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# SUSTAINABLE AGRICULTURE

Science Brief for Target 10 of the  
Post-2020 Global Biodiversity Framework



## **TARGET 10 – PRODUCTIVE SECTORS**

### **SCIENCE BRIEFS ON TARGETS, GOALS AND MONITORING IN SUPPORT OF THE POST-2020 GLOBAL BIODIVERSITY FRAMEWORK NEGOTIATIONS**

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## TARGET 10 – PRODUCTIVE SECTORS

### Background on the science briefs

The bioDISCOVERY programme of Future Earth and the Secretariat of the Group on Earth Observations Biodiversity Observation Network (GEO BON), convened a group of experts to prepare six briefs to provide scientific support for the negotiations of the post-2020 global biodiversity framework (GBF) at the fourth meeting of the Working Group on the Post-2020 Global Biodiversity Framework in Nairobi, from 21 to 26 June 2022. This includes four briefs on individual Targets 3, 7, 8 and 10, a brief on the GBF monitoring framework, and a brief on the ecosystem area and integrity objectives of the GBF that also addresses Targets 1 and 2 in detail. **This science brief addresses the inclusion of sustainable agriculture of Target 10.**

The analysis in this brief focuses on the wording elements of Target 10, definitions of key terminology, evidence review of biodiversity in agriculture and assessment of the adequacy and availability of indicators for tracking the achievement of this target.

This analysis is based on the text of the first draft of the post-2020 global biodiversity framework, CBD/WG2020/3/3 and subsequent negotiations of this text:

***Target 10. Ensure all areas under agriculture, aquaculture and forestry are managed sustainably, in particular through the conservation and sustainable use of biodiversity, increasing the productivity and resilience of these production systems***

This analysis focuses on sustainable agriculture emphasizing the current pressures that agriculture puts on nature which are currently a major source of degradation, and on the potential of sustainable practices to regenerate nature's contributions to people, notably food, fuel, and fibre production, but also non-production related contributions such as climate mitigation. It emphasizes that clear environmental performance metrics are necessary to monitor agriculture's transition to net positive environmental values and highlights existing metrics validated by the scientific community.

### Structure of this brief

- Key messages (1 page summary)
- Background
  - 1) Relevance for biodiversity, nature's contributions to people and good quality of life
  - 2) Target formulation, numerical objectives, indicators and impacts on SDGs
  - 3) Indicators
  - 4) References

## **KEY MESSAGES CONCERNING THE SUSTAINABLE AGRICULTURE COMPONENT OF TARGET 10**

- Sustainable management and use of terrestrial and aquatic food production systems are key to reducing pressures on biodiversity and preventing the transgression of planetary boundaries.
- Between 18 to 33% of agricultural lands currently have insufficient biodiversity: this degrades ecosystem functions, creates unacceptable risk for food security, and compromises the resilience and sustainability sought in Target 10.

### **Sustainability:**

- The approach to sustainability across various production systems needs clarity on its operationalization by including metrics to analyse and monitor the i) change in biodiversity, ii) production of nature's contribution to people (NCP), iii) interlinkages between biodiversity and production, iv) relationships between biodiversity and demand-side factors, and v) diversification strategies within land uses, between land uses and across landscapes or basins. The GBF would profit from greater clarity on this in the wording of Target 10 and in the choice of indicators for this target.

### **Sustainable Production:**

- Sustainable production includes many management approaches that can make agriculture sustainable such as: i) diversifying production systems, ii) making use of locally adapted and nutritious crop species and varieties, iii) ensuring water use is within the limits needed to maintain environmental flows and iv) maintaining complexity by embedding natural habitat in agricultural landscapes. The GBF, perhaps in the glossary, would benefit clarification of sustainable agriculture practices.
- Greater integration of biodiversity, including dietary diversity, in sustainable production is necessary for improving health, eliminating hunger and achieving nature-positive outcomes.
- Enhancing crop diversity in production systems and landscapes to produce more diverse foods can be a win-win solution for both improved nutrition and biodiversity.
- Regenerative agricultural practices can generate additional critical ecosystem services by maintaining biodiversity in and around agricultural lands, which when implemented at scale, offer potential benefits including but not limited to carbon sequestration, habitats and connectivity for biodiversity including pollinating and pest regulating species.
- Innovation and investment in productive and sustainable production can address trade-offs and close both yield and NCP production gaps.
- Investment is needed to close the production gap of crops contributing to healthy diets, in line with Sustainable Development Goals (SDGs) 2 and 3, including urgent investments in undervalued and underproduced agrobiodiversity vital to dietary health.

### **Policies:**

- Agriculture and biodiversity need to be more strongly integrated into global policies, practices and other public sector instruments across all sectors of government. These public sector instruments should be guided by science-based targets and true cost accounting to incentivize transitions to sustainable agriculture, recognizing producers (e.g., farmers) as producers of both material goods and of environmental benefits and to make healthy food affordable and available.
- More investment is needed to build the capacity of scientists, policy officials and institutions in the Global South, filling the knowledge gaps on agricultural systems.
- Sustainability in trade can be supported through direct investment in agriculture producing countries to support them in complying with the standards, due diligence requirements, tracing mechanisms, enforcement and border tariffs to reduce adverse impacts of consumption patterns on ecosystems and biodiversity.
- The aspects advanced through Target 10 help deliver several of the other targets of the GBF as well as the SDGs, especially SDG 2, 3, 12, 13 and 15.

## **BACKGROUND ON THE SUSTAINABLE AGRICULTURE COMPONENT OF TARGET 10**

Agriculture is the largest single driver of environmental degradation and biodiversity loss, responsible for over 30% of global greenhouse gas (GHG) emissions, 70% of freshwater use and 80% of land conversion. Thus, agriculture must be part of the solution to solve the current global environmental challenges. This brief provides scientific evidence to guide the decision-making process around the inclusion of food systems in the post-2020 global biodiversity framework (GBF). Ultimately, the scientific and technical guidelines on biodiversity will require political decision, collective action and commitment across sectors to achieve the transformation required on the ground.

### **1) Relevance for biodiversity, nature's contributions to people and good quality of life**

Target 10 refers to the nearly 40% of the earth's ice-free surface and the growing portions of freshwater and marine ecosystems (Costello et al. 2020) used to produce food and other goods with varying levels of intensity to produce material goods essential to people's lives and livelihoods. All areas should be sustainably managed because unsustainable exploitation and practices must be eliminated as evidence shows these have driven the transgression of planetary boundaries (Springmann et al. 2018, Willett et al. 2019, Rockström et al. 2020). This is compatible and complementary to Target 1, which calls for "100% spatial planning that is 'biodiversity inclusive'".

The target and the headline indicator should be clearer on what is intended by the term 'sustainable', including clear metrics tracking the change in biodiversity, and the NCP's it provides. The term 'production' here should include both material good production and NCP production including provisioning nutritious foods and ecological functions that support material good production, regulate climate, water, nutrient, and pollution in relation to planetary boundaries (Rockstrom et al. 2009, Steffen et al. 2015, DeClerck et al. 2016, Rockström et al. 2020, DeClerck et al. 2021b).

Much of the justification provided below is focused on agricultural production, as that is where the greatest evidence has been collected, and interlinkages between biodiversity and production, of a wide portfolio of benefits, are clearer. Comprehensive reviews of the evidence for roles of biodiversity in food production, including those prepared for the United Nations Food System Summit strongly inform this Science Brief (DeClerck et al. 2021b, a).

We note that most of the evidence presented here relates to the roles of and impacts on biodiversity in terrestrial food production systems and that aquatic systems are under-valued and studied (Costello et al. 2020), but have high potential (Gephart et al. 2021). It delves into the relationships between biodiversity and diets or demand-side factors (areas not addressed but also relevant to sustainability that include production factors such as the practices used, pollution and waste in production and supply chains).

Other similar arguments can be made with other production systems (e.g., fisheries, forestry, aquaculture) so the logic of producing sustainably can be extended across those and other production systems in operationalizing Target 10, especially as many of these systems are interconnected (e.g., terrestrial and aquatic). The areas addressed by Target 10 (production scapes on lands and waters) help deliver many of the other targets of the GBF as well as the Sustainable Development Goals (SDGs), addressed in more detail below.

### **2) Target formulation, numerical elements, indicators and impacts on SDGs**

This target refers to lands and waters managed by people for the production of goods which support healthy and enjoyable lives. The target should ensure inclusion of the diversity of production systems that depend on lands and waters, and their biodiversity. These include agriculture, aquaculture, fisheries, forestry which can more simply be referred to as "production systems". This target has an important relationship to Target 1. First, it covers the 40% of ice-free land under production systems (Willett et al. 2019, Leclère et al. 2020) that must meet the criteria of "100% spatial planning that is biodiversity inclusive" in the first part of Target 1. Second, improving the productivity in production scapes, along with consumption side interventions is a necessary precondition to avoiding the further loss of intact landscapes and wildernesses cited in Target 1. Finally, lands and waters under production systems

addressed in this target are distinct from intact ecosystems and wilderness areas addressed in the second part of Target 1, and actions must be complementary across their boundaries.

There are concerns that sustainable production is not compatible with sufficient production, notably with food security. There are some suggestions that food production may need to increase 60% by 2050 which would be a challenge as population growth is only 33%, that 30% of food is lost and wasted, and that overconsumption, notably of animals sourced foods, drives environmental pressures. Improved sustainable production practices combined with healthy diets, reducing food loss and waste, and trade, are necessary contributions which permit sustainable production, and significant conservation (Targets 1 and 3) (Benton & Bailey 2019, Willett et al. 2019, Leclère et al. 2020).

Converted lands used to produce food, fuel, fiber and other goods include 40% of global ice free total and converted rivers include 77% of rivers globally (Grill et al. 2019). Therefore regenerating ecosystem function in converted lands and waters is crucial to meet global climate, water, and biodiversity targets and goals, and to bend environmental curves (Tilman & Clark 2014, Tilman et al. 2017, Clark et al. 2020, Leclère et al. 2020). These converted systems can contribute to regenerating ecosystem functions, such as climate mitigation (Willett et al. 2019), and interventions to underpin assisted regeneration, such as landscape restoration, can promote ecosystem connectivity (Mbow et al. 2014, Griscom et al. 2017, Ripple et al. 2017, 2019, Amelung et al. 2020, Bossio et al. 2020, Clark et al. 2020, Lal 2020). More impactful, but production compatible innovations may be needed to regenerate carbon capture in production lands and waters.

*Agroecology, as an ecological science, focuses on the contribution of the conservation and sustainable use of biodiversity on enhancing the generation of ecosystem services (NCP's) to and from agriculture with the aim of regenerating these services. Diversification, agroecological, or regenerative agricultural practices are overlapping and include a diversity of management options from fields to landscapes (DeClerck et al. 2021b).*

The Food and Agriculture Organization of the United Nations (FAO) and the High Level Panel of Experts (HLPE) Report #14 (FAO-HLPE 2019) on agroecological and other innovative approaches suggests a concise set of thirteen agroecological principles related to: recycling; reducing the use of inputs; soil health; animal health and welfare; biodiversity; synergy (managing interactions); economic diversification; co-creation of knowledge (embracing local knowledge and global science); social values and diets; fairness; connectivity; land and natural resource governance; and participation as all necessary for the sustainable management of production lands and waters.

**GBF Glossary** (CBD/WG2020/3/3/Add.2/Rev.1) - Sustainable agriculture and aquaculture. The vision of FAO for sustainable food and agriculture is one in which food is nutritious and accessible for everyone, and where natural resources are managed in a way that maintains ecosystem functions to support current, as well as future human needs. (FAO, <http://www.fao.org/sustainability/background/en/>)

### **Evidence Review:**

In early 2021, thirty ecologists undertook a rapid evidence review of biodiversity in agriculture led by the CGIAR research program on Water Land and Ecosystems, with the following key messages (DeClerck et al 2021a, DeClerck et al. 2021b).

Agriculture is the largest single source of environmental degradation, responsible for over 30% of global GHG emissions, 70% of freshwater use and 80% of land conversion: food production and consumption remains the single largest driver of biodiversity loss (Foley et al. 2005, 2011, IPBES 2019, Willett et al. 2019). While too many still struggle from acute hunger, a growing number of individuals, including low and middle-income countries (LMICs), struggle to access healthy foods with 2 billion facing diseases related to overconsumption or poor consumption. Greater consideration for, and integration of, biodiversity, including dietary diversity, in sustainable production is necessary for improving health, eliminating hunger and achieving nature-positive outcomes. This diversity contributes to sustainable production (Tamburini et al. 2020).



In light of agriculture's vast environmental footprint, the broader food system must be a key part of the solution. Production systems as somehow independent of the natural world exonerated from environmental responsibilities are no longer compatible with global goals on food and nutritional security, climate security, environmental security and livelihood security (Ripple et al. 2017, 2019, Benton & Bailey 2019).

Healthy diets require dietary diversity, which requires greater crop diversity and agricultural biodiversity supporting production. Low dietary diversity is the common denominator for the 2 billion who continue to struggle with unhealthy diets (Remans et al. 2014, 2015, DeFries et al. 2015, Lachat et al. 2018). Increasing crop diversity in production systems to match consumptive needs is a means of achieving Target 1 by reducing the net amount of land needed for food production, and Target 16. Ensuring diverse healthy diets for all could avert up to 11 million premature deaths per year (Willett et al. 2019). **Enhancing production of more diverse foods can be a win-win solution for both improved nutrition and biodiversity [High Agreement, Robust Evidence].**

It is possible to produce healthy diets for 10 billion people and halt the loss of biodiversity, securing its contribution to climate regulation and other planetary boundaries, despite significant challenges and trade-offs in several regions of the world, especially in developing economies [High Agreement, Medium Evidence].

Sustainable production, notably of healthy diets, is dependent on increasing diversity in production landscapes. The majority of foods whose production must increase to ensure food and nutrition security are pollination dependent with important overlaps in malnutrition and pollination dependence (Chaplin-Kramer et al. 2014). At least 10-20% (Willett et al. 2019, Rockström et al. 2020, Garibaldi et al. 2021) of semi-natural habitat per km<sup>2</sup> is needed to ensure ecosystem functions, notably pollination, biological pest control and climate regulation, and to prevent soil erosion, nutrient loss and water contamination. **Today, 18-33% of agricultural lands have insufficient biodiversity to provide those services, an unacceptable risk for food security compromising the resilience sought by Target 10 (Figure 1; DeClerck et al. 2021).**

Sustainability is dependent on diversification strategies within land uses, between land uses and across landscapes or basins which often are regenerative, synergistic and multipurpose, and can bolster ecosystem functions within resilient agricultural production systems. Regenerative agricultural practices can generate additional critical ecosystem services by maintaining biodiversity in agricultural lands. **At scale, these practices offer the potential to sequester 4.3-6.9 Gt CO<sub>2</sub>e year<sup>-1</sup> [Medium Agreement, Medium Evidence], create 12-17 M km<sup>2</sup> habitat for biodiversity [High Agreement, High Evidence] and increase connectivity for biodiversity [High Agreement, Limited Evidence].**

**There is no evidence that diversified production systems compromise food security – many agricultural diversification practices provide multiple complementary benefits (Garbach et al. 2016, Tamburini et al. 2020) [High Agreement, High Evidence]. Innovation and investment in productive and sustainable production can address trade-offs and close both yield and NCP production gaps (Costello et al. 2020).**

#### **Means of achieving 100% Target 10:**

1. Agriculture needs to be more strongly integrated and mainstreamed into global policies and agreements and across all sectors.
2. A transition to managing agricultural systems as ecological systems (agroecosystems) is needed through the systematic adjustment of agricultural, land use and fisheries policies and practices guided by science-based targets and true cost accounting to incentivize long-term adoption of regenerative, carbon-sequestering and nature-positive production systems.
3. Critical investments in performance analysis across multiple dimensions and synergies of production systems are needed (e.g., increasing production, diversifying tree-crop composition, above or below ground carbon capture, soil health and measures of the ecological integrity of production systems). Global support and alignment for nature-positive production by scaling a

diversity of context-specific diversification practices will increase the resilience of food systems.

4. A coordinated, consensus-based, transformational adjustment of policies, incentives, regulations and other public sector instruments and public funds (as well as private) is needed to make healthy and sustainable food affordable and available for all while enabling farming communities to gain greater recognition and reward for actions that produce healthy foods as well as biodiversity and climate benefits. Closing policy implementation gaps is also fundamental.
5. Investment is needed to close the production gap of crops contributing to healthy diets, including whole grains adapted to local environments, fruits, nuts, vegetables and seeds to supply healthy diets at local, regional and global scales, in line with SDGs 2 and 3, including urgent investments in undervalued and underproduced agrobiodiversity vital to dietary health and integrating sustainable livestock production into cropping systems.
6. Investment is needed in research to fill knowledge gaps on agricultural systems of LMICs, including on building the capacity of scientists, policy officials and institutions in the Global South, increasing their capacities to engage with regional food system actors, and increasing the access and participation of LMIC scientists in global science-policy interfaces.
7. Financial markets need to shift investment flows away from unsustainable, unhealthy and socially unjust practices and into investments in tools, innovations, technologies and enabling environments that drive transformative change; food companies should integrate environmental, social and health risks into company disclosures.
8. International trade should be re-imagined so that higher-income countries take account of the adverse impacts of their consumption on ecosystems and biodiversity through trade in commodities, goods and services with lower-income countries. Sustainability in trade can be supported through direct investment in the producing countries to support them in complying with the standards, due diligence requirements, tracing mechanisms, enforcement and border tariffs.

Determining national contributions – in a national context, ‘global’ refers to 100% of land, freshwater and ocean territories, thus full coverage of all of these by spatial planning processes that meet the criteria and deliver the objectives of this target. The potential contributions of countries may be identified from integrating global prioritization analyses (top-down) with national (including local) aggregation and priority setting processes (bottom-up) to identify national targets. Aggregation of national contributions to the global target may be done nominally (by country) or by area, as relevant to each specific indicator. A growing number of environmental performance indicators related to sustainability in production lands and waters can now, or will shortly, be measured with remote sensing technologies.

### **3) Indicators**

**The most recent indicators** (as of 14 March 2022) are listed below with **Headline in bold**, component indicator in plain and *complementary indicator in italics*.

#### **10.0.1 Proportion of agricultural area under productive and sustainable agriculture**

10.1.1. Average income of small-scale food producers, by sex and indigenous status (SDG indicator 2.3.2)

*t10.1. Changes in soil organic carbon stocks*

*t10.2. Red List Index (wild relatives of domesticated animals)*

*t10.3. Red List Index (pollinating species)*

*t10.4. Proportion of local breeds classified as being at risk of extinction*

#### **Comments on indicators and potential new indicators**



The existing list of indicators does not capture several aspects of agricultural management that impact negatively on biodiversity or that have the potential to positively contribute to biodiversity conservation. Critical is the absence of clear metrics around sustainability. The headline indicator under Target 10 is ‘proportion for agricultural area under productive and sustainable agriculture’. But, there is no information on what is considered sustainable and a risk that it includes only organic and conservation agriculture but not the many other management approaches and innovations, both traditional and modern, that can make agriculture sustainable, namely diversifying production systems, making use of locally adapted and nutritious crop species and varieties, ensuring water use is within the limits needed to maintain environmental flows, maintaining complexity by embedding natural habitat in agricultural landscapes.

The Food System Countdown Initiative (Fanzo et al. 2021) which includes contributions from over forty scientists in collaboration with FAO has proposed six key indicators domains for assessing the environmental sustainability of production systems. Critical to the success of the GBF are clear metrics of sustainability, notably those that relate to biodiversity, or its contribution to sustainable production as well as alignment of these metrics with other UN initiatives and commitments.

<b>Domain</b>	<b>Definition/Description</b>
Land and soil	Agriculture dominates global land use with approximately 1.5 billion hectares of cropland, of which 30-40% is used to produce feed, and 3.5 billion hectares of grazing land (Mbow et al. 2019). Together, these lands cover approximately 40% of the world’s ice-free land (Ramankutty et al. 2018). Monitoring land use change is essential, as it is at the center of many environmental processes. Halting deforestation and land conversion will reduce GHG emissions, improve water cycles, and protect biodiversity; together with restoration, avoiding conversion has the potential to store 200-330 gigatons of carbon (Leclère et al. 2020). The concept analogous to land use for aquatic systems is the spatial expanse of inland waters and oceans used for aquatic capture food production.
Biosphere integrity	Biosphere integrity is a measure of the quantity and quality of natural systems and resources required to maintain nature’s contributions to people and halt species extinction (Gerten et al. 2020; DeClerck et al. 2021). Within food production systems, it is nature’s capacity to support food production which can be assessed as the quantity of semi-natural and or natural habitat per km <sup>2</sup> . Studies suggest that 10% habitat per km <sup>2</sup> is a threshold beyond which NCPs are no longer provided (Willett et al. 2019), and that 20% per km <sup>2</sup> may be a more appropriate target (Garibaldi et al. 2021). Approximately 18-33% of production lands are below this threshold and target respectively (DeClerck et al. 2021). Edge density for land covers within 10x10km landscapes with at least 100ha agricultural land can provide a complementary surrogate (Figure 1).
Greenhouse gas emissions/capture	Food systems account for 21-37% of total GHG emissions, two-thirds of which come from crop and livestock production, land use, and land use change, and the remainder from processing, transport, and packaging (Poore & Nemecek 2018, Mbow et al. 2019, Clark et al. 2020, Crippa et al. 2021, Tubiello et al. 2021). Specific emissions of concern relevant to food systems are methane from enteric fermentation (in ruminant animals) and rice paddies; carbon dioxide from land use change, transport, and processing; and nitrous oxide from fertilizer application and manures. Production scapes, in addition to restored lands, remain the only known means of sequestering greenhouse gases for storage either in above or below-ground biomass (Griscom et al. 2017, Bradford et al. 2019, Amelung et al. 2020, Bossio et al. 2020, Chapman et al. 2020). Biological carbon capture is an essential critical metric for Target 10.
Water use	Water scarcity constrains food systems and human well-being; an estimated 1.2 billion people experience physical water scarcity and another 1.6 billion have insufficiently-developed water resources (Molden et al. 2007). Food production is responsible for 70-80% of global freshwater “consumptive use”—surface and groundwater removed from the local water cycle—which can drive water

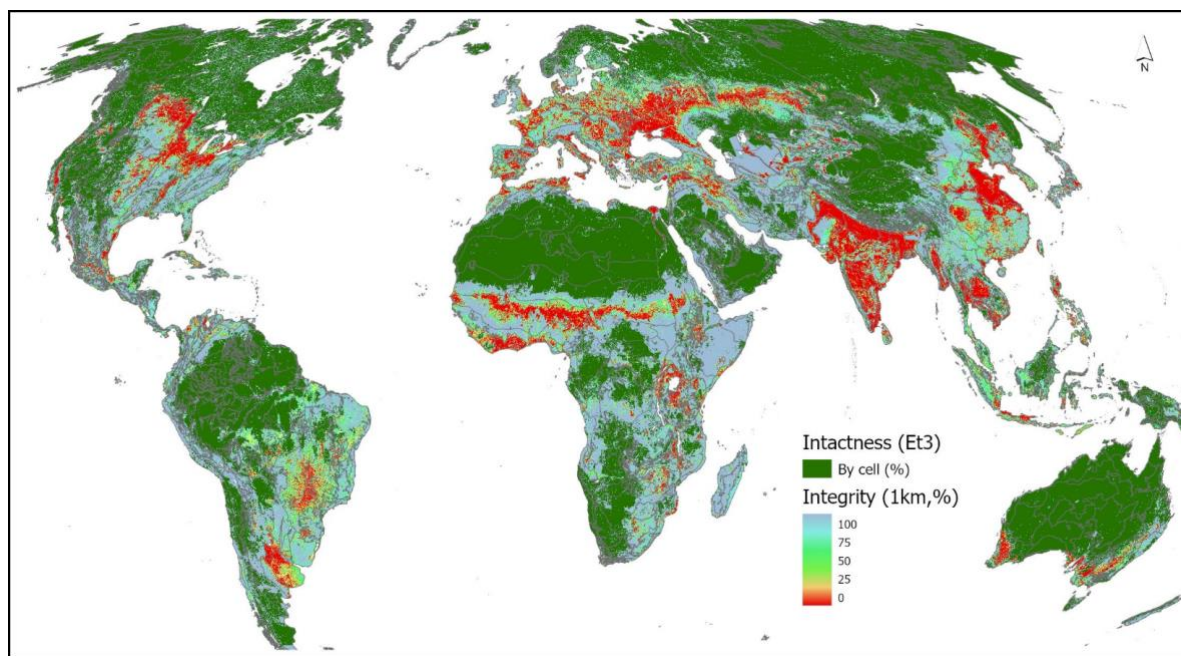
	scarcity if not locally replenished (D’Odorico et al. 2020). Sustainable use of water in production landscapes should not exceed $\pm 20\%$ of monthly environmental flows.
Pollution	Environmental pollution from food systems can be classified into four major categories: (1) nutrient loss and run-off (e.g., nitrogen, phosphorus) from food production into water bodies, land, and/or air, and soil degradation (Häder et al. 2020); (2) novel entities, notably biocides (e.g., pesticides, antibiotics) used in agricultural production systems; (3) particulate air pollution from food systems (e.g., burning residues or land clearing, air pollution caused, to a large degree, from manure and nitrogen fertilizer application) (Lelieveld et al. 2015); and (4) solid waste across food value chains (e.g., non-degradable plastics, other non-degradable unrecycled materials, excess animal waste not used as fertilizer, food waste of which 95% is estimated to be sent to landfills) (Melikoglu et al. 2013, Geyer et al. 2017, Yates et al. 2021). Established science-based targets for nutrient losses and soil degradation, and air quality are established (Steffen et al. 2015) and metrics have been proposed for biocides (Persson et al. 2022). Reductions in food loss require sustainable management of production systems, and are essential for achieving Target 1 and Target 16.
Agrobiodiversity Index	The diversity of plants, animals and microorganisms that directly or indirectly support food and agriculture is critical to achieving healthy diets and sustainable production systems. The Agrobiodiversity Index (Persson et al. 2022) (based on 22 indicators) provides a monitoring framework and informs food systems policy. Mean agrobiodiversity status scores in consumption and conservation are 14–82% higher in developed countries than in developing countries, while scores in production are consistently low across least developed, developing and developed countries. There is an absence of globally consistent data for several important components of agrobiodiversity, including varietal, functional and underutilized species diversity which are important components of Target 10.

According to the key indicators domains noted above, and in light of the most recent indicators for Target 10 (headline, component and complementary indicators), we note that the following domains are not sufficiently represented:

- Biosphere integrity in and around production systems
- Water use
- Pollution

We suggest implementing a pilot with a few Parties to look at the monitoring framework, their national data and own indicators vis-à-vis the domains suggested by the initiative to identify possible gaps and underrepresented domains in the current indicators. Other pilot initiatives can be organized as well according to the demand and needs of the Parties to embark on implementation.

**Figure 1:** Global raster map of remaining largely intact areas (green scale) covering approximately 49% of the earth’s surface, and functional integrity (>10% seminatural or natural habitat per km<sup>2</sup> (blue/red scale). Areas in red have insufficient embedded biodiversity to provide the pollination, pest control, sediment and nutrient capture NCP’s that support nature positive food production



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