Achieving global biodiversity targets requires shifting food and land use system trajectories

FABLE position paper
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Key messages:

- Utilizing integrated assessment tools, **the Food, Agriculture, Biodiversity, Land-use and Energy (FABLE) Consortium identifies potential trade-offs between food, biodiversity, climate, and socio-economic factors** as well as promising national pathways to achieving multiple goals in tandem.

- Results from FABLE show that **achieving at least three targets (1, 3, 10) in the Kunming-Montreal Global Biodiversity Framework (GBF) depends strongly on how food systems are managed** between now and 2050.

- Implementation of ambitious **changes in demand for agricultural commodities (including dietary shifts), closing yield gaps and replacing unproductive crops, wider use of agroecological practices, and widespread restoration and protectio**n, would bring the world closer to achieving global biodiversity conservation and climate mitigation targets by 2050, without compromising food and nutritional security.

- The most effective ways to implement levers of change **depend on country contexts and local conditions.**

- We call on Parties to the Convention on Biological Diversity (CBD) to **co-develop, through inter-agency dialogue and cooperation informed by research, integrated roadmap**s that simultaneously address the food and land use system drivers of biodiversity loss, malnutrition, and climate change.

- We urge Parties and international donors to **provide greater support for applied research on complex food and biodiversity challenges employing inter- and trans-disciplinary methods** that respond to policy challenges and equitably integrate local concerns, preferences, and needs**.**

The challenge: Food systems are both drivers and victims of biodiversity loss and climate change

Food and agricultural systems are significant contributors to biodiversity loss[1] and responsible for one-third of global greenhouse gas (GHG) emissions[2]. At the same time, biodiversity loss and climate change are eroding the resilience of food systems [3,4], thereby undermining their capacity to sustainably provide fair incomes to farmers and nutritious food to people **wordwide**[5,6]. The interconnectivity of food, biodiversity and climate represents a triple challenge to achieving the targets set out by the Global Biodiversity Framework (GBF), the Sustainable Development Goals (SDGs), and the UN Framework Convention on Climate Change.

Major drivers of biodiversity loss include agricultural expansion, intensification of food production, and simplification of agricultural landscapes through habitat loss and widespread use of monocultures[7,8], underpinned by food consumption and production patterns. Expansion of agriculture into natural lands reduces wild plant diversity and habitat availability to animals[9,10]. Intensification of agricultural land to increase yields, where this involves the application of toxic pesticides, the misuse and overuse of fertilizers[11], or unsustainable water extractions[12], degrades soils and waterways, killing life[13,14]. Simplification of agricultural fields, farms, and landscapes results in the direct loss of domesticated species, and loss of plants, insects, animals and birds at all spatial levels[15-19], undermining production system resilience to pests and diseases, climate change, and market shocks. Achieving the GBF targets depends on reversing these negative impacts on biodiversity. This will require shifting current trajectories of food and land use systems towards a more hopeful future for people and nature.

Solutions emerging from 22 countries

The FABLE consortium[20] mobilizes institutions and stakeholders to develop national food and land use pathways and model their impacts on progress towards national and global targets[21]. Pathway development in 2023 by 22 countries, accounting for 60% of global terrestrial land area, combined with regional pathways developed for the remaining countries in the six world regions,[i] [22] shows that, globally, **we will fail to achieve GBF Targets 1, 3 and 10 under current food and land use system trajectories**. Significant progress can be made on all three targets through ambitious changes in demand for agricultural commodities, increases in crop and livestock productivity, increased adoption of agroecological practices, and widespread land restoration and protection (Table 1).

Table 1: Global impacts on biodiversity of food and land use trajectories following Current Trends and Global Sustainability pathways.

FABLE global biodiversity target	Relevant GBF Target	Current Trends	Global Sustainability
No loss of land where natural processes predominate from 2030	Target 1	-97Mha	-35Mha
15% gain in land where natural processes predominate[ii] between 2020 and 2050	Target1	-1.6%	11.2%
No loss of mature forest from 2030	Target 1	-100Mha	-0.32Mha
Protected areas (including OECMs) cover 30% of total land in 2030	Target 3	21.1%	24.6%
50% of cropland under agroecological practices in 2030	Target 10	38.6%	43.3%

[i] National pathways were designed by researchers in the 22 countries based on their assessment of trends, policies and feasible futures, while regional pathways were designed by researchers in the FABLE secretariat, who support the FABLE network. Local policy stakeholders were consulted in 8 countries, and a public, online consultation was used to gather feedback on the assumptions for all countries and regions.

[ii] Land where natural processes predominate (LNPP) is used in FABLE to describe land areas where there is low human disturbance and/or ecologically relatively intact vegetation[23].

These results are based on modelling Current Trends and Global Sustainability pathways for food and land use systems to 2050. While **Current Trends** represents a continuation of historical trends and existing policies, the **Global Sustainability** pathway represents ambitious, feasible actions that could be taken to align national and regional pathways with global sustainability targets. The results demonstrate that **three major transitions within food and land use systems are essential** to progress on achieving global biodiversity targets:

1. Shifting diets and reducing food loss and waste. Different crops and livestock require different land areas to provide the same quantity of kilocalories and micronutrients. Consequently, human diet, livestock feed, and biofuel choices have a significant impact on the amount of land that is used for agricultural production. Currently about 50% of the world's kilocalories are used for human food, 16% for feed, and 23% for biofuel and other non-food uses, while food loss and waste accounts for the remaining 14%. Shifting diets is therefore a major lever for reducing the land area required for agricultural production.

Dietary changes that are required and feasible to provide the human population with adequate nutrition while making progress towards global biodiversity targets **vary significantly across countries**[23-26]. FABLE modelling results show that under the Global Sustainability pathway, there is a necessity for a reduction in per capita calorie consumption in countries that currently exhibit high levels. This reduction must encompass a considerable decrease in consumption of animal products, saturated fats and sugar. Conversely, increases in food consumption are necessary in countries with a currently low per capita food intake. Increased consumption of vegetables, legumes, fruits, and nuts are needed in almost all countries. The Global Sustainability pathway implies a reduction in post-harvest food loss and waste of 1.8% per year between 2020 and 2050, with the largest share of reductions occurring in Australia, Canada, China, Finland, Norway, UK, the USA, and the Rest of the European Union region.

2. Increasing crop and livestock productivity. Increases in agricultural land productivity will be essential to ensure production keeps up with future demand while avoiding the expansion of agricultural land. Under the Global Sustainability pathway, results depend on a **global average increase of 18% in cropland productivity and 35% in livestock productivity**[iii], by 2050 compared to 2020. Much of this productivity increase needs to happen in the next decade for productivity to grow at the same rate as food demand[27]. These gains will require **closing yield gaps** for commodities and regions with low productivity, such as for rainfed cereal crops in sub-Saharan Africa, and **replacing unproductive or nutrient-poor crops** with nutritious species that are better adapted to the local context, soils, and climate. Currently neglected and under-utilized varieties will be vital to enable the transition to more nutritious and productive alternative crops[28]. This highlights the importance of GBF Target 4, concerning the restoration of genetic diversity including within domesticated species. Additional efforts are needed to rapidly collate and disseminate information on the nutritional, ecological, and agronomical properties of all edible plants, thereby enabling farmers to identify suitable alternatives[29,30]. Citizen science tools, such as Tricot, represent a bottom-up, easily scalable option for this purpose[31].

Nutrient and water inputs will be needed to close yield gaps on nutrient- and water-limited land but need to be applied with care to avoid long-term soil degradation, nitrogen and phosphorus pollution[11], unsustainable water withdrawals[12], increasing inequality among farmers through uneven access to quality inputs,[32] or creating poverty traps by creating farmer dependency on costly external inputs[33]. **Agroecological approaches may provide a means for achieving productivity gains without compromising social and environmental outcomes**[34,35] by restoring ecological functioning (e.g., through soil inoculants, agroforestry, flower strips, cover crops, cultivar mixtures), whole-farm circularity (e.g., crop-livestock integration, farm-generated energy sources), and increasing farmer and consumer agency (e.g., long-term procurement contracts, regulations to ensure full product traceability)[36]. Agroecology is already embedded in GBF Target 10. Our results indicate that the share of cropland under agroecological practices (which included organic farming, cultivar mixtures, cover crops,

[iii] Productivity is expressed in kilocalorie production per hectare of land. For ruminant livestock it is the outcome of the evolution of the number of animals per ha and the productivity by animal.

embedded natural habitat such as flower strips, or a mixture of diversified farming practices) **increased from 37% to 43% by 2030 under the Global Sustainability pathway, without compromising global food security.** However, agroecological practices can lead to productivity reductions or maintain existing yield gaps, particularly for rainfed cereal crops, which are constrained primarily by nutrient inputs. These productivity reductions could drive undesirable agricultural land expansion. Therefore, the requirement for productivity increases on agricultural land needs supporting by action research and investment to identify how to achieve high productivity through agroecological measures, building on existing evidence[17,37-39].

3. Land restoration and protection. Land where natural processes predominate (LNPP), where biodiversity can thrive relatively undisturbed by humans, is being lost around the world every day, with agricultural land expansion a key driver[23]. Losses have slowed in the Global North, where agricultural land area is shrinking due to productivity increases and dependency on imports, allowing more land to be restored to natural uses. In the Global South, agricultural expansion continues including into biodiversity-rich areas, often driven by international trade[40]. The Global Sustainability pathway shows that, globally, agricultural land expansion continues to 2050 but declines, with almost no loss of mature forest over the period (although non-forest natural land continues to be lost), and 62 Mha less LNPP area is lost compared to the Current Trends pathway. Abandonment of agricultural land (particularly in Argentina, Australia, Brazil, Denmark, Germany, Mexico, Norway, Russia, USA, and the North Africa and Middle East region) allows LNPP to increase by 11% between 2020 and 2050, assuming this land is restored to biodiversity-rich status with native flora and fauna.

Yet, even under the Global Sustainability pathway, agricultural land expansion will drive the loss of vast biodiversity-rich areas (35 Mha LNPP), and this almost triples under Current Trends (97 Mha) removing hope of achieving GBF Target 1. Expanding protected areas and Other Effective Conservation Management (OECMs) zones to cover the remaining LNPP will help safeguard these spaces. **Agricultural expansion should be avoided in these zones**, while existing agricultural and other human uses of land in protected areas and OECMs should be managed in ways that conserve on and off-farm biodiversity[41], through plans that are **co-designed with local and indigenous groups and that respect and respond to their knowledge and needs**[42-44]. Currently only 20% of the world's LNPP is inside designated Protected Areas with a highly uneven coverage across the world's biomes and ecoregions[23]. Under the Global Sustainability pathway, global coverage of protected areas and OECMs increases from 21% to 24% (driven by Australia, Sweden, and the rest of Central and South America, Asia and Pacific, and Europe non-EU regions) getting closer to the 30% target (GBF Target 3). **Regulations and incentives to speed up restoration** of abandoned agricultural land (in line with GBF Target 2) would increase connectivity across landscapes helping species to find suitable habitat and reach LNPP and protected areas in which they can thrive.

Operationalizing sustainable food and land use system pathways

The Global Sustainability pathway offers benefits beyond making progress towards global biodiversity targets. By 2050, it increases the number of countries with sufficient food to enable all people to meet their minimum dietary energy requirements, reduces greenhouse gas emissions from agriculture to below 5 Gt CO2eq, and reduces agricultural nitrogen, phosphorus and water use, helping meet global food security (SDG2), climate (SDG13; Paris Agreement), pollution (SDG6, 14, 15) and land degradation neutrality targets[27]. This points to the **urgent need for coordination across health, agricultural, biodiversity, climate, and development agencies**, to develop a common vision for sustainable food and land use futures and aligned cross-sector policies to achieve it. **Reimagining feasible policy interventions** will be important; while the Global Sustainability pathway accelerates progress towards many global targets, no biodiversity targets are fully achieved indicating the need for even greater ambition or different approaches.

We call on Parties of the CBD to:

1. Develop a national roadmap setting out a time-bound plan for achieving the sustainable food and land use system transition that will enable progress towards national and global biodiversity, food, climate and development targets. These roadmaps should be operationalized through NBSAPs, Nationally Determined Contributions (NDCs), Land Degradation Neutrality (LDN) action plans, and national and local development plans. The roadmaps should be developed in collaboration with diverse stakeholders along the entire value chain and respond sensitively to their concerns, in particular, farmers, Indigenous Peoples, and rural communities. Development of an integrated roadmap will be greatly facilitated by using modelling tools, like the FABLE Calculator, that can identify synergies and trade-offs and explore the effects of a range of policy levers that can be used to make progress towards multiple long-term objectives[45]. It will be important to convert national roadmaps to spatially explicit plans, co-developed with local people from multiple sectors, to iteratively improve land use and management proposals (e.g. see [46,47]). These plans will help ensure progress towards several biodiversity targets sensitive to place-based characteristics (e.g., Target 2 on degradation) and land use configurations (e.g., Target 1 on inclusive planning).

2. Mobilise a government inter-agency coordination taskforce to review and align food and land use system targets across NBSAPs, NDC, LDN, and national and local development plans, foster dialogue to equitably reconcile conflicting priorities, and organize cross-sector policies, actions, and monitoring efforts. Such an agency could take charge of centralizing cross-sector datasets to provide faster insights into how to resolve trade-offs among sectors in sites with overlapping priorities, e.g., by environmental, health, and development agencies working together to identify agricultural landscape management strategies that fill human nutrition gaps, conserve biodiversity, and boost rural economies in tandem[48,49]. In countries with devolved decision-making on land use and management (e.g., India, UK), an inter-agency task force could help coordinate efforts across jurisdictions.

3. Create public and private sector incentives to catalyse the desired food system transition including addressing structural inequalities in food and land use systems to ensure equitable participation and distribution of benefits[33,50]. This could include funding farmers during the transition to sustainable practices, reforming agricultural education systems to train extension services and farmers in agroecological practices and sustainable food system principles, and strengthening regulations on forest, agricultural land, and protected area management. Market-based instruments will be important, to create demand for nutritious diets locally sourced from agroecologically managed production systems, e.g., public procurement schemes[51], farm to school programmes[52], and environmental and fair-trade certification[53,54]. Incentive mechanisms should seek to strengthen the sustainability of local and national food systems, while fostering regional and global cooperation to ensure nutrition gaps are filled in countries where it will be challenging to meet future food needs through domestic production (e.g. Rwanda[55]).

4. Invest in systems research embedded in science-policy collaborations, to enable inter and trans-disciplinary projects that close knowledge gaps on which practices, technologies, business models, and policies are most cost-effective in fostering positive social and environmental outcomes in food and land use systems. Specific gaps include how to close yield gaps in socially and environmentally sustainable ways, how to cost-effectively map and monitor trends in agrobiodiversity in production (e.g., pollinators, crop varieties, on-farm tree species) and consumption (e.g., number of food groups and plant species consumed per person, food sources), how to create profitable agribusinesses who act in the interests of human and environmental health, and how to shift diets to nutritious, low-carbon, biodiversity-positive pathways while respecting cultural preferences and ensuring inclusive access.

About the authors

This position paper was prepared by the Food, Agriculture, Biodiversity, Land-Use, and Energy (FABLE) Consortium. FABLE (https://fableconsortium.org/) is a collaborative initiative to support the development of globally consistent mid-century national food and land-use pathways that could inform policies towards greater sustainability. The Consortium brings together teams of researchers from 24 countries and international partners from the UN Sustainable Development Solutions Network (SDSN), the Alliance of Bioversity International and CIAT, the International Institute for Applied Systems Analysis (IIASA), and the Potsdam Institute for Climate Impact Research (PIK).

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