefits can be expressed in economic terms, which is useful for advocacy and policy prioritization.

Eliminating hunger and improving nutrition status generates immediate and long-term gains by allowing undernourished people to escape the nutrition-based poverty trap. In the short run, higher calorie consumption allows the undernourished to raise their productivity and increase their resilience to disease. In addition, addressing the nutritional constraints facing pregnant women and children allows the subsequent generation to achieve higher levels of physical and mental development, which leads to higher levels of human capital

and incomes. A strong and positive linkage between caloric intake and labor productivity at the family farm level was demonstrated more than 30 years ago.[13] By introducing this relation in MIRAGRODEP, recent analysis shows that eliminating global hunger (5 percent or less at the country level) would boost global GDP by US$276 billion in 2030 (2011 constant dollars), equivalent to 0.5 percent of expected total developing country GDP for 2030, when the direct and immediate boost to labor productivity from removing the calorie constraint is considered.[14] For some countries severely affected by hunger today, such as Ethiopia and Zambia, the gains would range between 4 and 6 percent of national GDP. Of course, these benefits are only a part of the long-term dividends from addressing hunger and undernutrition, which run much more deeply and broadly through society.

Modeling the cost of improving nutrition via diet change

Some attempts have been made to model the cost of ending malnutrition.[15] The difficulty lies in linking broad food- and agriculture-based investments with nutrition outcomes. The World Bank's attempt in the Investment Framework highlights this difficulty by ignoring agricultural interventions in lieu of more easily quantifiable, nutrition-specific interventions. How-

ever, to better model the cost of improving nutrition, the cost of investing in all significant and relevant drivers must be included.

Diets constitute the main link between agriculture and nutrition. Because many foods are not highly tradable, domestic agricultural supply has a major influence on the prices of different foods. Previous modeling work on diets has largely focused on caloric sufficiency, even though inadequate supply of calories is just one form of malnutrition. Research under IFPRI's Advancing Research on Nutrition and Agriculture (ARENA) project[16] promotes a more holistic dietary indicator that conceptualizes a healthy and nutritious diet as one with an appropriate quantity of calories (avoiding too few or too many calories) as well as sufficient dietary diversity to eliminate common micronutrient deficiencies. Using entropy methods, the ARENA approach also factors in context-specific dietary constraints stemming from food preferences, agroecological conditions, and market constraints. It is hoped that this approach will provide a user-friendly means of integrating diets into standard economywide modeling exercises.

CONCLUSION

The models and frameworks reviewed offer a range of cost estimates—from US$7 billion to US$265 billion annually—associated with ending hunger. The wide range reflects the different policy pathways that could be followed toward ending hunger and reaching other development goals. These include ending hunger by ending poverty first; reducing hunger by improving agricultural productivity in the context of climate change; ending hunger by targeting vulnerable households; and reducing undernutrition through select nutrition interventions. Along with emerging studies on the benefits of ending hunger and the cost of improving nutrition through diet change, these models and frameworks can provide insight for setting investment priorities to end hunger and achieve the many interconnected SDGs.

NOTES

1. M. T. Ruel, "Food Security and Nutrition: Linkages and Complementarities," in *The Road to Good Nutrition: A Global Perspective*, eds. M. Eggersdorfe, et al. (Basel: Karger Publishers), 24–38.

2. United States Environmental Protection Agency, *Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990–2030 EPA*, Office of Atmospheric Programs, Climate Change Division (Washington, DC: 2012); A. J. Challinor et al.; "A Meta-analysis of Crop Yield under Climate Change and Adaptation," *Nature Climate Change* 4 (2014): 287–291.

3. FAO, *Global Food Losses and Food Waste–Extent, Causes and Prevention* (Rome: 2011).

4. All simulation models of the type reported here make simplifying assumptions and aggregations, and their estimates cannot be subjected to statistical confidence interval tests.

5. FAO, IFAD (International Fund for Agricultural Development), and WFP (World Food Programme), *Achieving Zero Hunger: The Critical Role of Investments in Social Protection and Agriculture* (Rome: FAO, 2015).

6. M. W. Rosegrant et al., *Quantitative Foresight Modeling to Inform the CGIAR Research Portfolio*, project report for USAID (Washington, DC: IFPRI, 2017.

7. D. Mason-D'Croz et al., "IMPACT Projections of Investments in Agriculture and Implications for Reducing Hunger in Africa by 2030: Results from the IMPACT Model, Version 3.3," Project Report (Washington, DC: IFPRI, 2016).

8. AGRODEP (African Growth and Development Policy Modeling Consortium), MIRAGRODEP Model, accessed January 30, 2018, www.agrodep.org/model/miragrodep-model.

9. D. Laborde et al., *Ending Hunger: What Would It Cost?*, International Institute for Sustainable Development (IISD) and IFPRI Briefing Note (Winnipeg, MB, Canada: IISD, 2016).

10. M. Shekar et al., *An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting*, Directions in Development (Washington, DC: World Bank, 2017).

11. J. Hoddinott et al., "The Economic Rationale for Investing in Stunting Reduction," *Maternal and Child Nutrition* 9, Issue Supplement 2 (2013): 69–82; N. C. Rollins et al., "Why Invest, and What It Will Take to Improve Breastfeeding Practices?" *Lancet* 387, no. 10017 (2016): 491–504.; S. Horton and J. Ross, "The Economics of Iron Deficiency," *Food Policy* 28, no. 1 (2003): 51–75.

12. H. Alderman and J. R. Behrman, "Reducing the Incidence of Low Birth Weight in Low-Income Countries Has Substantial Economic Benefits," *World Bank Research Observer* 21, no. 1 (2006): 25–48; Z. A. Bhutta, et al., "What Works? Interventions for Maternal and Child Undernutrition and Survival," *Lancet* 371, no. 9610 (2008): 417-440; P. Pinstrup-Andersen and S. Shimokawa, "Do Poverty and Poor Health and Nutrition Increase the Risk of Armed Conflict Onset?," *Food Policy* 33, no. 6 (2008): 513-520; J. G. da Silva and S. Fan, *Conflict, Migration, and Food Security: The Role of Agriculture and Rural Development*, FAO-IFPRI Joint Brief (Rome and Washington, DC: FAO and IFPRI, 2017).

13. J. Strauss, "Does Better Nutrition Raise Farm Productivity?," *Journal of Political Economy* 94, no. 2 (1986): 297–320.

14. D. Laborde, "Macroeconomic Benefits of Ending Hunger by 2030" (unpublished, 2018).

15. Malnutrition refers to hunger (caloric deficiency), undernutrition (micronutrient deficiencies), and overnutrition (too many calories).

16. IFPRI, Advancing Research on Nutrition and Agriculture (ARENA), accessed January 30, 2018, www.ifpri.org/project/advancing-research-nutrition-and-agriculture-arena

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