Biodiversity in the food system: A preliminary exploration

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This study was carried out by Wageningen University & Research and was commissioned and financed by the Netherlands Food Partnership.

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Introduction

One of the most urgent challenges facing the world today is the rapid loss of biodiversity. There is a growing consensus globally that addressing this issue requires simultaneously tackling related issues such as food insecurity, chronic poverty, and the vulnerability to climate change impacts. This consensus is evident in four recent and interconnected international convention and agreements made between 2021 and 2022: the United Nations (UN) Decade on Ecosystem Restoration, the UN Food System Summit, the UN Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP 27), and the Convention on Biological Diversity's (CBD) Global Biodiversity Framework. These agreements call for a fundamental transformation of the global economy, advocating for an integrated approach to restoring ecosystems, reforming food systems, addressing global warming, and halting biodiversity loss.

The interconnectedness of biodiversity loss with food production is clearly illustrated by the food – climate – biodiversity nexus. Food production has been identified as the primary driver of biodiversity loss worldwide, accounting for 70% of terrestrial and 50% of freshwater biodiversity loss, mainly due to land conversion for agricultural purposes and the use of unsustainable farming practices[1]. Food systems are also responsible for around a third of global green-house gas emissions thereby contributing significantly to climate change, which is another important threat to both biodiversity and food production systems worldwide[2]. At the same time, biodiversity is increasingly recognized as indispensable to food production and food security. Additionally, biodiversity is increasingly acknowledged to play an essential role in climate change mitigation, and in safeguarding the resilience of ecosystems and food production systems to the shocks and stresses associated with climate change. Biodiversity is as such both foundational for food systems to function and majorly impacted by food system activities. This interconnectedness between biodiversity and the food system points at the need to give priority to the role of biodiversity in the food system. This starts with improving our understanding of the biodiversity-food connection, as biodiversity and food security are strongly interrelated through multiple connections and interventions. These interventions aimed at improving only biodiversity or only food security often unintentionally lead to negative impacts on the other. Understanding these interconnections is therefore essential in identifying synergies between increasing biodiversity and other food system outcomes and identifying strategic interventions that promote biodiversity friendly food systems.

The Netherlands Food Partnership (NFP) connects people and knowledge through communities, partnerships, and coalitions to promote food systems in low- and middle-income countries that are economically, socially, and environmentally sustainable. In recent years, biodiversity has become a key element of sustainable food systems, contributing to resilience, productivity, and environmental health. However, incorporating biodiversity into food systems transformation remains challenging, as it demands further research and strategic insights to pinpoint effective areas for intervention. Recognizing the essential role of healthy ecosystems in sustainable food production, the NFP aims to bridge the gap between traditional food systems frameworks and biodiversity approaches. In addition, the current food systems framework often fails to identify leverage points for action when integrating biodiversity into food systems. Therefore, the NFP is focused on enhancing its understanding of these leverage points to identify areas where it can add unique value, ensuring alignment with its overall strategy and mission.

[1] WWF 2021. Farming with Biodiversity. Towards nature-positive production at scale. WWF International, Gland, Switzerland. From: https://wwfint.awsassets.panda.org/downloads/farming_with_biodiversity_towards_nature_positive_production_at_scale.pdf

[2] Tubiello, F. N., Rosenzweig, C., Conchedda, G., Karl, K., Gütschow, J., Xueyao, P., ... & Sandalow, D. (2021). Greenhouse gas emissions from food systems: building the evidence base. *Environmental Research Letters*, *16*(6), 065007. From: https://iopscience.iop.org/article/10.1088/1748-9326/ac018e/pdf

For this NFP assignment, it is our aim to provide a framework that clearly illustrates the biodiversity – food connection and allows for a more systematic integration of biodiversity in the food system. Based on a proposed framework that puts biodiversity more central to the food systems framework, this article sets out to describe the biodiversity-food connection throughout the food system, illustrating the many entry-points for strategic interventions focused on improving biodiversity in the food system. Key questions and considerations to support decision-making on most suitable entry points for the Netherlands Food Partnership (NFP) are discussed. Lastly, a full list of possibly high level entry-points is provided in annex I.

Biodiversity refers to the variety of life on Earth at all levels of biological organization. It encompasses the variety of species of plants, animals, and microorganisms, the genetic differences among them, and the ecosystems they create and processes that support these. The convention on Biological Diversity signed at the United Nations Conference on Environment and Development in 1992 defines biological diversity as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (United Nations Environment Programme, 1992). Since this definition in 1992, the concept of biodiversity has continuously developed, and currently many different, largely overlapping definitions exist. A common definition describes it as the variety and variability of living organisms, their habitats and their contribution and role in the ecosystem processes. Biodiversity is complex and operates on different levels, therefore it is often divided into three component:

1. Genetic diversity – referring to the variation in genes within a species.
2. Species diversity – referring to the variety of species in a particular region or ecosystem.
3. Ecosystem diversity – referring to the variety of habitats, ecological communities, and ecological processes in the biosphere.

The Food System – Biodiversity connection

One side of the food – biodiversity connection is illustrated by the dependency of food production on biodiversity. Biodiversity determines to a large extent the food system's performance through what is defined in the IPBES report (2019) as nature's contributions to humans[3]. These contributions can be subdivided into material, non-material and regulating contributions. **Material contributions** include the provisioning of a rich variety of crops, livestock, and the raw materials used in the food system, as well as the wild species that are harvested for food and the micro-organisms that play a critical role in food processing and other agro-industrial processes. It also includes genetic biodiversity, which is essential for the ability of species and ecosystems to adapt to changing conditions, resist diseases and maintain long-term stability and resilience. **Non-material contributions** encompass cultural and traditional knowledge and the intrinsic value of nature. **Regulating contributions** refers to the critical ecological processes - pollination, pest control, soil fertility, climate and water regulation among others - that provide the foundation of agricultural production. For some of these the role of different species is easily identifiable: bees and other pollinators provide pollination, mollusks contribute to water purification through their filter-feeding activity, trees and shrubs provide shade and their roots help keep soil together whereby counteracting erosion, earthworms play an essential role in soil fertility by driving decomposition and nutrient cycling, and many more examples can be mentioned. The provisioning of these contributions however depends on the functioning and health of ecosystems at large, which is influenced by many complex ecological processes, in which numerous species are involved, and many of which are not yet well understood. What is certain is that biodiversity is the driving force behind these essential contributions. Biodiversity is therefore a major determinant for the productive capacity and resilience of food production systems[4][5]. This is reflected in the increasing amount of evidence that higher biodiversity in agricultural landscapes enhances soil fertility and nutrient cycling and is linked to higher crop production and lower

[3] IPBES (2019), Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Brondizio, E. S.,Settele, J., Diaz, S., Ngo, H. T. (eds). IPBES secretariat, Bonn, Germany. 1144 pages. ISBN: 978-3-947851-20-1
[4] IPBES (2019) Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
[5] FAO. 2019. *The State of the World's Biodiversity for Food and Agriculture*, J. Bélanger & D. Pilling (eds.). FAO Commission on Genetic Resources for Food and Assessments. Rome. 572 pp.

dependency on chemical inputs[6]. Moreover, biodiversity is essential in maintaining ecosystem functioning under pressures of environmental change such as climate change, with studies showing that higher biodiversity and ecosystem complexity is linked with higher resilience compared to species-poor communities or monocultures[7].

On the other side of the biodiversity-food connection is the food system's impact on biodiversity. The food system currently has a significant negative impact on biodiversity mostly through land use-change, exploitation, climate change, pollution and invasive species[8]. These are what IPBES identifies as the direct drivers of biodiversity loss. When it comes to the direct drivers of biodiversity loss, it is the activities in the food value chain that contribute most to these, with agricultural production as main contributor but also through its other stages of transport, trade, processing, distribution, consumption and waste disposal. The conversion of land for agricultural purposes, with livestock farming being the most important driver, leads to habitat degradation and destruction and consequently a loss of species that depend on these[9]. Furthermore, intensive agricultural practices including monoculture cropping and the widespread use of chemical inputs like pesticides and fertilizers degrades soil health and disrupts ecosystems. Although less direct and impactful, the processing and distribution phases often contribute to pollution, and the overexploitation of resources such as freshwater, emissions of greenhouse gases through a high energy demand, as well as food loss and waste, further driving biodiversity indirectly.

Stepping up efforts across the value chain to bend the curve of biodiversity has therefore become a high priority. Because the most direct impacts on biodiversity take place at the level of agricultural production, it seems intuitive to focus efforts on this part of the food system. This however ignores the fact that there are many other activities and drivers in a food system that influence agricultural production and the rest of the value chain.

An analytical tool that is increasingly used to enhance our understanding of how activities in the value chain interact with elements of the environment, people, inputs, infrastructure, and institutes, is a food systems framework. The van Berkum framework is such a framework (figure 1)[10]. ***A food system*** as defined in this framework encompasses the entire network and processes involved in feeding a population. This includes the activities that take place in the value chain, and the environmental, economic, social, and political factors that influence how food is grown, harvested, processed, transported, marketed, consumed, and ultimately disposed of. A food system also includes the inputs needed and outputs generated at each stage, such as agricultural inputs, labour, energy, food waste, and by-products.

The food system approach has made major contributions to efforts to address food related challenges by expanding the focus to include activities and drivers beyond the value chain. The van Berkum framework defines the food system as consisting of three subsystems: food systems activities, which includes the value chain, environmental drivers and socio-economic drivers. These sub-systems interact to produce certain outcomes. System outcomes are emergent properties of a system, they are the consequences of the complex interactions between food system elements. This means that if we want to change these outcomes, it is not sufficient to look only at the activities in the value chain, but we need to look at the drivers that create the conditions within which these take place. The food systems approach also provides a lens to zoom in to identify contextualized actions at meso or micro level and assess their effect on food systems outcomes, and zoom out to observe broader patterns that influence food system activities. In helping to understand the connections and feedbacks at different scales, the food systems approach helps to shape policies and interventions to steer the system towards more desirable outcomes.

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[6] Dainese, M., Martin, E. A., Aizen, M. A., Albrecht, M., Bartomeus, I., Bommarco, R., ... & Steffan-Dewenter, I. (2019). A global synthesis reveals biodiversity-mediated benefits for crop production. *Science advances*, *5*(10), eaax0121.
[7] Hong, P., Schmid, B., De Laender, F., Eisenhauer, N., Zhang, X., Chen, H., ... & Wang, S. (2022). Biodiversity promotes ecosystem functioning despite environmental change. *Ecology Letters*, *25*(2), 555-569.
[8] IPBES (2019), Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
[9] Benton, T. G., Bieg, C., Harwatt, H., Pudasaini, R., & Wellesley, L. (2021). Food system impacts on biodiversity loss. *Three levers for food system transformation in support of nature. Chatham House, London*, 02-03.
[10] Van Berkum, S., Dengerink, J., Ruben, Ruerd. 2018. The food systems approach; sustainable solutions for as sufficient supply of healthy food. From: https://research.wur.nl/en/publications/the-food-systems-approach-sustainable-solutions-for-a-sufficient-

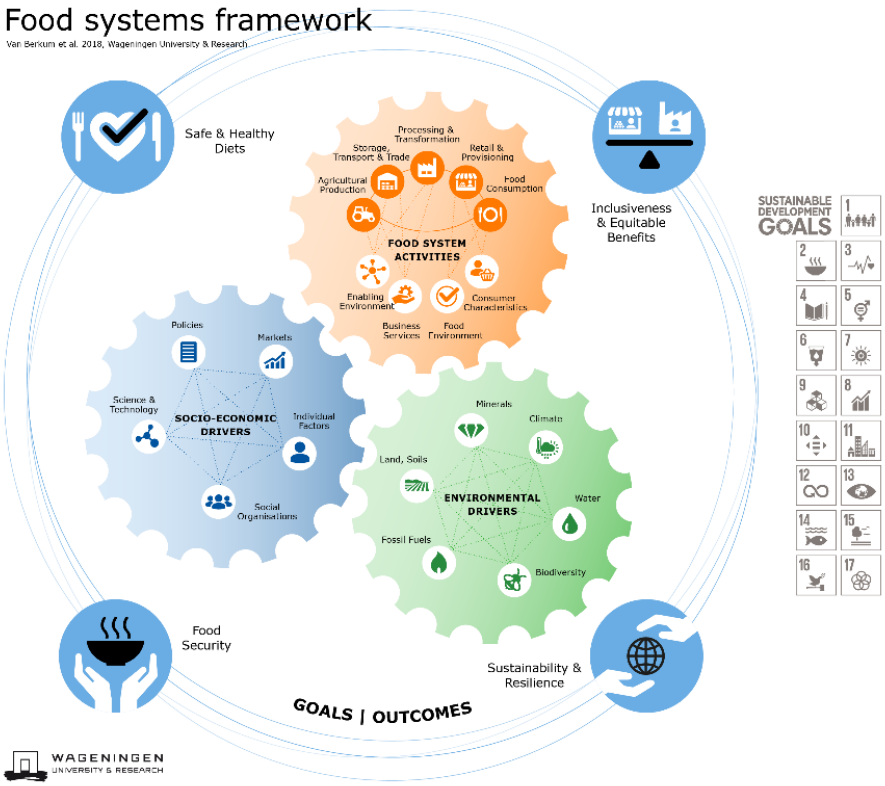

Figure 1. The Food Systems Framework by Van Berkum et al. 2018.

Integrating biodiversity into the food system

Biodiversity loss can be seen as an unintended outcome of our current food systems. It is emergent in the sense that no particular activity, actor or driver is solely responsible, instead it is the combined interactions between the different food system activities and drivers, from which this pressure on biodiversity emerges.

This highlights the importance to look beyond agriculture and the rest of the value chain if one wants to effectively address biodiversity loss. Systems thinking allows one to set boundaries for analysis that fit the focus of the analysis and include all relevant drivers, including those external to the system, which makes the food systems approach a fitting tool for this purpose. In the van Berkum framework however, biodiversity is represented only as one of the environmental drivers influencing food systems activities and vice versa, and as one of the indicators for environmental outcomes of the food systems. Additionally, biodiversity is implied in the goal of sustainability and resilience. The extent to which biodiversity is prioritized as an outcome depends on the importance given to it by policy makers, donors, practitioners etc. To emphasize the importance of prioritizing the role of biodiversity in the food system we have reconfigured the van Berkum framework in a way that puts biodiversity more central to it (figure 2).

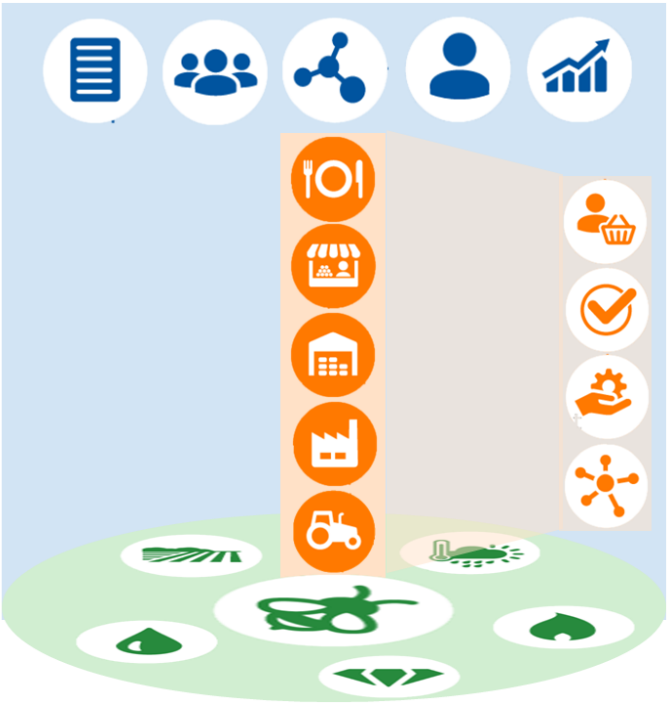

Figure 2. Reconfigured Food Systems Framework, based on Van Berkum et al. 2018.

In this reconfigured version of the food system framework, biodiversity (and its related environmental drivers) is positioned as part of the landscape within which food system activities take place. This reflects the foundational role of biodiversity in the food system as well as its spatial character, which means that *where* food systems activities take place determines to a large extent the impact on biodiversity. It also recognizes that biodiversity is subject to and interacts with other landscape elements and dynamics. Landscapes are complex socio-ecological systems; the characteristics of a specific landscape are the result of the interactions between the natural conditions of that area and the actions and interactions of the people living and working in the landscape[11][12].

Like in the original framework, the food value chain is placed in the middle of the framework, this is for several reasons. First, this positioning is meant to reflect that the activities in the value chain take place in a biophysical environment that is made up by the environmental drivers, biodiversity, water, climate, minerals, land, soils, fossil fuels on which food systems activities rely. These are the spatial conditions of a landscape, the foundation on which food systems activities are built. These environmental drivers are inherently place based, but they are impacted by activities and drivers both at local, regional and global scale. Second, food systems activities are put central to the framework because this is where the impact of the food systems on biodiversity is most direct, and as such where change needs to happen, even if this change needs to be triggered by interventions beyond the value chain.

The vertical position of the value chain reflects that while some activities may take place in one landscape, others may take place in and influence other landscapes. Highlighting the latter also points to an important challenge in integrating biodiversity in the food system: the increasingly globalized character of food systems means that the different steps in food production and the drivers influencing this production can take place long distances away from each other. This globalized character in combination with the spatial character of biodiversity means that the demand for a certain food in one place can drive biodiversity loss in a landscape far away.

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[11] European Landscape Convention
[12] van Oosten, C. (2021). *Landscape governance: from analysing challenges to capacitating stakeholders* (Doctoral dissertation, Wageningen University and Research).

The placement of the icon for agricultural production in this framework directly on the landscape of environmental drivers, reflects the duality of agricultural production having the most direct impact on while also being particularly dependent on the biodiversity and the ecosystems of a landscape. The relative impact of agricultural production depends on the ecosystem and biodiversity present in that landscape and the agricultural practices used. If one takes the example of palm oil, the production generally takes place in highly biodiverse landscapes, which makes the impact higher than production in less biodiverse landscapes. Moreover, palm oil production often entails monoculture systems with high inputs of chemical fertilizers and pesticides. More biodiversity friendly practices that combine different crops are possible, which would decrease the impact on biodiversity[13].

We furthermore position biodiversity in a landscape to emphasize that biodiversity crosses the borders of production systems as well as many formal governance boundaries, and biodiversity and ecological processes are influenced by the wider landscape. To illustrate this, waste streams from a processing plant upstream can significantly affect biodiversity downstream, and the extensive use of grassland can improve pollination services for surrounding production systems too. Efforts to improve biodiversity should therefore adopt system boundaries that fit the local biodiversity and flow of ecosystems services of that particular landscape.

Most importantly, this framework emphasizes that no matter where the food system activities take place and what drives these, they take place in the context of a natural landscape and interact with the various elements that make up these landscapes. Moreover, both the value chain activities and the landscape itself - including the environmental drivers that are part of it - are influenced by socio-economic drivers, which are therefore positioned as an overarching driver of both food systems and landscapes.

The following sections elaborate on the different components of the food systems framework and their link to biodiversity.

Environmental drivers

The environmental drivers of the food system are deeply interconnected and collectively influence the impact of the food system on biodiversity. Agricultural practices heavily depend on the natural resources that landscapes provide; unsustainable use can lead to biodiversity loss. For instance, overexploitation of water for irrigation can reduce aquatic biodiversity, while deforestation and land conversion for agriculture destroy habitats and reduce species diversity. The excessive use of fossil fuels contributes to climate change, which further threatens biodiversity by altering ecosystems and species distributions. Depletion of soil health through intensive farming degrades ecosystems and reduces their capacity to support diverse life forms. Moreover, the loss of biodiversity itself undermines ecosystem resilience, making the food system more vulnerable to environmental shocks and less sustainable in the long term. The way these environmental drivers are managed within the food system and how food system activities interact with these drivers can as such either mitigate or exacerbate biodiversity loss.

Food systems activities

The food system's impact on biodiversity is largely the result of food system activities interacting with the environmental drivers. Particularly the food system activities that take place in the value chain most directly impact biodiversity by contributing to the direct drivers of biodiversity loss as identified by IPBES: land-use, exploitation, pollution, invasive species and climate change.

[13] https://www.wur.nl/nl/nieuws/verduurzamen-van-palmolie-in-de-praktijk.htm

Food systems activities in the value chain

Agricultural production is the largest contributor to biodiversity loss globally, with the conversion of natural ecosystems into managed land as the main driver of habitat loss. Unsustainable farming practices associated with intensive agriculture such as monoculture practices, overgrazing, heavy tilling, the use of heavy machinery and harmful amounts of fertilizer herbicides and pesticides, and overexploitation of freshwater resources for irrigation add to the negative impact of land use change on biodiversity loss. Pollution resulting from these practices lead to ecosystem degradation and biodiversity loss within and far beyond agricultural fields, and greenhouse gas emissions contribute to climate change.

With land-use being the leading driver of biodiversity loss, interventions to increase biodiversity at production level could focus on decreasing land-use for agricultural production, and on increasing biodiversity at production system level. Global population growth, however, predicts that a 50% increase in food production is necessary while we currently observe a diminishing trend in the rate of productivity increase[14]. As such, productivity of existing agricultural lands needs to be increased in a biodiversity friendly way. This can be approached in different ways. Some say that sustainable intensification through technological improvement (like precision farming) and efforts to close the yield gap - the latter in particular in low- and middle-income countries - can significantly increase productivity on existing land, but the challenge then remains to do this in a biodiversity friendly way[15]. Such efforts to reduce the land used for agricultural production combined with restoration and protection efforts to preserve natural areas, also called land sparing, has the potential reduce biodiversity loss. It is important to note however that closing the yield gap requires more that technological innovation as Giller clearly explains in "*The Food Security Conundrum in sub-Saharan Africa*", thereby emphasizing the importance of a systems approach to tackling the issue of biodiversity loss and food security[16].

Another pathway would be to focus on ecological intensification, by upscaling and mainstreaming biodiversity friendly practices that optimise the use of ecosystem services, such as agro-ecology, agroforestry, organic, regenerative, and nature-inclusive farming. These practices can be combined with land sharing, in which natural elements are interwoven with production systems[17]. Increased biodiversity as a result of these practices improves ecological functioning, which can lead to higher outputs while requiring less input in terms of land, water, pesticides and fertilizers, resulting to less costs for the farmer. Whether these benefits translate into increased profit is however highly uncertain, which is one of the main barriers for farmer uptake[18]. This is mainly because productivity of these farming systems is currently less high than that of conventional systems. Land use would as such need to increase to maintain or increase yields. Implementation of biodiversity friendly farming practices is moreover knowledge intensive and highly context specific, depending on the crop that is cultivated and its requirements, the ecological and climatic characteristics of the field, and wider landscape a production system is part of. Ways to increase productivity through ecological farming approaches in different contexts therefore warrants further research. Moreover, these practices need to fit the socio-economic realities of the farmers implementing them. According to Muller et al. (2017) organic production nevertheless has the potential to feed a growing population if this is combined with other changes in the food system, namely a shift to plant-based diets and significant reduction in food waste[19]. Moreover, choices at producer level are influenced by, among other things, market demand and market access, food prices and costs of production, consumer preferences and enabling factors such as policies and regulations, financial resources, knowledge of biodiversity positive agricultural practices as well as awareness of the importance of biodiversity and of course motivation and agency to

[14] Kok, M. T., Alkemade, R., Bakkenes, M., van Eerdt, M., Janse, J., Mandryk, M., ... & van Vuuren, D. P. (2018). Pathways for agriculture and forestry to contribute to terrestrial biodiversity conservation: a global scenario-study. *Biological Conservation*, *221*, 137-150.
[15] Kok et al. (2018)
[16] Giller, K. (2020). The Food Security Conundrum of sub-Saharan Africa. *Global Food Security*, *26*, 100431.
[17] Kok et al. (2018)
[18] Scheper, J., Badenhausser, I., Kantelhardt, J., Kirchweger, S., Bartomeus, I., Bretagnolle, V., ... & Kleijn, D. (2023). Biodiversity and pollination benefits trade off against profit in an intensive farming system. *Proceedings of the National Academy of Sciences*, *120*(28), e2212124120.
[19] Muller, A., Schader, C., El-Hage Scialabba, N., Brüggemann, J., Isensee, A., Erb, K. H., ... & Niggli, U. (2017). Strategies for feeding the world more sustainably with organic agriculture. *Nature communications*, *8*(1), 1-13.

make the necessary changes. Incentives, like ensuring higher prices for sustainably farmed products and farmer compensation for enhancing ecosystem services as a public good can play a crucial role here.

While the link between **food storage, transport and trade** with biodiversity is less obvious than for agricultural production, there are significant interactions. The development and maintenance of infrastructures for storage and transport drives land-use change, habitat fragmentation and pollution and refrigeration in the cold chain requires significant energy. While improvements in storage and transport of perishable goods reduce food loss, it also enables year-round supply over large distances of these goods, thereby driving demand for land-intensive products such as meat and dairy. Food trade also indirectly drives biodiversity loss by influencing food prices and demand, which can lead to agricultural expansion and thereby habitat destruction in countries where production is cheaper. Biodiversity impacts of food production are thereby shifted to exporting countries, which is why deforestation and biodiversity are often linked to South-North trade patterns. As such, food trade is an important driver of land-use globally. The biodiversity impact then depends on the relative biodiversity richness and agricultural practices of exporting countries. While transport and storage technologies have improved, particularly in low- and middle-income countries where these innovations are less available, food loss is a problem. Technological improvements, interventions to safeguard biodiversity in global trade - for example by favoring certified products and including biodiversity criteria in agreements -, and implementing mechanism to internalize environmental costs are examples of strategies to mitigate the contribution of food storage, transport and trade to biodiversity loss.

Food processing and transformation directly impacts biodiversity mainly through high inputs of water and energy and pollution from waste streams from processing plants and packaging. Regulations around waste disposal and pollution are crucial in limiting the impacts of these activities on biodiversity and innovation in processing technologies including the use of rest-streams for other (food)products can benefit both biodiversity and livelihoods. In this and the preceding steps in the value chain, food loss is also a significant indirect driver of land-use change and thus biodiversity loss. According the FAO Food Loss Index, 13% of the food produced is lost post-harvest at the farm, in transports, storage, wholesale and processing[20].

Food retailers and provisioning services play an important role in mediating supply and demand through product selection, pricing strategies, marketing and advertising. The expansion of modern retailers such as supermarkets and food provisioning services like online food platforms and delivery services, are influencing consumer choices. Food waste in this stage is also significant. Retailers can play an important role in promoting biodiversity friendly food production through their influence on consumers, and their relationships with producers.

Consumption patterns have a major influence on biodiversity in the food system. Currently animal farming is the most important contributor to land-use change and biodiversity loss in agricultural production. This production is driven by a high demand for animal products such as meats and dairy mainly in high-income countries. Global demand is observed and expected to increase as a result of population growth as well as changing diets in low- and middle-income countries[21]. This change in diet to include more animal products in low- and middle-income countries is linked to increased incomes and associated changes in lifestyle. A significant expansion of animal farming is therefore projected. Additionally globalization and urbanization and associated lifestyle changes drive a demand for fresh fruits and vegetables on the one hand and convenient, pre-packaged, ready to eat foods and a shift from more traditional, local foods to processed foods, further driving demand for specific food products that are required in increasingly industrialized food processing[22][23]. Pollution, through improper disposal of food and drink packaging and food waste, is an another important contributor to biodiversity loss in this stage. Additionally, fuel for cooking drives biodiversity loss, particularly in low- and middle-income countries where harvesting of wood and

[20] FAO, 2022
[21] FAO. 2019. The State of the World's Biodiversity for Food and Agriculture
[22] De Bruin, S., Dengerink, J., van Vliet, J. (2021). Urbanisation as driver of food systems transformation and opportunities for rural livelihoods. *Food Security*, *13*(4), 781-798.
[23] FAO. 2019. The State of the World's Biodiversity for Food and Agriculture

charcoal for fuel is an important driver of deforestation[24]. Another important indirect driver of biodiversity loss at this stage is food waste. The UNEP Food Waste Index Report 19% of food produced for human consumption is wasted at retail, food service and household level, with the latter making up 60% of this total[25]

Other food system activities

In identifying interventions for integrating biodiversity in the different stages of the value chain, it is important to realise that these value chain activities take place within a food system supply context, which is described through the enabling environment, business services, food environment, and consumer characteristics. The **enabling environment**, which includes policies, regulations, and governance structures, plays a critical role in shaping agricultural practices and land use. Policies promoting sustainable agriculture, conservation, and ecosystem restoration can encourage biodiversity-friendly practices. Conversely, policies that prioritize industrial agriculture and monocultures can lead to habitat loss, soil degradation, and reduced biodiversity. The **business services** sector, including financing, technology, extension services, and market infrastructure, further impacts biodiversity by determining which agricultural practices are promoted and viable. For instance, access to sustainable farming technologies and eco-friendly inputs can support practices that enhance biodiversity. However, when business services favor large-scale, high-yield operations, they often promote practices that harm biodiversity, such as excessive pesticide use or deforestation. The **food environment**—which encompasses the availability, affordability, and marketing of food—directly influences consumer choices and, subsequently, the demand for different types of food. A food environment that favors diverse, locally sourced, and organic foods can promote agricultural diversity and reduce pressure on ecosystems. However, an environment dominated by cheap, processed foods often drives demand for monocultures and industrial farming, which can deplete biodiversity. Lastly, **consumer characteristics**, including preferences, cultural practices, and awareness of sustainability issues, play a crucial role. Consumers who prioritize environmentally friendly and diverse diets contribute to sustaining biodiversity through their food choices. Conversely, a lack of awareness or preference for convenience foods can lead to greater consumption of products that are harmful to biodiversity. Collectively, these elements of the food system interact to either support or undermine biodiversity, depending on the priorities set within each component.

Socio-economic drivers

Food system activities and their impact of biodiversity are further influenced by multiple interacting socio-economic drivers of change. Each of these drivers influences food systems activities and can be leveraged to promote biodiversity positive practices in the value chain. **Markets** can influence food systems activities by driving supply and demand, through global prices, profit, incomes, wages and global trade all of which drive which food products are produced, and where the different food systems activities take place. As such, markets are important drivers of land-use globally. Market can be leveraged to positively influence biodiversity by creating a demand for sustainably produced foods, for example by setting requirements and standards for market access through certification. **Policies** can influence the impact of the food system on biodiversity by influencing the supply and demand side of food production, and establishing protected areas. Policies can be designed to promote the effective uptake of biodiversity friendly agricultural practices, setting regulations for agricultural production that restrict unsustainable practices, creating incentives for biodiversity friendly practices, and supporting farmers in transitioning to biodiversity friendly practices. On the demand side, policies and regulation can be geared at creating biodiversity friendly food environments and influencing market dynamics for creating demand for sustainably produced foods. Important hindering factors in leveraging policies for biodiversity positive food systems are a lack of awareness of policy makers on the importance of biodiversity for food security and livelihoods, limited understanding of the impacts of other policies on biodiversity, and conflicts of interest.

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[24] Ibid.
[25] United Nations Environment Programme (2024). Food Waste Index Report 2024. Nairobi. Production: United Nations Environment Programme https://www.unep.org/resources/publication/food-waste-index-report-2024

Making food systems biodiversity positive requires better and collective understanding of the roles of biodiversity in the ecological processes that underpin food and agricultural production. **Science and technology** can play an important role in improving understanding of food-biodiversity interactions and fostering innovations in technology for agricultural production that supports biodiversity positive practices. While biodiversity friendly agricultural practices exist, relatively little is known about their effectiveness, applicability and production potential in different contexts. Research on the effectiveness and possibilities of upscaling these practices also require advances in assessment and monitoring of biodiversity. Successful implementation of these practices also requires a thorough understanding of the socio-economic implications. Research on consumer behaviour and effective strategies for behaviour change research can inform effective policies to influence demand.

Social organisations can promote biodiversity friendly practices in the food system by empowering farmers through strong farmer networks, engaging local communities more in decision-making, fostering agency and awareness among consumers through education, and linking consumers and farmers through community supported agriculture for example. Together social organisations can shift norms around food production and consumption.

Individual factors include the lifestyles, norms, attitudes and cultures that influence the choices of individual actors in the food system. These factors are often place based, and are influenced by the food system, for example by services such as food-waste apps and the offer of local foods or organic foods.

These biodiversity-food connections reveal that there are many different entry-points possible for strategic interventions that aim at promoting biodiversity in the food system. In annex I we provide a list entry-points that can be identified taking in consideration the interconnectedness of biodiversity with other food system outcomes. In the following section we propose points for consideration when choosing entry-points for strategic action.

Identifying entry-points for biodiversity positive change

In making decisions on where to focus efforts for improving biodiversity in the food system, some key considerations can be formulated to support decision making. Annex I lists general entry points for biodiversity positive food system change. In addition annex II poses some questions that highlight the discussed considerations for making decisions on entry points.

1. The adapted framework highlights the importance of the value chain - landscape connection in taking biodiversity positive action in food systems. The value chain and landscape approaches are connected in promoting biodiversity-positive impacts by integrating sustainable practices throughout the entire supply chain while considering the broader landscape context in which biodiversity is measured (e.g., ecosystems, watersheds). Such integrated approach can support setting boundaries that help to focus the biodiversity work in the food system.
2. To catalyse sustainable change in a system it is important to address both deep and shallow leverage points. Deep leverage points often involve altering underlying structures, mindsets, or paradigms that govern how a system operates, enabling shifts that can lead to long-lasting improvements. Activities associated with this could be education, advocacy or awareness raising. Shallow leverage points are areas in a system where changes can be made easily, but they typically result in limited or incremental impacts. These points often involve adjusting surface-level parameters, such as regulations or incentives, without altering the underlying structure or dynamics of the system.
3. Build on key strengths of your organization and partners. This could range from building up technical knowledge to policy development, education, advocacy or awareness raising. Building on the key strengths of the organization also implies knowing your network and being deliberate in the partners that you choose to work with. Such partners could be the 'usual suspects' or new 'unusual' partners. It could be an option to start first with already motivated 'usual' partners, and then continue to connect and include the more 'unusual' partners. It is also important to understand and explore where the needs and energy of partners is focused in terms of biodiversity work. This may also help

to decide on the most relevant entry point for biodiversity positive change, since a motivated coalition could be formed.

4. Build a narrative: Biodiversity-positive approaches can provide multiple societal or economic benefits. Depending on the stakeholders you work with or the target audience, it is good to build a shared narrative. This may be that biodiversity is a goal itself, based on the instrumentalism and intrinsic value of biodiversity. However, for other partners who may work towards other food system goals, connecting the importance of biodiversity for other societal or economic goals is important. This means searching for synergies with business or society, which will provide more feasibility for action. Societal benefits are especially important to consider when working in sensitive social-cultural contexts, with marginalized groups or with people living in poverty or with high food insecurity. Biodiversity-positive approaches often have a multitude of spin-off benefits for society and is therefore important for other food system priorities. In the entry point table (Annex 1) we have create a column to reflect on some of these synergies.
5. Biodiversity as a means or biodiversity as the main goal. Working in the organization on biodiversity can be done in different ways. Biodiversity could be integrated in current projects with other outcomes, in which case biodiversity can be supportive to other outcomes, or biodiversity specific projects/pilot could be set up with biodiversity outcomes as the main goal. Integrating biodiversity in other projects may be helpful when the organization is new to the topic of biodiversity and it already involved in many food system activities (orange elements in the food system framework). This approach ensures that biodiversity considerations are embedded from the outset, minimizing negative impacts and promoting co-benefits, such as maintaining ecosystem services, reducing conflicts between food system development, food security and conservation, and aligning projects with broader environmental goals. This integration may also help setting the boundaries for the biodiversity effort, such as a landscape, sector or value chain, which is helpful in building a biodiversity narrative and creating positive examples of good practices. Such pilot projects may be good examples for further building the biodiversity agenda. There is a risk with integrating biodiversity in projects, where biodiversity work serves other purposes (e.g., 'biodiversity for the food system'), namely that biodiversity may become instrumentalized, valued only for its utility rather than its intrinsic ecological value. This can lead to narrow, short-term approaches that prioritize immediate benefits (e.g., increased crop yields or pest control) over broader, long-term biodiversity goals. Therefore, as an organization which wants to work on biodiversity because it is aware of the importance of biodiversity for the food system, there is a responsibility to ensure the food system also 'works' (e.g., minimizes its impact) for biodiversity.
6. As biodiversity work is implemented it is also important to think ahead on how to monitor and evaluate biodiversity outcomes and impact in line with the organizations ToC and biodiversity standards. Pilot projects may be useful to create a good understanding on how this can be monitored and evaluated sufficiently. Whereas it is not an entry point as such for a biodiversity positive food system, it is important for future discussions and choosing entry points with most biodiversity impact potential. To this end, an initial evaluation of what specific biodiversity issues are most pressing in the targeted food system or, which associated food system practices and processes at different scales have the most negative biodiversity impact may also help to set the target.

Annex I – Entry points for Biodiversity positive action in the Food System

There are multiple general entry points for biodiversity positive action in the food system. Each of these entry points can provide synergies between biodiversity positive and other food system outcomes, or can be of interest for different stakeholders. A short description and potential synergies or interested stakeholders are identified in the below table. These general entry points are based on the WUR biodiversity positive food system program, the food systems framework, and the 2022 Mansholt lecture on Nature positive futures. The following entry points are representing different angles – some help to define boundaries (e.g., landscape, commodities, themes like diets) whereas others represent different tools in the food system that can be used (e.g., policy, finance, education). Therefore, multiple entry points could be combined depending on the organization's way of working and strategy.

Entry point	**Description**	**Synergies**	**Stakeholders[26]**
Finance & Trade	Environmental impacts are reflected in prices of products, and negative impacts are not shifted to other parts of the world or next generations. Safeguarding biodiversity is explicit in global trade agreements and regulations. Finance and trade can be used as an entry point for a biodiversity-positive food system by strategically directing financial resources and trade policies to support sustainable and biodiversity-friendly practices. For instance, providing targeted subsidies, grants, or low-interest loans for practices like organic farming, agroforestry, and habitat restoration can incentivize farmers to adopt methods that enhance biodiversity. Additionally, trade policies that favor products certified for environmental sustainability or that promote the inclusion of biodiversity-friendly criteria in trade agreements can create market demand for such practices. By aligning financial incentives and trade regulations with biodiversity conservation goals, these mechanisms can drive systemic change towards a more sustainable and ecologically resilient food system. This also means stopping harmful economic investments and accounting environmental financial risks in the food system or internalizing environmental costs.	By directing financial resources, such as subsidies and low-interest loans, towards biodiversity-friendly practices it can also improve access to finance. Aligning trade policies with sustainability goals, such as favouring certified products and including biodiversity criteria in agreements, drives market demand for eco-friendly practices, promoting wider adoption across supply chains. Additionally, internalizing environmental costs and halting harmful investments ensure that negative impacts are not externalized, leading to more equitable and resilient food systems. These synergies enhance food security, and support rural development.	Financial institutions and investors, government, trade organizations and regulators, certification bodies, food industry and retailers, farmers (cooperatives), knowledge institutes.

[26] These suggested stakeholders are just a starting point, as they are closely connected to the topic. However, the list is by no means exhaustive and can be expanded to include many more relevant actors based on the evolving needs and focus areas.

Markets	The market can be leveraged to promote a biodiversity-positive food system by creating demand for sustainably produced goods, thereby encouraging producers to adopt biodiversity-friendly practices and connect this to consumer demand. Enhancing market access for smallholder and sustainable farmers helps integrate these practices into mainstream supply chains, while market-based incentives like payments for ecosystem services can align economic rewards with biodiversity conservation. Additionally, setting supply chain standards or certifications that include biodiversity criteria ensures that large-scale retailers and food companies support and promote sustainable practices, driving systemic change towards a more biodiversity-conscious food system.	By fostering demand for sustainably produced goods, markets encourage producers to adopt biodiversity-friendly practices while maintaining business viability. Improving market access for smallholders and sustainable farmers integrates these practices into mainstream supply chains, bolstering rural economies and promoting equity. Market-based incentives align financial rewards with biodiversity conservation, while setting supply chain standards ensures that large-scale retailers and food companies support sustainable practices.	Food retailers, supermarkets, certification and standards organizations, NGOs/CSOs, government, consumers, farmers cooperatives, knowledge institutes.
Conscious Consumers	Demand can also drive the food system's production activities. Creating more connection between consumer and the production, through labelling and consumer education, can support consumer to make more biodiversity positive choices. For instance, foot printing is a method used to assess the environmental impact of an activity—creating a biodiversity footprint for a food system activity can specifically quantify its effects on biodiversity. Biodiversity footprints can be used in various ways to encourage more sustainable investments throughout supply chains while also enhancing labelling practices and boosting consumer awareness about biodiversity impacts.	Enhanced consumer awareness helps bridge the gap between production and consumption, leading to increased support investments in biodiversity-friendly practices. This alignment promotes environmental stewardship and can also improve public health by encouraging the consumption of more diverse and nutritious foods. Additionally, heightened consumer awareness and demand for sustainable products can influence market dynamics or policy.	Consumers groups, food retailers and supermarkets, food producers or processors, labelling and certification organizations, knowledge institutes, government, consumer focused NGOs/CSOs.

Policy & Governance	The policy and governance element can be used as an entry point for a biodiversity-positive food system by developing and implementing policies and regulations that prioritize biodiversity conservation and sustainable agricultural practices. This can include creating incentives for food system practices that enhance biodiversity, such as subsidies for regenerative farming or agro-ecology, or food processing, and establishing regulations that protect critical habitats and promote ecosystem restoration. Strengthening governance frameworks to ensure effective enforcement of environmental standards and integrating biodiversity goals into agricultural and trade policies can also drive systemic changes (either on regional, national or international level). This could also mean implementing or building on the interventions in the EU Farm to Fork Strategy and the Biodiversity Strategy to 2030 or supporting LMIC countries with governance and policy.	Leveraging policy and governance as an entry point for a biodiversity-positive food system creates synergies by supporting economic viability via subsidies and incentives for sustainable practices. These policies also improve consumer health by fostering safer and more nutritious food, influence market dynamics by creating demand for sustainably produced goods, and stimulate innovation and research in agricultural technologies.	Government, knowledge institutes, policy oriented NGOs/CSOs. For link to implementation also food industry or agricultural private sector.
Science & Technological Innovation	The science & technology element can be leveraged as an entry point for a biodiversity-positive food system by fostering innovations and research that support sustainable agricultural practices, processing and distribution techniques. For example, developing and implementing precision agriculture technologies can optimize resource use and minimize environmental impact, thereby preserving natural habitats and supporting biodiversity. Research into crop varieties that are more resilient to pests and climate change can reduce the need for chemical inputs, which helps protect ecosystems. Additionally, advancements in biotechnology, such as genome editing, can create crops that enhance soil health and support biodiversity by promoting practices like agroforestry and polyculture. Investing in and applying technologies that monitor and assess biodiversity can also help track and manage the impacts of food system practices on ecosystems, enabling more informed and effective conservation strategies.	The main benefits of leveraging science and technological innovation include increased agricultural productivity and efficiency, which supports food security by ensuring stable food supplies. These innovations enhance crop resilience, helping the food system adapt to climate change and reducing vulnerability to pests and diseases. Additionally, improved monitoring and assessment of biodiversity allow for more effective conservation efforts.	Knowledge institutes and implementation partners; agricultural producers, technology/biotech companies, government, CSOs/NGOs on environment, food industry companies, investors/financial companies.

Scaling biodiversity positive agricultural practices	There are already various biodiversity positive practices developed, such as regenerative agriculture, which moves from 'doing no harm' towards actively seeking to improve biodiversity for food and agriculture. Another popular practice is agro-ecology, which focuses on managing almost closed cycles of nutrients and hardly use pesticides on a wide diversity of crop species that are grown in smaller field systems. A point of entry could be to scale and distribute already developed biodiversity positive agricultural practices and create context specific options. This could entail creating focus on specific practices, such as regenerative agriculture, agro-ecology, or fertilizer/pesticide use.	Scaling biodiversity-positive agricultural practices benefits the food system by increasing its resilience to climate change, pests, and diseases, leading to more reliable and sustainable food production. These practices improve soil health, support diverse cropping systems, and enhance long-term food security while reducing reliance on synthetic fertilizers and pesticides. Additionally, they promote nutritional diversity by encouraging a broader range of crops, which can improve public health.	Farmers, CSOs, knowledge institutes, private sector/NGOs in agricultural practices, financial institutions and investors, government on different administrative levels.
Social Organisation	By strengthening networks among farmers, consumers, and other stakeholders, social organization can promote the adoption of biodiversity-friendly practices. Additionally, empowering local communities and enhancing their participation in decision-making processes can lead to more equitable resource management and conservation efforts that are aligned with both ecological and social goals. This collective action can drive systemic changes, encouraging policies and market dynamics that support biodiversity, ultimately creating a more resilient and sustainable food system. Biodiversity positive change usually imply shifting societal and individual norms. These changes are often facilitated by 'agents of change' – formal or informal leaders – who can shift public perception and build momentum to trigger change. While it is often difficult to predict exactly when this will occur, interventions can be designed to equip agents of change with enabling conditions that help to trigger this shift of norms in their actor networks.	Strengthening social organization in the food system provides several other benefits: it enhances knowledge sharing and innovation by connecting diverse stakeholders, leading to more effective solutions and practices. This collective approach also boosts community engagement and social cohesion, creating a stronger support network. Moreover, it can lead to more robust local food systems that are better equipped to respond to environmental and economic challenges, and can improve food security by fostering local production and consumption networks.	Social enterprises and cooperatives, farmers, local communities, knowledge institutes, government, NGOs/CSOs, private sector. Note: Social organization mostly happens around a topic, which defines the most relevant stakeholders

Biodiverse landscapes and seascapes	Sharing space with nature - on farms, in cities, and with energy and transport systems - leverages our potential to mitigate and adapt to a changing climate and build sustainable and resilient food systems. Landscapes include both the human and natural systems in a spatial area. This holistic perspective addresses the interconnected nature of habitats, species, and human activities, promoting biodiversity while balancing ecological, social, and economic needs. Transformations at the landscape level require inclusive engagement across multistakeholder groups with diverse views, from local neighbourhoods to national and transnational level. Involvement of those who live in the landscape is critical for negotiating the pros and cons of implementations. Integrated landscape planning is not only about optimizing various functions in the landscape, but also about acknowledging and addressing different values, conflicts and burdens of decisions, many of which will be equally legitimate but irreconcilable. Lastly, setting spatial boundaries may help in setting clear biodiversity indicators and targets.	This approach integrates multiple land uses, balancing agriculture with conservation and recreation, and fosters community engagement by involving local stakeholders in planning and management. Such inclusivity ensures that diverse values and needs are addressed, leading to more effective and equitable land use strategies. Additionally, cross-sector collaboration among agriculture, urban planning, and other sectors promotes comprehensive solutions that support both food production, resilience, and ecological health.	Government, urban Planners and local governments**,** local communities and indigenous groups, CSOs/NGOs, farmers, research institutes, landscape active private sector, recreational and tourism organizations**.** Note: chosen landscape defines which are the main stakeholders
Shifting Diets	People care about the environmental impacts of their food and their own health, and make nature-positive decisions with regard to their diet. National Dietary Guidelines tailored to local contexts offer clear recommendations for sustainable and healthy diets, emphasizing reduced consumption of meat and animal products while promoting diverse, affordable plant-based options. Governments create a healthy food environment that facilitates nature-positive choices by enhancing access to affordable, sustainably-sourced food, supporting local food initiatives, and ensuring transparent labelling of environmental impacts and product traceability. There are two confounding and persistent challenges related to consumers and their diets in which biodiversity could be addressed – the nutrition transition and the protein transition. This should be combined with the knowledge about what impact shifting diets has on human health.	Dietary shifts support better public health by addressing nutritional deficiencies and promoting diverse, nutrient-dense foods. It also strengthens local economies through enhanced access to affordable, sustainably-sourced food and fosters consumer engagement via transparent labelling and clear dietary guidelines.	Government, food industry companies, health and nutrition organizations, NGOs/CSOs, consumer advocacy groups, local food initiatives and community organizations, knowledge institutes.

Food loss and waste	Food loss and waste represent a significant resource inefficiency, costing billions of euros annually and leading to the unnecessary use of land and natural resources to produce the same quantity of food. This inefficiency indirectly contributes to biodiversity loss. Additionally, strategies aimed at reducing food loss at the field and landscape levels must explicitly account for biodiversity needs to avoid unintended negative impacts. Waste throughout the value chain could also lead to direct pollution, which is one of the main drivers of biodiversity loss.	Economic savings from reduced waste can enhance the sustainability of the food system, while strategies to minimize food loss, such as leaving field residues, can support soil health and provide resources for wildlife and pollinators. Additionally, reducing waste can improve food security, drive innovations in waste management, and promote consumer awareness about sustainability, leading to more responsible consumption patterns and overall system resilience.	Food industry companies, farmers, waste management and recycling companies, research institutes, consumer advocacy groups, CSOs/NGOs, government, food industry companies.
Sourcing biodiversity friendly raw materials	The food industry is facing heightened difficulties in accessing raw materials, resulting in price fluctuations that make many food products and imports increasingly unaffordable, which intensifies global hunger. Recent disruptions in the global supply chain have exposed the vulnerability of this system, prompting a reassessment of the benefits of more localized food networks. This re-evaluation of how raw materials are sustainably sourced and traded within food systems allows for a broader perspective on the social and ecological ramifications of sustainable sourcing, particularly concerning agro-inputs and packaging.	Focusing on locally sourced and sustainable materials can help food systems lessen reliance on unpredictable global supply chains, stimulate local economies, and minimize environmental harm through the use of eco-friendly agro-inputs and packaging. This strategy not only tackles issues of price volatility and supply chain interruptions but also ensures more reliable access to affordable food. Furthermore, catering to consumer demand for sustainable options can improve brand image and market position while promoting innovation and cooperation in sustainable practices.	Private sector partners in the agro-inputs or food value chain (processing, packaging, distribution), supply chain and logistics companies, knowledge institutes, consumer organizations.

Socio-economic inclusion/ Local ownership and knowledge	Socio-economic inclusion can be an entry point for a biodiversity-positive food system by ensuring that marginalized and local communities are actively involved in and benefit from biodiversity-friendly practices. By providing these communities with access to resources, education, and technologies, they can adopt and advocate for sustainable agricultural practices that enhance biodiversity, such as agroecology, organic farming, supporting local species, and habitat conservation. Additionally, inclusive decision-making processes that involve diverse stakeholders can lead to more effective and locally adapted conservation strategies, as local knowledge and needs are integrated into policy and practice. Empowering smallholder farmers, women, and indigenous groups to manage and conserve natural resources can also lead to more resilient and biodiverse ecosystems, as these groups often have traditional practices and knowledge that support biodiversity conservation.	Socio-economic inclusion leverages diverse local knowledge and innovation, leading to more effective, context-specific strategies for conservation. Additionally, it strengthens market access for fair trade and biodiversity-positive products, providing economic incentives for sustainable practices. This inclusive approach also fosters more equitable and representative policy and governance structures, ensuring that conservation and sustainability goals are better aligned with the needs and capabilities of all stakeholders in the food system.	Local communities and smallholder farms, indigenous groups, government at different administrative levels, agricultural cooperatives, CSOs/NGOs.
Commodity/ Sector	Using a commodity and its value chain as an entry point for fostering a biodiversity-positive food system can be more effective than other approaches due to its broad and immediate impact across multiple levels of the food system. Unlike localized or niche interventions, focusing on a widely traded commodity influences a vast network of farmers, suppliers, processors, and consumers. By transforming the practices within this value chain—such as integrating biodiversity-friendly farming techniques, processing or sustainable certification —there is potential to create significant and scalable change. Examples could be the seed sector or the cocoa or coffee value chain.	Targeting a commodity sector can synergize with other food system outcomes by enhancing climate resilience, improving food security, and boosting nutritional quality. It can also increase economic viability for farmers or process/distribution companies by reducing costs and opening premium markets, while promoting social equity by supporting smallholders and marginalized communities.	Farmers and producer organizations, food companies, government, CSOs/NGOs, financial/investors institutions, consumers, knowledge institutes.

Biodiversity for [climate] resilience	Biodiversity for resilience as an entry point for a biodiversity-positive food system focuses on enhancing the resilience of agricultural landscapes by promoting diverse ecosystems that can better withstand environmental stresses like pests, diseases, and climate change. By integrating a variety of species, crops, and farming practices, this approach creates more stable and self-sustaining systems. This not only conserves biodiversity but also builds a food system that is more adaptable and resilient to shocks, ultimately ensuring long-term food security and sustainability. *Note with this entry point, biodiversity is framed as a means to another goal, namely resilient food systems. Such narratives may be helpful to create motivation and willingness behind biodiversity positive food system practices. There are more narrative possibilities when biodiversity is presented as a means to another goal. This just serves as an example.*	*With this entry point, biodiversity is framed as a means to another goal, namely resilient food systems.* Using biodiversity for resilience as an entry point for a biodiversity-positive food system can lead to enhanced food security by stabilizing production and reducing the risk of crop failures. It may also make the production less dependent on synthetic inputs or increases nutritional diversity by encouraging the cultivation of a wider range of crops, which supports better health outcomes.	Farmer and agricultural cooperatives, CSOs/NGOs, government at different administrative levels, food companies, knowledge institutes, local communities.
Education, advocacy and awareness raising	Education, awareness raising, and advocacy can empower individuals and communities with the knowledge and tools necessary to understand and engage with biodiversity issues. Through educational initiatives, people can learn about the importance of biodiversity, the threats it faces, and the role they can play in its conservation. Awareness-raising campaigns can foster a collective consciousness about biodiversity, inspiring action and behavioural change at the local, national, and global levels. Advocacy efforts can influence policy decisions, mobilize resources, and hold stakeholders accountable, ensuring that biodiversity considerations are integrated into development plans and practices.	Education, advocacy or awareness raising can promote practices that simultaneously benefit health, livelihoods, and sustainability. For instance, educating communities about biodiversity practices that enhance soil health, boosting crop resilience, and improving nutritional outcomes. Advocacy for biodiversity-friendly food production can reduce reliance on chemical inputs, thereby safeguarding water quality and reducing greenhouse gas emissions. Raising awareness around sustainable consumption can shift consumer demand toward healthier, locally sourced, and seasonal foods, which supports small-scale farmers and strengthens local economies.	Educational institutes, environmental NGOs/CSOs, government at different administrative levels, producer organizations, consumer groups, local communities, media and communication platforms, advocacy groups, knowledge institutes.

Annex II – Additional considerations for choosing entry points

Choosing entry points for biodiversity improvement in the food system depends on the impact you want to achieve. Some key questions to ask:

- *What specific biodiversity issues are most pressing in the food system I am targeting? Which practices or processes in the food system have the greatest impact on biodiversity within the system?*

Overall land use change and exploitation are proven to be the main driver of biodiversity loss[27]. Practices with the greatest impact on biodiversity in the food system include land use changes that convert natural habitats into agricultural areas, monoculture farming that reduces plant diversity, and the use of pesticides and herbicides that harm non-target species like pollinators. Intensive livestock production contributes to habitat destruction and pollution, while certain soil management practices degrade soil health and microbial diversity. Water management issues, such as over-extraction and pollution, affect aquatic ecosystems, and the introduction of invasive species can outcompete native species and disrupt ecosystems. Additionally, genetic uniformity in crops and livestock reduces overall genetic diversity, impacting resilience and adaptability.

However, main issues may differ between contexts. This also means the indirect drivers can be most pressing in certain contexts. For example, there might already suitable policy in place but the limiting factor is the implementation. A context analysis, of main biodiversity issues and pressures can therefore be helpful.

- *On what scale lie my strengths and can most impact be achieved? Landscape, national, value chain?*

Looking at biodiversity improvement from a landscape scale offers a holistic approach by integrating various ecosystems and addressing habitat fragmentation, which enhances overall ecological resilience and ecosystem services. Since ecological processes are mostly spatially based, this approach can target multiple assets of biodiversity in one area. Landscape approaches are, however, sometimes more difficult to understand by the multiple stakeholders in the landscape. Conversely, examining biodiversity at a value chain scale allows for targeted interventions at specific stages of production, directly influencing key players and integrating biodiversity with economic incentives. This approach can lead to more immediate and practical changes, streamline efforts for greater efficiency, and engage consumers through biodiversity-friendly practices and products. Both scales provide unique advantages, with the landscape scale focusing on broader ecological impacts and the value chain scale addressing practical, economic, and consumer-oriented aspects.

Some additional questions to reflect on when determining what entry points are most relevant:

- *What are my or my organization's strength in terms of biodiversity related topics?*
- *What are the potential benefits and trade-offs of different intervention strategies, when also considering other social/economics or environment outcomes?*
- *On the basis that collaboration is needed to crate change - where do partners have most energy to contribute or collaborate?*
- *Who are your preferred partners – the usual suspects or more unusual?*
- *What are existing resources, partnerships or frameworks that could be leveraged?*
- *How will the biodiversity work or approach be monitored, incl. what are our indicators of success?*

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[27] Semenchuk, P., Plutzar, C., Kastner, T., Matej, S., Bidoglio, G., Erb, K.H., Essl, F., Haberl, H., Wessely, J., Krausmann, F. and Dullinger, S., 2022. Relative effects of land conversion and land-use intensity on terrestrial vertebrate diversity. *Nature communications*, *13*(1), p.615. Relative effects of land conversion and land-use intensity on terrestrial vertebrate diversity | Nature Communications
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