Ceres2030
Sustainable Solutions to End Hunger

COMMENTARY

Ending Hunger Sustainably: Biodiversity

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Ceres 2030 brings together the International Institute for Sustainable Development (IISD), Cornell University, and the International Food Policy Research Institute (IFPRI) to answer two linked questions: (i) What will it cost governments to end hunger as defined by Sustainable Development Goal (SDG) 2? And, (ii), What are the most effective public investments to end hunger sustainably based on the available evidence? Ceres2030 is a three-year project that will conclude early in 2021. SDG 2 is the second of 17 SDGs that together comprise the UN's 2030 Agenda for Sustainable Development (UN General Assembly, 2015). SDG 2 is a commitment to end hunger sustainably, with sub-goals focused on ending hunger, improving nutrition, increasing small-scale producers' income, and reducing the environmental footprint of agriculture.

The project combines a state-of-the-art economic model that costs the interventions needed to end hunger with a machine-learning enhanced approach to systematic evidence syntheses that assess the effectiveness of agricultural policy interventions. The evidence syntheses are designed to support decision-makers in making better use of available evidence when they choose interventions to invest in to advance sustainable food systems and end hunger. The project is focused on SDG 2.1, the commitment to end hunger, SDG 2.3 on doubling the productivity and income of small-scale food producers, and SDG 2.4 on ensuring agricultural sustainability and resilience.

This paper is about biological diversity and agriculture. It is one of a series of papers written by the Ceres2030 project team on issues that are critical to the project's overall ambition but that are complex and not easy to do justice to with the tools the project relies upon—namely, an economic cost model and syntheses of available published evidence on the effectiveness of agricultural interventions. For the economic cost model, there is a dearth of data about biodiversity, making the issue difficult to incorporate. On the evidence synthesis side, the published literature tends to highlight knowledge gaps mostly focused on small-scale producers' livelihoods and well-being. Biodiversity, as with many environmental dimensions of food systems, is not yet a well-integrated dimension in interventions to end hunger and raise agricultural productivity.

WHAT IS THE ISSUE?

Biodiversity is defined as "the variability among living organisms and the ecological complexes of which they are part, including diversity within species (genetic diversity), between species, and of ecosystems" (Secretariat of the Convention on Biological Diversity [CBD], 2008, p. 10). Agricultural biodiversity, more particularly, "includes all components of biodiversity—at genetic, species, and ecosystem levels—that are relevant to food and agriculture and that support the ecosystems in which agriculture occurs (agroecosystems)" (CBD, 2008, p. 10).

SDG 2 has a sub-goal (SDG 2.5) focused on biodiversity, which commits governments to a goal for 2020: "By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed" (UN General Assembly, 2015). Other SDGs with a biodiversity focus include SDG 14, which is about life below water, and SDG 15, about life on land. Biodiversity and healthy ecosystems are essential to support society and its economic activities, such as agriculture, forestry, fisheries, and tourism.

Agriculture, forestry, infrastructure development, urban encroachment, and climate change are all major drivers of biodiversity loss. Between 2010 and 2050, the fastest-growing drivers of biodiversity loss on land are predicted to be climate change, crop production, and infrastructure development (Montanarella et al., 2018). Land-use change and the habitat loss caused by human activities, including agriculture, typically lead to a reduction in biodiversity. Other adverse effects include changes in water runoff, higher greenhouse gas (GHG) emissions, and soil and ecosystem degradation (Foley et al., 2005; CBD, 2008).

Agricultural modernization is associated with an increase in mechanization and the use of agrochemicals (such as fertilizers, pesticides, and herbicides). These technologies have raised the productivity of agricultural sectors but at the expense of soil and water quality, the overall health of ecosystems, and biological diversity (Woodhouse, 2010). Threats to genetic diversity are associated with the continuing use of unsustainable approaches that drive excessive use of fertilizers and pesticides, pollution of aquifers and waterways, declining levels of groundwater, and mismanagement of soils (FAO, 2011).

The challenge is how to protect biodiversity while simultaneously producing enough food. Biodiversity is necessary to many of the ecosystem functions that are critical to agricultural production, such as pollination, soil fertility, water quality, and agricultural genetic diversity (CBD, 2008). At least one-third of the world's agricultural crops depend upon pollinators (Aizen et al., 2009; CBD, 2018; University of California, 2006). Genetic diversity in agriculture protects species' capacity to evolve as environmental conditions change and increases species' resistance to diseases, pests, and parasites (CBD, 2008; FAO, 2015). Genetic diversity also increases the range of available foods that provide nutritional benefits (Millennium Ecosystem Assessment [MEA], 2005).

Biodiversity and ecosystem services contribute directly to household food security and nutrition, too. Many small-scale producers and their communities rely on both cultivated and uncultivated foods for their food security, found in forests, grasslands, oceans, or rivers (CBD et al., 2019). Their knowledge of biodiversity, as well as the rich body of traditional knowledge of their ecosystems maintained by Indigenous communities, can make a significant contribution to the conservation and sustainable use of plant species and animal breeds (CBD, 2008, 2019).

The linkages between agriculture, food security, nutrition, biodiversity, and ecosystem services are summarized in the Aichi Biodiversity Targets, agreed under the UN Convention on Biological Diversity for the period 2011–2020 (CBD, 2020). There are 20 Aichi targets, grouped under five strategic goals. Among these targets, Target 7 on sustainable agriculture, aquaculture, and forestry includes indicators relevant to SDG 2, such as (CBD, n.d.):

- Trends in area of forest, agricultural, and aquaculture ecosystems under sustainable management
- Trends in population of forest and agriculture dependent species in production systems
- Trends in production per input
- Trends in proportion of products derived from sustainable sources.

Other relevant Aichi targets for SDG 2 include Target 6 on sustainable management of aquatic living resources and Target 13 on safeguarding genetic diversity.

THE IMPORTANCE OF BIODIVERSITY TO ENDING HUNGER SUSTAINABLY

To achieve the SDG 2 targets, governments must protect biodiversity and natural ecosystems. Box 1 illustrates the specific relationships among agriculture, natural ecosystems, and biodiversity, and proposes some interventions for the SDG targets.

BOX 1. INTEGRATION OF BIODIVERSITY INTO SDG TARGETS IN THE CONTEXT OF CERES2030 FOCUS AREAS

The cost model's three targets come from three SDG 2 sub-goals

SDG 2.1 End Hunger

Target 1
Reduce Hunger to 5%
Reduce the prevalence of undernourishment to 5% or less in every country

SDG 2.3 Smallholder productivity

Target 2
Double Small-Scale Producers' Incomes
Double the average net income of small-scale agricultural producers

SDG 2.4 Sustainability

Target 3
Respect Environmental Boundaries
While the model considers the different dimensions of sustainability, it defines environmental targets such as greenhouse gas emissions in line with the Paris Agreement

EXAMPLES OF BIODIVERSITY ISSUES AND CHALLENGES

- Many people depend on food gathered from natural ecosystems, such as forests, grasslands, oceans, and rivers.
- For Indigenous communities, wildlife hunting can represent the primary source of animal protein.

- Small-scale farmers' productivity strongly depends on the quality of natural resources (including biodiversity) as they have limited access to agricultural inputs.
- Small-scale farmers can play a critical role in safeguarding biodiversity, natural resources, and agricultural crop and livestock diversity.

- The depletion of common property natural resources poses a severe threat to the livelihoods and food security of poor rural populations, especially women and children.
- Degradation of natural resources can result in increased conflicts and migration.

EXAMPLES OF INTERVENTIONS TO SAFEGUARD BIODIVERSITY

- Creation of targeted food security, nutrition, and health care programs to complement agricultural interventions and natural resource management.
- Market regulations that discourage consumption of species of high biodiversity value and unhealthy foods, while promoting the availability and consumption of healthy foods.
- Inclusion of information on food security and nutrition in biodiversity and natural resource management plans and policies.

- Low-input and ecosystem-based approaches to agriculture are highly relevant in promoting the conservation and sustainable use of biodiversity.
- Programs to encourage farmers' participation in practices that protect biodiversity through creating habitats and reducing their water use, especially in times of droughts and other environmental challenges.
- Policies that are sensitive to the needs of small-scale producers, such as land rights and support for environmentally focused landscape-level management.
- Traditional knowledge and practices by Indigenous and local communities can make a significant contribution to the conservation and sustainable use of plant species and animal breeds.

- Diversity of grown crops/livestock/fish has been managed or influenced by farmers, livestock keepers and pastoralists, and fishers for generations. This diversity increases the resilience of farmers to climate change and other shocks, as well as providing additional nutritional benefits.
- Sustainable agricultural practices provide opportunities to meet growing food demand while reducing negative impacts on natural resources, including biodiversity.

Sources: CBD, 2008, 2019; Montanarella et al., 2018; MEA, 2005; United Nations Convention to Combat Desertification (UNCCD), 2017.

HOW IS BIODIVERSITY INTEGRATED IN CERES2030?

Ceres2030 uses a dynamic computable general equilibrium model that is both multi-country and multi-sector. It simulates the operation and interactions of national and international markets, considering production, demand, and prices. The model integrates this economic simulation with an analysis of biophysical and socioeconomic trends. It also integrates the central economic factors that affect agriculture, thereby providing a robust quantitative framework for estimating the costs of agricultural policy interventions. In addition, it tracks household-level consumption, the production of major food items, and other sources of income.

The economic model used in Ceres2030 includes parameters that count the environmental impact of interventions to end hunger, including on GHG emissions, and the effect of interventions on water quantity and quality. The model also accounts for the changes in land use implied by the interventions proposed in the scenarios it runs. This indicator shows if the implementation of the proposed interventions to achieve SDG 2 will require an increase in the area of land in production, or if, instead, the land in production stays constant or even decreases with the intervention. In this way, the model outcomes will address one of the indicators of Aichi Target 7 on sustainable agriculture, aquaculture, and forestry. Land-use change and habitat losses represent the extent to which biodiversity can be accounted for in the model at this time.

The evidence syntheses provide some additional information about the linkages between biodiversity and agricultural interventions. Specifically, three of the project's evidence synthesis papers (all to be published in *Nature Research Journals* in October 2020) included biodiversity: the synthesis of evidence on incentive schemes to promote sustainable agricultural practices (Piñeiro et al., 2020); the synthesis of evidence on the role of farmers' organizations (Bizikova et al., 2020); and the synthesis of evidence on drought-prone land and small-scale food producers (Ricciardi et al., 2020). Biodiversity was captured in approximately 7% of the papers reviewed for the synthesis looking at water scarcity and 16% of the papers on the strategies used by farmers' organizations. The authors of those two synthesis pieces found the research often covered biodiversity in the context of other environmental impacts of agricultural interventions, such as GHG emissions, water quality and quantity changes, and land conversion and degradation, rather than as a subject in its own right. The authors of the synthesis of evidence on incentives for sustainable agricultural practices provide recommendations on how measures such as payments for ecosystem services can improve biodiversity and other environmental outcomes in agriculture. That paper also reports that the availability of technical support or other complementary practices can boost the adoption of agricultural practices that promote biodiversity protection (Piñeiro et al., 2020). However, the authors found that the scant data in the studies they reviewed rarely allowed proper measurement of the participation costs of agriculture incentive programs.

Biodiversity and ecosystem services are critical to enabling long-term agricultural production. It is important that decision-makers work with researchers to develop policies and monitoring to improve the contributions of interventions to achieve SDG 2. This may include additional evidence syntheses, such as reviews of biodiversity-centred interventions, policies that target agricultural biodiversity, and evaluations of past programs intended to protect biodiversity. These analyses may also uncover where and how specific agricultural practices make a significant contribution to biodiversity that can be captured in outcomes at the national and global levels.

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ABOUT CERES2030

Ceres2030 brings together three institutions who 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.

The partnership brings together Cornell University, the International Food Policy Research Institute (IFPRI) and the International Institute for Sustainable Development (IISD). Funding support comes from Germany's Federal Ministry of Economic Cooperation and Development (BMZ) and the Bill & Melinda Gates Foundation (BMGF).

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