REPORT

Ending Hunger, Increasing Incomes, and Protecting the Climate:

What would it cost donors?

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1. THREE PROBLEMS, FIVE FINDINGS

Hunger is rising, reversing decades of progress. Today 690 million people are hungry, an increase of 60 million people over the past five years (Food and Agriculture Organization of the United Nations [FAO] et al., 2020). We predict that a further 95 million people will be living in extreme poverty and hunger as a result of COVID-19 (Laborde & Smaller, 2020). Perversely, the very people whose livelihoods depend on food and agriculture are among the most likely to experience hunger. Small-scale food producers and food workers and their families are among those most often left out of economic growth, technological change, and political decision making. Globally, today's food systems are not producing affordable, healthy, and sustainable diets for all (FAO et al., 2020). The climate crisis poses a mounting threat to food systems (FAO et al., 2018; Intergovernmental Panel on Climate Change [IPCC], 2018), while at the same time, the current food system is a major driver of climate change (FAO et al., 2020).

In response to the global commitment to rid the world of hunger, Ceres2030 partnered with Nature Research to answer two linked questions: First, what does the published evidence tell us about agricultural interventions that work, in particular to double the incomes of small-scale producers and to improve environmental outcomes for agriculture? And second, what will it cost governments to end hunger, double the incomes of small-scale producers, and protect the climate by 2030? The project focuses on three of the five targets in the second sustainable development goal (SDG 2, Zero Hunger) and looks at the public spending needed in low- and middle-income countries, including the contribution from donors through official development assistance (ODA) (Laborde et al., 2020).

This report answers the second question. The answer to the first question is published as a special collection of Nature Research. This report is published alongside a complementary research project by the Centre for Development Research (ZEF) and the FAO that also identifies high-impact, cost-effective interventions to address the challenges of SDG 2. The use of different research approaches and methodologies helps to identify levels of coherence and strengthens the credibility of proposed policy actions and investments. The approaches show results that are consistent and compatible, confirming that between now and 2030 donors need to double their efforts (von Braun et al., 2020).[1]

The Ceres2030 project was guided by the premise within SDG 2 that increasing the incomes of small-scale producers in a way that supports the transition to environmental sustainability is the most effective way to end hunger and realize the multifaceted objectives of the 2030 Agenda for Sustainable Development.

[1] The three targets of SDG 2 are ending hunger (target 2.1), doubling the incomes and productivity of small-scale producers (target 2.3), and producing food sustainably and resiliently (target 2.4). Nutrition (target 2.2) and biodiversity and preservation of associated traditional knowledge (target 2.5) were not included. See Box 1.

THREE PROBLEMS

1. Today 690 million people are hungry, and 95 million more people are at risk as a result of COVID-19 (FAO et al., 2020; Laborde & Smaller, 2020).
2. The people whose livelihoods depend on food and agriculture are among the most likely to experience hunger. The households of small-scale producers, especially those who live in Africa, are the people most often left out of economic growth, technological change, and political decision making (International Fund for Agricultural Development [IFAD], 2016).
3. Food systems are a central driver of deteriorating environmental conditions, particularly climate change and biodiversity loss, while at the same time being one of the sectors put most at risk by the climate crisis. There is an urgent need for food systems to reduce greenhouse gas emissions, adapt to deteriorating environmental conditions, and provide affordable, healthy diets for all (FAO et al., 2018, 2020; IPCC, 2018).

FIVE FINDINGS

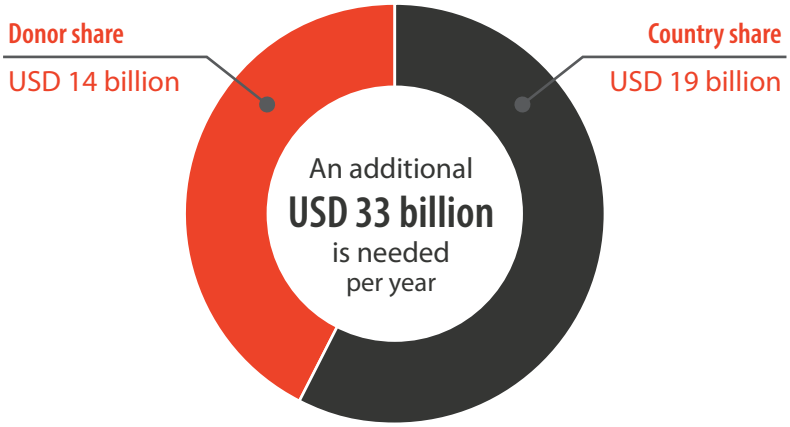
1. Donors need to contribute an additional USD 14 billion[2] per year until 2030 to end hunger and double the incomes of small-scale producers. This is achieved while maintaining greenhouse gas emissions for agriculture below the commitments made in the Paris Agreement. Donors currently spend USD 12 billion per year on food security and nutrition and therefore need to double their contributions to meet the goals.[3]
2. Aid will not be enough. Additional efforts of USD 19 billion per year on average will have to be provided by low- and middle-income countries through increased taxation.
3. The additional public spending will prevent 490 million people from experiencing hunger and double the incomes of 545 million small-scale producers on average, while at the same time maintaining greenhouse gas emissions for agriculture below the commitments made in the Paris Agreement. The additional public spending will also spur an extra USD 52 billion in private investment per year on average in primary and processed food sectors from both small- and large-scale producers.

[2] 2018 constant USD. All the numbers in this document use this monetary unit.

[3] All figures of existing donor spending represent 3-year averages (2016-2018) of ODA from listed public donors, extracted from the Organisation for Economic Cooperation and Development (OECD) Development Assistance Committee (DAC) Creditor Reporting System (CRS) database (OECD, n.d.a). Spending on food security and nutrition is defined by the DAC codes, including but not limited to: basic nutrition (12240), agriculture (311), agro-industries (32161), rural development (43040), and non-emergency food aid (52010).

Donors must spend an additional USD 14 billion a year on average to end hunger sustainably

FIGURE 1. ADDITIONAL PUBLIC SPENDING AND DONOR CONTRIBUTION



Source: Authors' calculations.

4. Any delay in spending will not only have human costs but will also increase the total monetary costs. Early spending, on the other hand, allows investment in interventions that take more time—like research and development (R&D)—but have a bigger payoff. It also allows downstream (processing) and upstream (farm inputs) investments to be spread over time.
5. A portfolio of interventions is needed to achieve the multiple SDG 2 targets. Ceres2030 estimated the optimal investment using three categories of interventions: (1) empower the excluded, (2) on the farm, and (3) food on the move. The interventions in the model are balanced by their synergies and trade-offs according to the impact on greenhouse gas emissions, economic growth, and the country context. This report offers a starting point for considering proper portfolio balance.

2. THE IMPORTANCE OF AID

Aid is a critical source of finance for developing countries, especially in Africa. Analysis of the sources of foreign finance for developing countries shows that ODA has been the largest single source of foreign finance since 2002, consistently providing over 30% of the total. In 2017, ODA represented 36% of the foreign finance received by African countries south of the Sahara, compared with 31% from overseas personal remittances and 23% from foreign direct investment (FDI) (Organisation for Economic Co-operation and Development [OECD], n.d.b). In other regions, ODA is less dominant. The main source of foreign finance in South Asia, for example, is personal remittances, comprising 55% of foreign finance; in South America, it is FDI, at 68% of the total (OECD, n.d.b). Despite these differences, and especially in Africa and South Asia, ODA is a crucial resource for economic development (Eber-Rose et al., 2020).

In this context, capturing both the financial constraints faced by low- and middle-income countries and the role of donors in alleviating these constraints in the short and long terms is key. The model used to estimate the costs integrates these elements and considerations. Details on how the donor contribution is calculated can be found in Section 4.

3. WHAT WOULD IT COST?

The results from the model show that donors need to contribute an additional USD 14 billion per year on average until 2030 to end hunger and double incomes of small-scale producers in low- and middle-income countries. The investment achieves these goals while maintaining greenhouse gas emissions for agriculture below the commitments made in the Paris Agreement.

Donors currently spend USD 12 billion per year on food security and nutrition and therefore need to double their contributions to meet the goals. However, ODA alone will not be enough. Additional public spending of USD 19 billion per year on average until 2030 will have to be provided by low- and middle-income countries through increased taxation.

Together, the additional public investment from donors and low- and middle-income countries will prevent 490 million people from experiencing hunger, double the incomes of 545 million producers and their families on average, and limit greenhouse gas emissions for agriculture to the commitments made in the Paris Agreement.[4]

To be effective, the additional public investment needs to be allocated to a balanced portfolio of interventions. Ceres2030 modelled a portfolio of interventions using 14 policy instruments grouped into three broad categories: (1) empower the excluded, (2) on the farm, and (3) food on the move (see Figure 2).

The first category includes interventions such as social safety nets, targeting the broader population and aimed to promote inclusiveness and enhance human capital. The second category increases the economic productivity of farmers, allowing them to be more cost efficient and address the rising needs of the population. The last category of interventions connects farmers to markets, guaranteeing the distribution of surplus production and providing better prices for farmers while reducing the cost for consumers.

[4] The results from the modelling should be interpreted as an estimate of the scale of resources needed at the big-picture level. This is useful to inform resource allocation decisions at the global level and can be helpful at the national level for our focus countries and the sub-regional level (see Box 2), but it is insufficient to inform strategy, planning, and programming at the subnational level.

The additional investment needs to be distributed across three categories of interventions

FIGURE 2. THREE CATEGORIES OF INTERVENTIONS

The public spending is grouped into three broad categories of interventions, and the model assigns costs for policy instruments, such as research and development that each fall into one of these categories.

Empower the Excluded

Interventions related to social protection, institutions such as farmers' organizations, and education through vocational training.

On the Farm

Interventions provided directly to farmers, including farm inputs, R&D, improved livestock feed, and irrigation infrastructure.

Food on the Move

Interventions to reduce post-harvest losses, including storage, to improve returns from sales, and to support the mix of services provided by SMEs, such as cooperatives, traders, and processors.

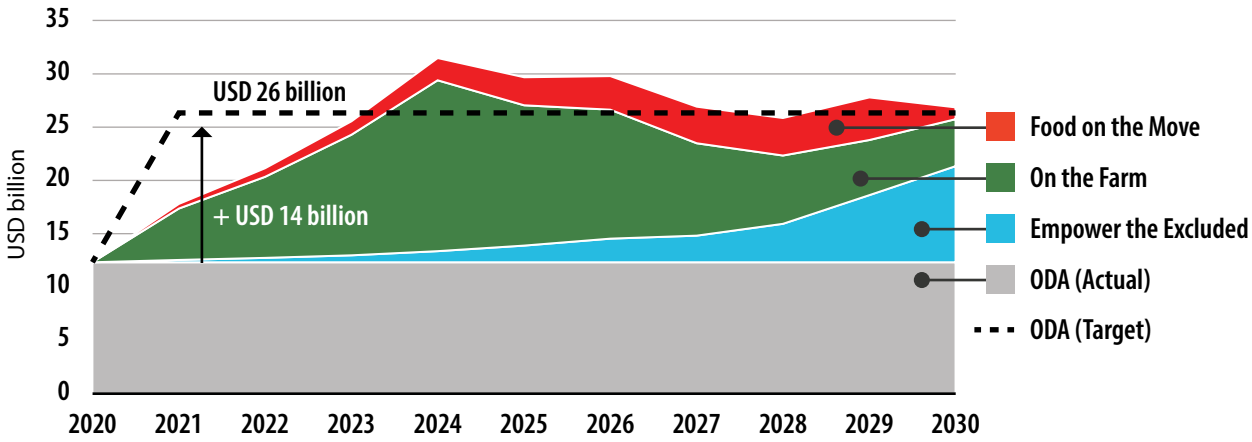
Note: These categories can be mapped to the donor classification system of the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) Creditor Reporting System (CRS) database.

Even if not exhaustive, Ceres2030's holistic modelling approach uses diverse policy instruments so that investment in interventions will benefit from synergies, avoid bottlenecks, and balance trade-offs. For example, a fertilizer subsidy could be provided to help farmers increase yields, but its effectiveness would be hampered if a poor road network makes it too costly for produce to reach markets. A production subsidy may boost food production and producer incomes but could result in clearing of land and unsustainable agricultural practices. The mix of policy instruments used in the model thus includes interventions that account for these interactions and complement each other, illustrating with broad strokes an appropriate investment strategy to accomplish multiple objectives.

Figure 3 shows the funding gap over time and by category of intervention. It compares actual levels of ODA, based on a 3-year average of USD 12 billion, to the additional donor contribution needed over the investment period of 2020 to 2030, an average of USD 14 billion per year, with detail on how the additional donor contribution is distributed among the three categories of interventions.

The current level of donor spending averages USD 12 billion per year, only half of what is needed to meet the goal of ending hunger by 2030

FIGURE 3. THE FUNDING GAP OVER TIME AND BY CATEGORY OF INTERVENTION

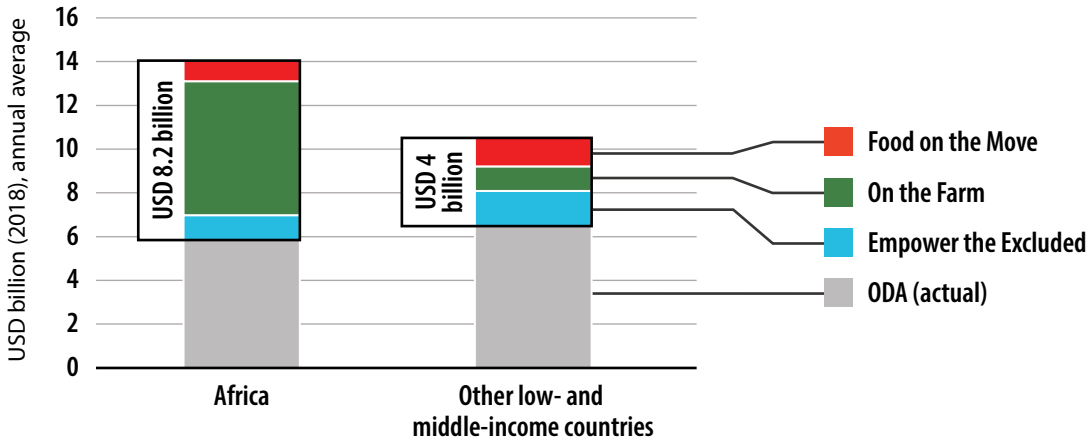


Source: Authors' calculations.

By far the region with the greatest need for additional resources is in Africa. Figure 4 shows the donor contribution needed in Africa compared to other low- and middle-income countries and distributed across the three categories of interventions. The need in Africa is particularly high, since more than half of the global undernourished population will be concentrated on this continent by 2030.

Two thirds of the additional public spending is needed in Africa to achieve the targets

FIGURE 4 . FUNDING GAP BY REGION AND BY CATEGORY OF INTERVENTION*



Funding gap by region and by category of intervention

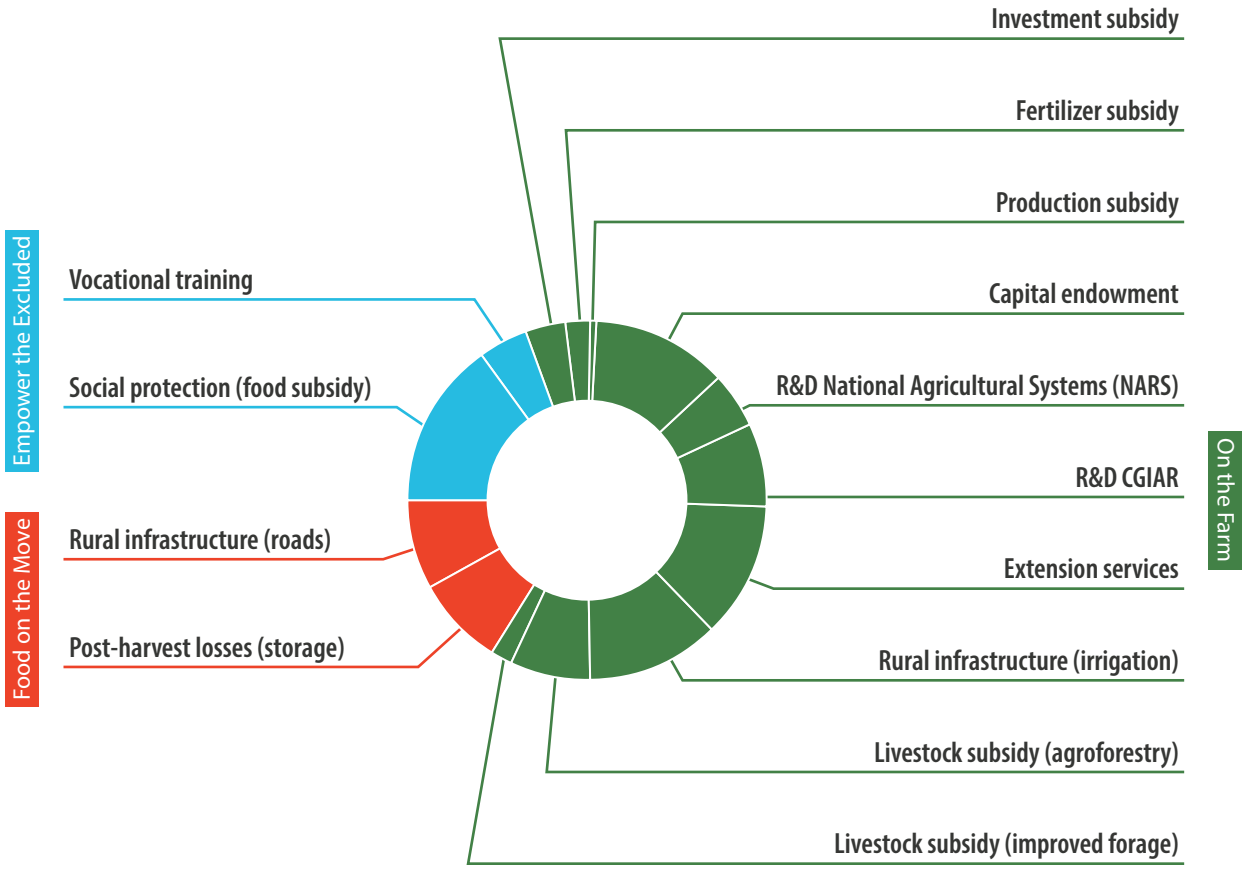
Source: Authors' calculations.

** Funding gap for global R&D is not included in the regional breakdown.*

Figure 5 shows the funding estimation for the three categories disaggregated into the estimations for each of the 14 modelled policy instruments. To generate an estimate of the donor contribution needed for empowering the excluded, there are two modelled policy instruments: income support through food subsidies (social protection programs) and vocational training programs. The donor contribution for these interventions is an additional USD 3 billion on average per year. Investments in human capital (vocational training) should start early to generate several years of returns for workers, while social safety nets increase over time to make sure that income is properly distributed so that the undernourishment goal is achieved by 2030.

Social protection, financial capital, rural infrastructure, and extension services are among the top policy instruments that donors should target as part of their investments

FIGURE 5. FUNDING GAP BY MODELLED POLICY INSTRUMENT



Source: Authors' calculations.

To estimate the donor contribution needed for interventions on the farm, the modellers used 10 policy instruments that directly affect the technologies available for small-scale producers and what and how they produce: investment subsidies, fertilizer subsidies, capital endowments, production subsidies, national R&D, international R&D, extension services, irrigation infrastructure, agroforestry, and improved forage. The donor contribution for this category is an additional USD 9 billion per year on average. Interestingly, each instrument's investment follows a different time profile to achieve the targets by 2030, with spending on core public goods—especially R&D, which has a long lag before payoff but a high return—to be prioritized first.

To generate an estimate of the donor contribution needed for interventions to move food to market, there are two policy instruments that directly contribute to increased income opportunities for farmers while reducing overall costs for consumers. They are increased rural infrastructure (roads) and storage opportunities, both of which contribute to a reduction in post-harvest losses and an increase in prices for farmers. The donor contribution for this group of interventions is an additional USD 2 billion.

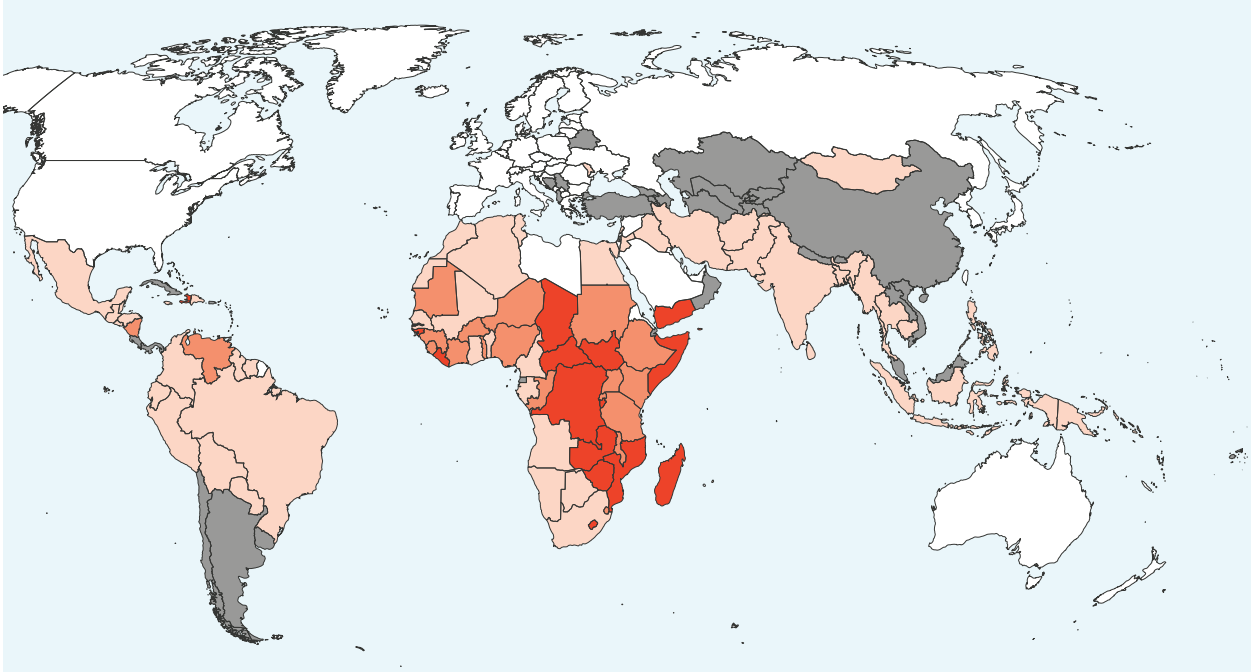
The additional public spending will also spur an extra USD 52 billion in private investment per year on average in both primary and processed food production activities. This number includes, among other investments, increased investments by small-scale producers, made possible by higher incomes, and by large-scale producers, due to enhanced agricultural productivity and increased food demand.

THE NEED FOR IMPROVED TARGETING

Figure 6 provides a picture of the external financing needs of each country. It shows the donor priority levels for countries and regions, based on their degree of dependency on external resources (see Appendix 2). Among regions, Africa will need the greatest level of support, especially to achieve the ending hunger target. However, other countries, including in Asia, will require important attention to increase productivity and incomes of small-scale producers. Some countries, such as the Democratic Republic of Congo, South Sudan, and Eritrea, will rely on donor support for more than 90% of their public budgets.

Africa will need the greatest level of support

FIGURE 6. PRIORITY COUNTRIES FOR DONOR INVESTMENT BASED ON THEIR DEPENDENCY ON EXTERNAL RESOURCES UNTIL 2030



Note: "High Priority" includes countries that will depend on donors for over 50% of their budgets; "Medium Priority" includes countries that will depend on donors for between 30% to 50% of their budgets; "Low Priority" includes countries that will depend on donors for less than 30% of their budgets. "On Target" includes countries that will need to retain existing levels of donor support but will not need any extra donor support from now until 2030. For a full list of countries, see Appendix 2.

4. HOW DID WE CALCULATE THE COST?

THE MODEL

The modelling team used a computable general equilibrium (CGE) model to estimate the additional public investment needed to end hunger, double the incomes of small-scale producers, and protect the environment by 2030. The framework was developed based on three of the five targets of SDG 2: ending hunger (Target 2.1), doubling the incomes and economic productivity of small-scale producers (Target 2.3), and producing food sustainably and resiliently (Target 2.4).[5]

[5] The mode is adapted from the MIRAGRODEP model. See Laborde et al., 2013.

BOX 1. WHAT ABOUT NUTRITION (TARGET 2.2) AND BIODIVERSITY (TARGET 2.5)?

The project was not mandated to work on nutrition (Target 2.2) specifically because existing global efforts, such as those by 1000 Days, R4D, and the World Bank, have estimated the cost of ending some forms of malnutrition using a different model (see Shekar et al., 2016). Nutrition, moreover, is its own complex goal and would have required significantly more time and resources to include in the project. Costing nutrition goes beyond agriculture and food systems to include sanitation and access to clean water, for example (Development Initiatives, 2018). It also relies on data at the intra-household level, which is a level of granularity not yet widely available or comparable across countries. That said, it is important to note that doubling small-scale producer income can be expected to have an important positive impact on nutrition. Especially at lower income levels, increases in income are quickly captured in consumption of more, and more varied, foods.

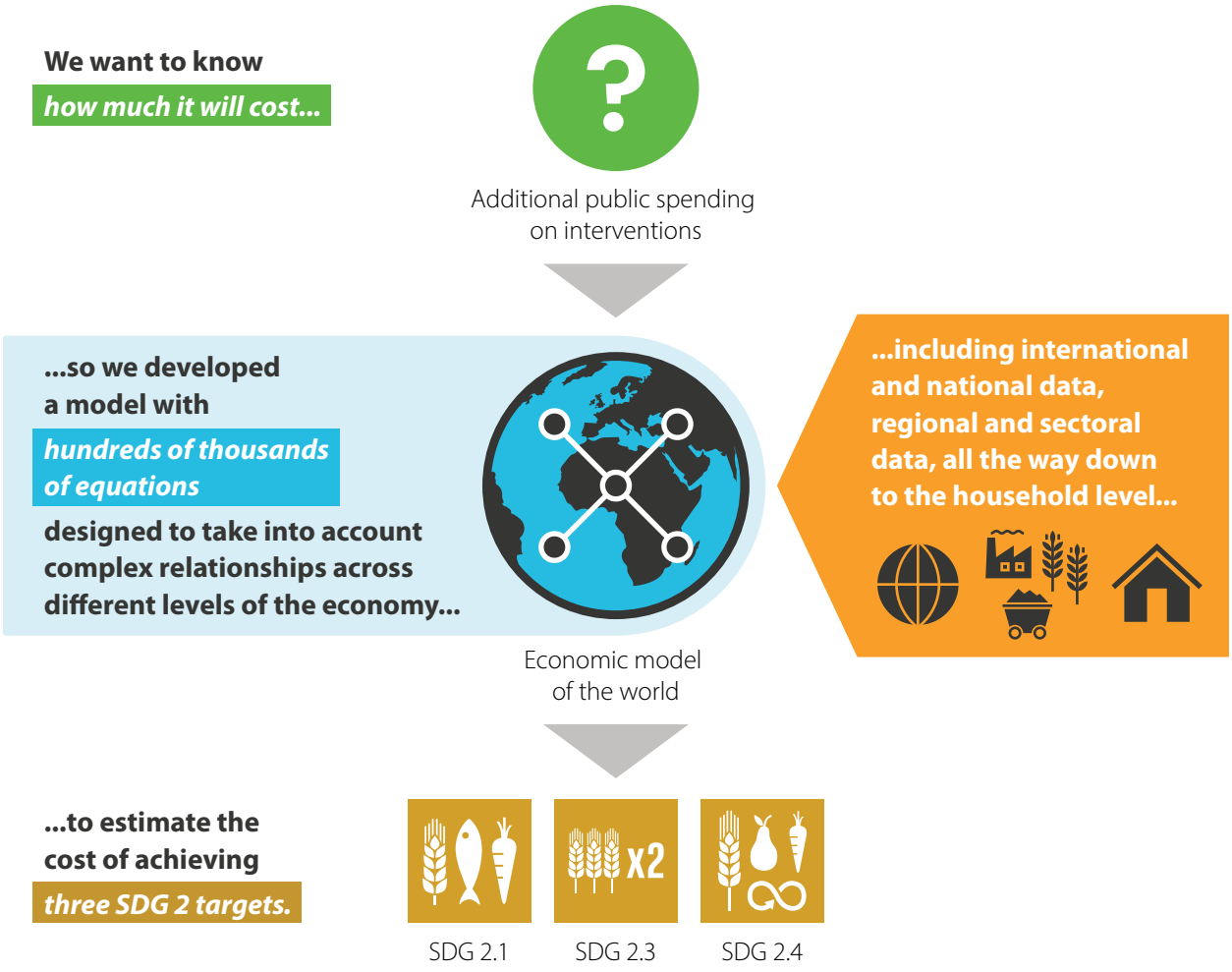
Biodiversity and preservation of associated traditional knowledge (Target 2.5) is also beyond the scope of the project. There is a dearth of data about biodiversity, and it remains an important area in which to develop quantification techniques that can be integrated into a model. Nevertheless, by limiting greenhouse gas emissions for agriculture, there is a reduction in land use changes due to agriculture, which should have a positive impact on biodiversity.

The model is a system of hundreds of thousands of equations designed to take into account complex relationships across different levels of the economy. It includes data from the international level all the way down to the household level, allowing for simulation of targeted public investment (see Figure 7). It captures household characteristics,[6] regional and sectoral interactions, including prices and quantities of goods, services, and factors of production, and interactions among countries, considering positive spillovers through increased income and demand as well as competitive effects through international trade. Earlier work using the model had found that governments are not on track to end hunger by 2030, but that the goal could be achieved if governments invested additional resources, prioritized countries with the highest need, and used a better mix of the most effective interventions (Laborde et al., 2016).

[6] Consumption and production data for households originated from the World Bank's Living Standards Measurement Study, but additional sources are used to increase the country coverage (for example for China). In addition, the calorie consumption pattern is reconciled with the FAO Prevalence of Undernourishment data.

Our computable general equilibrium model inputted data from the global to the household level, simulating markets with hundreds of thousands of equations

FIGURE 7. A COMPLEX MODEL TO END HUNGER, INCREASE INCOMES, AND PROTECT THE CLIMATE



Source: Authors' diagram.

Traditionally, equilibrium models are used to quantify the impact of a shock from a policy or package of policies, such as a reduction of tariffs linked to a new trade agreement or the introduction of a biofuels target for a renewable energy policy. The impact is quantified in respect to a business-as-usual world where the policy shock does not exist, referred to as the baseline. For example, applying the shock of a doubling of corn tariffs, a model can show how other variables in the model, such as farm income, will be affected by this change versus baseline conditions. Equilibrium models can show the full effect of a policy shock as it is transmitted through all the elements of the economic system that are presented in the model (Laborde et al., 2019).

In contrast to traditional equilibrium modelling, the approach used in Ceres2030 simulates a series of targets (the targets set out in SDGs 2.1, 2.3, and 2.4). The model minimizes the total public costs of achieving the targets by optimally allocating financial resources among the portfolio of 14 policy instruments. Resources are targeted through the instruments to households where they are most needed, but the model intentionally does not assume perfect targeting. For example, a food subsidy program is allocated based on income status, not hunger status, since the latter is not as easily observable. Each country has its own profile in the baseline of the model, so the balance of the portfolio of instruments and the trajectory of progress toward the targets are country specific.

Each of the 14 policy instruments has a cost, paid either by the public or private sector, and a direct impact, such as an increase in labour productivity, that will contribute to at least one of the three final outcomes—more calories available per household, greater net incomes for small-scale producer households, and limited greenhouse gas emissions. For example, the research and development spending on the Consultative Group on International Agricultural Research [CGIAR] is a fixed cost paid by the public sector for research services that increase agricultural productivity over time, with larger productivity benefits for low- and middle-income countries. Fertilizer subsidies, another instrument, are paid by the public sector for each unit of fertilizer, reducing the cost paid by the farmers receiving it on a recurrent basis. The parameters used for modelling instruments are based on existing data sources and a number of new parameters from the collection of evidence syntheses published in Nature Research (See Appendix 1 for a full list of policy instruments). Because the model accounts for a complex web of economic relationships, it captures not only the direct effect but also indirect and interactive effects of the interventions.

The portfolio of interventions relies on the interdependence of many kinds of capital: human, social, financial, and knowledge. While the evidence shows a significant lack of detailed information on complex outcomes, especially those involving such capital (Bizikova et al., 2020; Liverpool-Tasie, 2020; Stathers et al., 2020), the modelling approach captures some of the interlinkages between access to different forms of capital at the household level and its impact on the broader economy.

THE BASELINE AND THE SCENARIOS

The cost is calculated by comparing the baseline, in this case representing a business-as-usual trajectory of the world where existing spending patterns are maintained, to a scenario where the three targets of SDG 2 are reached. The core assumptions in the business-as-usual trajectory were based on: demographic growth,[7] yield projections, including climate change effects,[8] and economic growth.[9]

[7] Based on the medium scenario of the Population Division of the United Nation Department of Economic and Social Affairs.

[8] Based on FAO (2018).

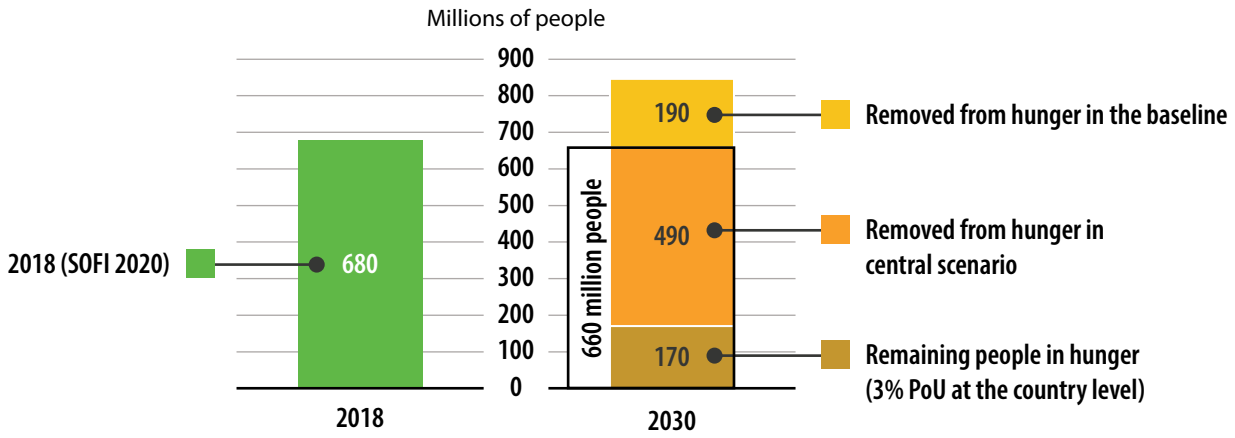
[9] Based on the mid-term macroeconomic projections of the IMF World Economic Outlook (October 2019, i.e., pre-COVID-19). The macroeconomic impact of the COVID-19 pandemic for the period 2020–2023 is included, based on Laborde & Smaller (2020), but we do not assume a long-term impact on productivity as a result of COVID-19.

Importantly, the climate targets as defined by the 2016 UNFCCC Paris Agreement were also included as a baseline assumption.

Combining these assumptions leads to a new baseline for the numbers of small-scale producers and people affected by hunger. In 2018, there were 680 million people affected by hunger (FAO et al., 2020). In the baseline used for our central estimate, taking into account current population and economic growth projections and constant donor contributions, we estimated that there would be 660 million people affected by hunger in 2030 (see Figure 8).

An additional USD 14 billion from donors and 19 billion from countries can prevent hunger for 490 million. If no additional effort is made, 660 million will still suffer in 2030

FIGURE 8. POPULATION AFFECTED BY HUNGER IN 2018 AND 2030



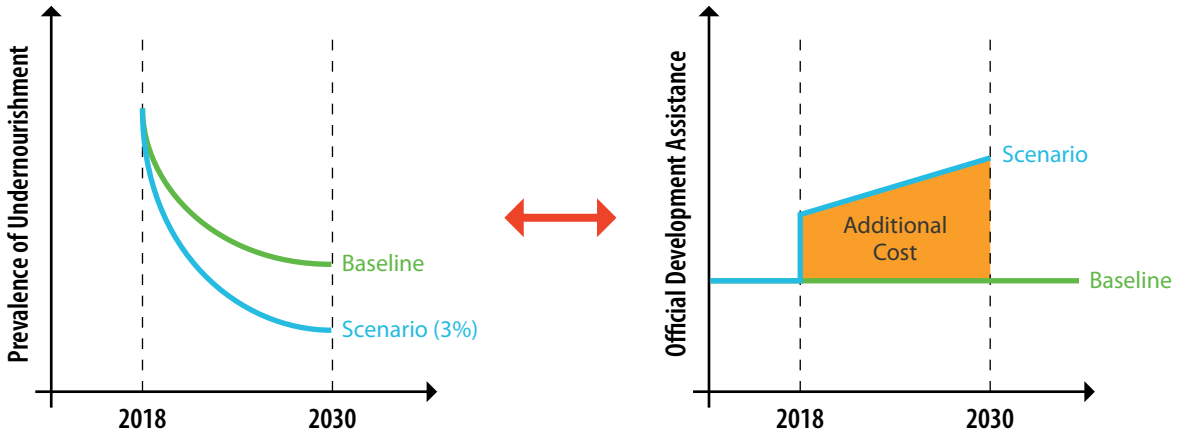
Source: Authors' calculation.

SDGs 2.1, 2.3, and 2.4 are each interpreted in the model as targets to be achieved, under some constraints. Corresponding to Target 2.1, the model simulates removal of households from the status of hunger, as defined by the FAO's Prevalence of Undernutrition (PoU). For Target 2.3, then net incomes of small-scale producers double on average between 2015 and 2030. For Target 2.4, greenhouse gas emissions for agriculture conform to the commitments made in the nationally determined contributions (NDCs) from the 2016 UNFCCC Paris Agreement. The NDCs are integrated into both the baseline and the scenario where SDG 2 is achieved. Each country has a carbon budget for its agriculture; land use emissions and production emissions from energy and fertilizer use are included in this budget. The model maintains the budget through a domestically determined carbon tax.

Figure 9 illustrates conceptually the relationship between achieving a target, Target 2.1 in this case, and estimating the additional donor spending required. The model calculates the donor spending in the baseline and the donor spending incurred in the scenario where the targets are achieved. The additional cost to donors is the difference between the two.

The additional cost to donors is the difference between the baseline and the scenario where the targets are achieved

FIGURE 9. FROM TARGET TO COST ESTIMATE



Source: Adapted from Laborde et al., 2019.

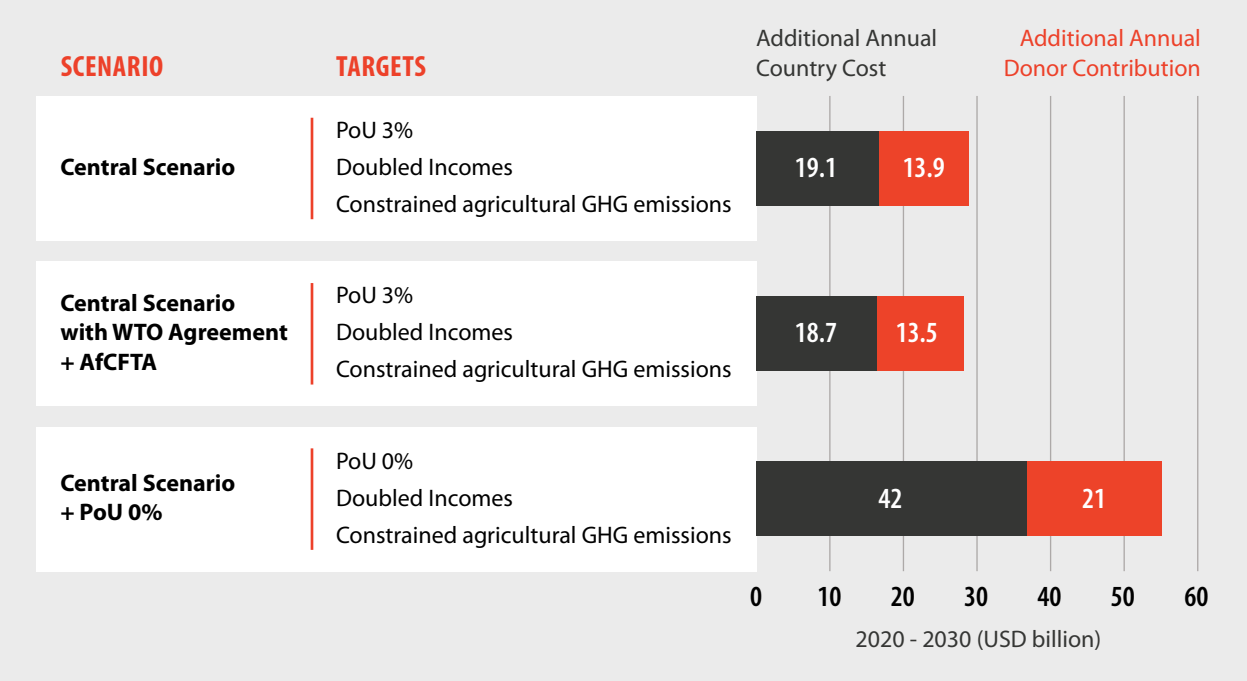
Figure 10 shows the additional public costs, including the donor contribution, using three scenarios. In the central scenario, the PoU is set so that hunger decreases to 3% or less in each country, net incomes of small-scale producers double on average, and greenhouse gas emissions conform to the NDCs.

The second scenario includes trade policy reform in the baseline assumptions and maintains the same targets as the central scenario. Specifically, it assumes that the negotiations at the World Trade Organization (WTO) to reduce domestic support and tariffs in the agricultural sector are concluded and that the African Continental Free Trade Area (AfCFTA) is implemented.

The third scenario reduces the PoU to 0% by 2030, in line with the principle of leaving no one behind. While this scenario is more coherent with SDG 2, it is not used in the central scenario for a few reasons. First, there is limited data on the population under the 3% PoU threshold, making it difficult both to measure the actual calorie deficit the affected households face and to identify a proper set of interventions to support this segment of the population. In this context, we assume that interventions needed for this segment of the population go beyond agricultural interventions and will be limited to safety nets with a fixed per capita payment determined at the country level.

Three scenarios to estimate the additional public cost to end hunger, double the incomes of small-scale producers, and ensure greenhouse gas emissions from agriculture conform to the Paris Agreement by 2030

FIGURE 10. ESTIMATING THE ADDITIONAL PUBLIC COSTS USING THREE SCENARIOS, INCLUDING THE DONOR CONTRIBUTION



CALCULATING THE DONOR CONTRIBUTION

In the model, we define the allocation between domestic and external resources based on an econometrically estimated co-funding rule that links the level of ODA contribution to a country's domestic public spending in relation to its income per capita. We found that the richer the country, the less it depends on external resources for its public spending. Full dependency on ODA occurs for countries with per capita income below USD 500. At the other end of the range, ODA is phased out from the model for countries that have per capita income of USD 15,000 or more. The model determines the total additional public expenditures required for each country annually and the split between the country and the donor (Laborde et al., 2016). The model assumes domestic taxation is used to make up the difference between the ODA contribution and total public funding needed. We have one exception to this rule: the spending on CGIAR R&D is paid in full by external donors.

BOX 2. ILLUSTRATING HETEROGENEITY THROUGH A FOCUS ON 11 COUNTRIES

In order to develop a global estimate, the model was applied at different levels and in different countries. The household-level analysis was conducted on 68 low- and middle-income countries. The detailed modelling across instruments and over time was done for 11 countries, mostly in Africa: Bangladesh, Ethiopia, Ghana, Guatemala, Malawi, Nigeria, Rwanda, Senegal, Tanzania, Uganda, and Zambia. A sub-regional aggregate (for example, Central Africa) was done for the remaining low- and middle-income countries. This means that the remaining countries have portfolios of interventions optimized at the sub-regional level instead of the country level. Population data, hunger levels, and economic growth projections remain country specific. The 11 countries were selected because of the levels of hunger, the availability and reliability of data, the diversity of socioeconomic and agricultural situations, and the relevance to donors. This sample gave us sufficient data to confidently extrapolate the cost of ending hunger and the donor contributions at a global scale.

The relative donor contribution varies greatly among the 11 countries. For example, Malawi is expected to still have a low per capita GDP in 2030; therefore, we calculate that the country will still depend on donors to cover 90% of its public budget. Nigeria, on the other hand, is expected to have a higher per capita GDP in 2030; as a result, we calculate that it will depend on donors for less than 10% of its public budget.

5. CONCLUSION

To achieve the global commitment to end hunger sustainably between now and 2030, donors need to double their current level of spending. That means an additional USD 14 billion per year is needed on top of current spending, which stands at USD 12 billion per year. Most of the additional resources need to be targeted to countries in Africa where there will be the highest concentration of hunger and the highest dependency on external resources in the next decade. But ODA will not be enough. Additional efforts of USD 19 billion per year on average will have to be committed by low- and middle-income countries. The additional public spending will prevent 490 million people from experiencing hunger and double the incomes of 545 million small-scale producers on average, while maintaining greenhouse gas emissions for agriculture below the commitments made in the Paris Agreement. Such an outcome would be truly historic.

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APPENDIX 1. LIST OF POLICY INSTRUMENTS MODELLED TO SIMULATE THE PORTFOLIO OF INTERVENTIONS

POLICY INSTRUMENTS	TARGETING / COVERAGE	STRUCTURAL EFFECTS	NATURE OF EXPENDITURE
		EMPOWER THE EXCLUDED	
Food subsidy	Food items for households with income below the poverty line (USD 1.95 purchasing power parity [PPP])	Food cost reduction per capita through an endogenous, homogenous subsidy rate at the household level	Cost of the public subsidies
Vocational training		Allows people to move between rural and urban employment more easily	Cost of the public subsidies
		ON THE FARM	
Investment subsidy	All agricultural sectors, all producers	*Ad volumen* subsidy to domestic investments	Cost of the public subsidies
Fertilizer subsidy	Crop sectors, all producers	*Ad valorem* subsidy on chemical inputs used by agricultural sectors and yield effects capturing changes in the production function	Cost of the public subsidies
Capital endowment	All agricultural sectors, only small-scale producers	Allocation of physical capital (e.g. machinery, livestock) given to targeted households	Investment goods bought by public expenditures
Production subsidy	All staple crop sectors, all producers	*Ad valorem* production subsidy applied to the farm gate price	Cost of the public subsidies
R&D National Agricultural Systems (NARS)	All agricultural sectors, all producers	Agricultural total factor productivity (TFP) is increased based on the stock evolution of NARS R&D	Additional NARS expenditures spent on public services
R&D CGIAR	All agricultural sectors, all producers	Agricultural TFP is increased based on the stock evolution of CGIAR R&D	Additional CGIAR expenditures spent on public services
Extension services	All agricultural sectors, small-scale producers	Efficiency of production factors, i.e. difference between physical and efficient units, for small-scale producers	Public services expenditures

POLICY INSTRUMENTS	TARGETING / COVERAGE	STRUCTURAL EFFECTS	NATURE OF EXPENDITURE
Rural Infrastructure (irrigation)	Crop sectors, all producers	Agricultural TFP is increased based on the growth of irrigated area	Aggregated capital goods for expenditures based on unit costs by type of investments
Livestock subsidy (agroforestry)	Dairy sector, small-scale producers	*Ad volumen* subsidy to year 1 fixed costs (extension and shrubs). Ad volumen reduction in GHG emissions.	Cost of the public subsidies
Livestock subsidy (improved forage)	Ruminant sector, small-scale producers	*Ad volumen* subsidy to year 1 fixed costs (extension, seed, and inputs)	Cost of the public subsidies
	FOOD ON THE MOVE		
Post-harvest losses (storage)	Crop sectors, small-scale producers	Efficiency of production factors for small-scale producers and reduction of an initial shadow tax on factors of production	Aggregated capital goods for expenditures based on unit costs by type of investment
Rural Infrastructure (roads)	All agricultural sectors, all producers	Agricultural TFP is increased based on the growth of road infrastructure	

APPENDIX 2. LIST OF COUNTRIES AND THEIR PRIORITY LEVEL

COUNTRY NAME	PRIORITY LEVEL
Afghanistan	Low Priority
Angola	Low Priority
Albania	On Target
Algeria	Low Priority
Andorra	On Target
Argentina	On Target
Armenia	On Target
Antigua and Barbuda	On Target
Azerbaijan	On Target
Burundi	High Priority
Benin	Low Priority
Burkina Faso	Medium Priority
Bangladesh	Low Priority
Bahamas	On Target
Bosnia and Herzegovina	On Target
Belarus	On Target
Belize	Low Priority
Bermuda	On Target
Bolivia	Low Priority
Brazil	Low Priority
Barbados	On Target
Bhutan	On Target

COUNTRY NAME	PRIORITY LEVEL
Botswana	Low Priority
Cabo Verde	Medium Priority
Central African Republic	High Priority
Chile	On Target
China	On Target
Cote d'Ivoire	Medium Priority
Cambodia	Low Priority
Cameroon	Low Priority
Chad	High Priority
Congo	Medium Priority
Colombia	Low Priority
Comoros	Medium Priority
Costa Rica	On Target
Cuba	On Target
Democratic Republic of Congo	High Priority
Djibouti	On Target
Dominica	Low Priority
Dominican Republic	Low Priority
Ecuador	Low Priority
Egypt	Low Priority
Eswatini	Medium Priority

COUNTRY NAME	PRIORITY LEVEL
Ethiopia	Medium Priority
Fiji	On Target
Gabon	Low Priority
Georgia	On Target
Ghana	Low Priority
Gibraltar	On Target
Guinea	Medium Priority
Gambia	Medium Priority
Guinea-Bissau	High Priority
Equatorial Guinea	On Target
Guatemala	Low Priority
Guyana	Low Priority
Honduras	Low Priority
Haiti	High Priority
Indonesia	Low Priority
India	Low Priority
Iran	Low Priority
Iraq	Low Priority
Jamaica	Low Priority
Jordan	Low Priority
Kazakhstan	On Target
Kenya	Medium Priority
Kyrgyz Republic	On Target

COUNTRY NAME	PRIORITY LEVEL
Kiribati	On Target
St. Kitts and Nevis	On Target
Lao PDR	On Target
Lebanon	Low Priority
Liberia	High Priority
Libya	Not included in assessment
St. Lucia	On Target
Sri Lanka	Low Priority
Lesotho	High Priority
Morocco	Low Priority
Moldova	Low Priority
Madagascar	High Priority
Maldives	On Target
Mexico	Low Priority
Mali	Low Priority
Myanmar	Low Priority
Mongolia	Low Priority
Mozambique	High Priority
Mauritania	Medium Priority
Mauritius	Low Priority
Malawi	Medium Priority
Malaysia	On Target
Namibia	Low Priority

COUNTRY NAME	PRIORITY LEVEL
Niger	Medium Priority
Nigeria	Medium Priority
Nicaragua	Medium Priority
Nepal	On Target
Nauru	On Target
Oman	On Target
Pakistan	Low Priority
Panama	On Target
Peru	Low Priority
Philippines	Low Priority
Palau	On Target
Papua New Guinea	Low Priority
Puerto Rico	On Target
Paraguay	Low Priority
West Bank and Gaza	On Target
Rwanda	Medium Priority
Sudan	Medium Priority
Senegal	Low Priority
Solomon Islands	Low Priority
Sierra Leone	Medium Priority
El Salvador	Low Priority
San Marino	On Target
Sao Tome and Principe	Low Priority

COUNTRY NAME	PRIORITY LEVEL
Serbia	On Target
Somalia	High Priority
South Sudan	High Priority
Seychelles	On Target
St. Vincent and the Grenadines	Low Priority
Suriname	Low Priority
Syrian Arab Republic	Not included in assessment
Turks and Caicos Islands	On Target
Togo	Medium Priority
Thailand	Low Priority
Tajikistan	On Target
Turkmenistan	On Target
Timor-Leste	Low Priority
Tonga	On Target
Trinidad and Tobago	On Target
Tunisia	Low Priority
Turkey	On Target
Tuvalu	On Target
Tanzania	Medium Priority
Uganda	Medium Priority
Uruguay	On Target
Uzbekistan	On Target

COUNTRY NAME	PRIORITY LEVEL
Venezuela	Medium Priority
Vietnam	On Target
Vanuatu	Low Priority
Samoa	On Target
Yemen	High Priority
South Africa	Low Priority
Zambia	High Priority
Zimbabwe	High Priority

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Ceres2030
Sustainable Solutions to End Hunger

ABOUT CERES2030

Ceres2030 brings together three institutions that share a common vision: a world without hunger, where small-scale producers enjoy greater agricultural incomes and productivity, in a way that supports sustainable food systems. Our mission is to provide the donor community with a menu of policy options for directing their investments, backed by the best available evidence and economic models.

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