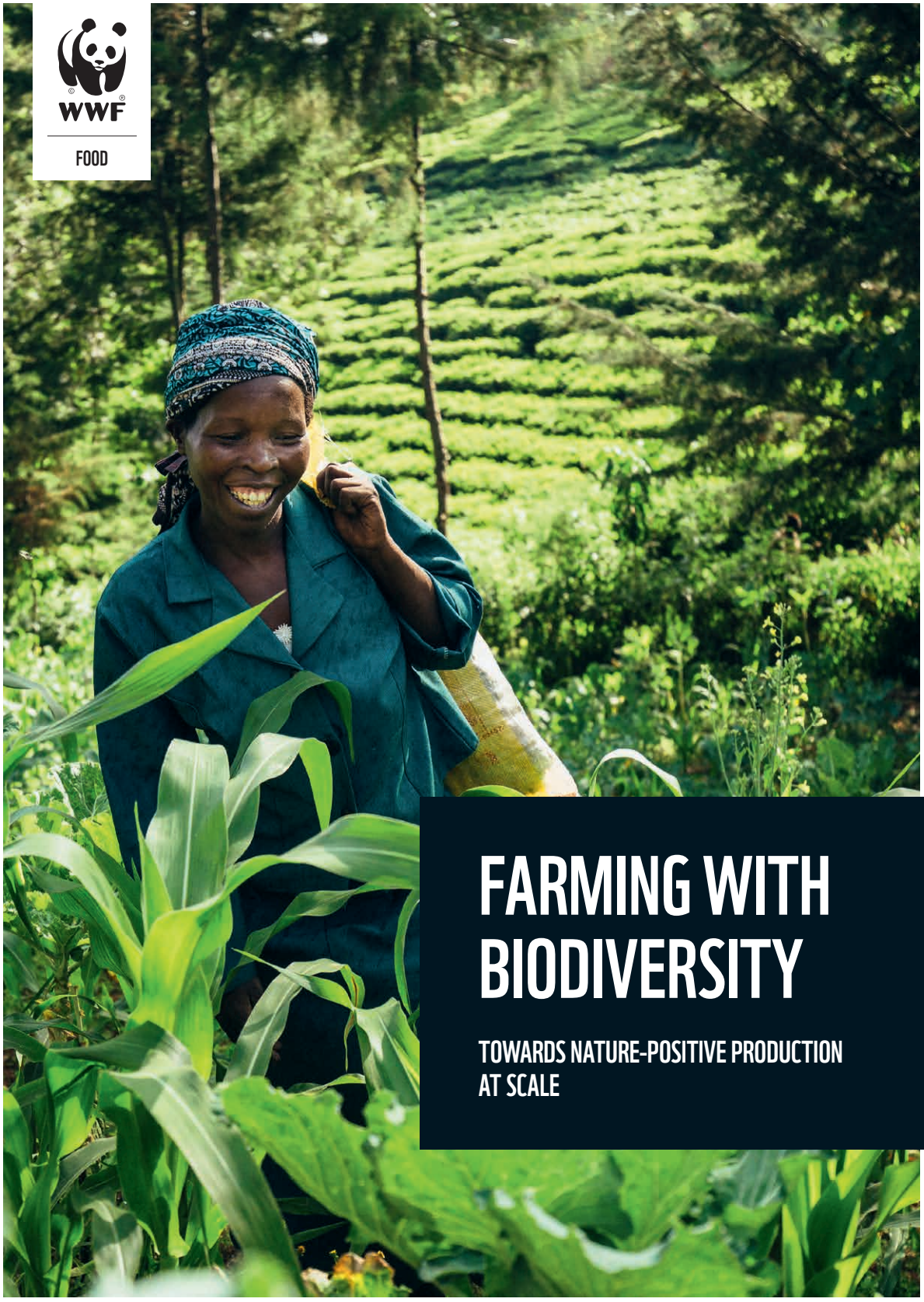
WWF

FOOD



FARMING WITH BIODIVERSITY

TOWARDS NATURE-POSITIVE PRODUCTION AT SCALE

WWF
WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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FOOD FOR CHANGE

Transforming our global food systems is central to meeting the largest challenges faced by humanity, including climate change, biodiversity loss, food insecurity and risks to future pandemics. The current food system is responsible for a third of greenhouse gases, 80% of deforestation, 70% of terrestrial biodiversity loss, and has been linked to a dramatic rise in our exposure to zoonotic diseases, such as Ebola, SARS, and COVID-19.

A healthy future requires us to halt and reverse biodiversity loss and limit climate change while meeting the fundamental human right to healthy and nutritious food for all. It is only possible to achieve this by transforming our food systems and adopting nature-positive production practices at scale and within planetary boundaries. Different solutions will be required in different contexts, but agroecological approaches, that apply ecological and social principles to agricultural production, are a fundamental part of this transformation.

The upcoming UN Food Systems Summit provides a unique opportunity to accelerate the adoption of agroecological approaches and to ensure that its relevant principles can be transferred to all nature-positive production practices. Aligned with outcomes of the conferences of the UN Framework to Combat Climate Change and UN Convention on Biological Diversity, such practices and principles when adopted at scale will bring us closer to achieving the 2030 Sustainability Agenda. Protecting nature and improving livelihoods, agroecological approaches deliver resilience and will advance all Sustainable Development Goals.

WWF is committed to further exploring how agroecological approaches can be implemented at pace and scale. We are delighted to present this paper, outlining the actions that can be taken at different levels and by different actors. We look forward to working in partnership with farming communities, civil society organizations, scientists, as well as public and private sectors to implement agroecological approaches as part of nature-positive food systems, for the benefit of both people and planet.

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SUMMARY

THE CHALLENGE AHEAD IS TO IMPROVE OUR FOOD PRODUCTION SYSTEMS WITHOUT EXCEEDING THE CARRYING CAPACITY OF ECOSYSTEMS AND THE PLANET

Our food systems are putting an impossible strain on nature and failing to nourish all people on the planet. Transforming our food systems is therefore key to bending the curve of biodiversity loss and achieving the Sustainable Development Goals. The challenge ahead is to improve our food production systems without exceeding the carrying capacity of ecosystems and the planet to meet the food and nutrition needs of current and future generations. This requires a paradigm shift from maximizing production at the expense of nature to farming with biodiversity to achieve nature-positive production at scale.

In landscapes that consist predominantly or to a large extent of intact natural ecosystems, the first priority should be to protect the remaining natural habitat, including indigenous territories, from conversion to agriculture. Land that is used to produce food needs to be managed in such a way that agriculture enhances the richness and abundance of biodiversity and ecosystem functions, reduces greenhouse gas emissions, and enhances resilience to climate change. Abandoned or degraded agricultural land needs to be restored to natural habitat or rehabilitated to support sustainable food production.

AGROECOLOGICAL APPROACHES PROVIDE A PATHWAY TO PROTECT NATURE, MANAGE AGRICULTURE IN WAYS THAT ENHANCE THE RICHNESS OF BIODIVERSITY AND RESTORE ECOSYSTEM FUNCTIONS

Around the world, research, evidence and experience shows that it is possible for agricultural systems within multi-functional landscapes to provide food, feed, fuel and fibre as well as habitat and corridor functions for biodiversity, climate resilience and enhanced ecosystem services. Agroecological approaches provide a pathway to protect nature, manage agriculture in ways that enhance the richness of biodiversity and restore the ecosystem functions of degraded systems, by applying a holistic and interconnected set of ecological and social concepts to the design and management of food and agricultural systems. The ten elements of agroecology can be applied at the farm, landscape and food system level, to realize nature-positive production at scale.

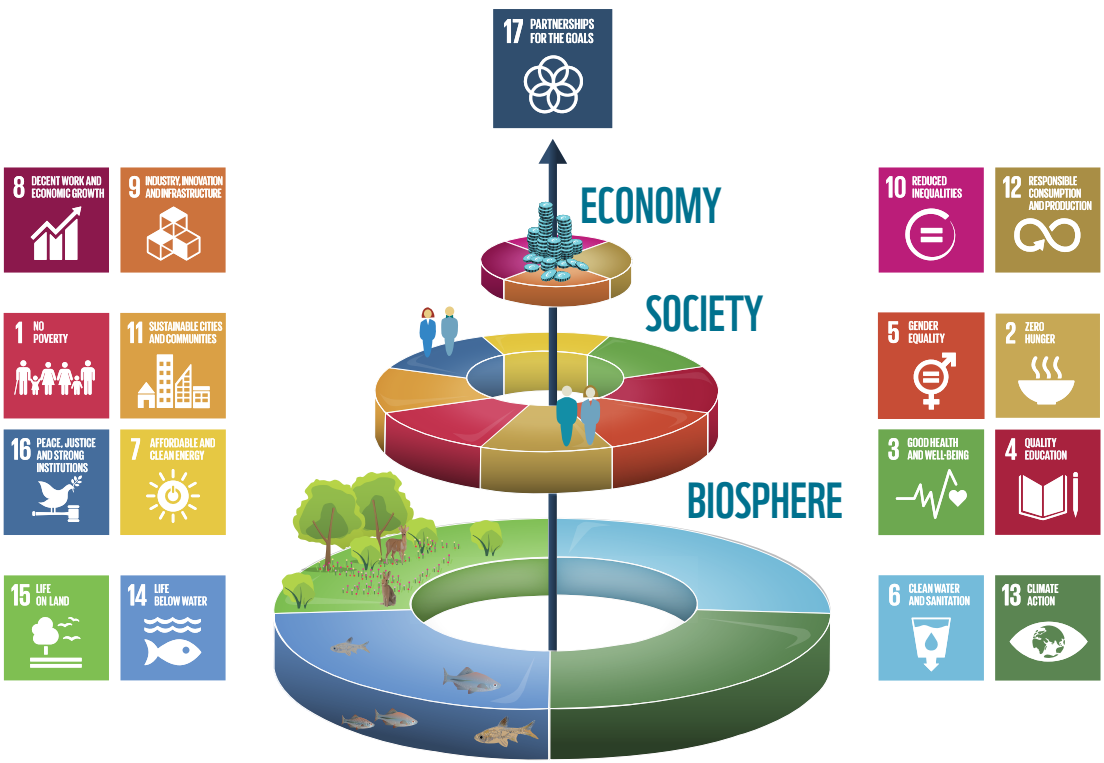
Key actors and sectors each have a role to play in accelerating this transition:

- **Civil society** plays a key role in changing the narrative, policy advocacy, raising awareness and strengthening movements in support of agroecological approaches.
- **Governments** should recognize the outcomes delivered by agroecological approaches, develop and adopt effective policy instruments and provide public incentives to mainstream nature-positive agriculture.
- **Market actors** need to set the rules to effect changes in business models and measures of success; to align long-term profitability with conservation of biodiversity, ecosystems and the ecosystem services they depend upon themselves, and to re-establish connections between producers and consumers of diversified foods produced following the principles and practices of agroecology.
- **Financial institutions** must fully integrate nature-related considerations into their decision-making, and channel investments towards diversified agroecological production systems.
- **Research** efforts and knowledge development should prioritize enhancing the scientific evidence associated with agroecological approaches to farming and landscape management, build upon experiential farmer knowledge and integrate this into education and extension.

THE CHALLENGE AHEAD

Almost all aspects of human life, from health to wealth and well-being, depend on a thriving natural world. Biodiversity provides the foundation for development, the economy, global security and human well-being as formulated in the Sustainable Development Goals (Figure 1). It plays a critical role in providing food, fibre, water, energy, medicines and other genetic materials; and is key to the regulation of our climate, water quality, pollution, pollination services, flood control and storm surges. In addition, nature contributes to non-material levels of human health – inspiration and learning, physical and psychological experiences, and the shaping of our identities – that are central to people's quality of life and cultural integrity.

Figure 1:
The Sustainable Development Goals fundamentally depend on biodiversity. Source: Azote Images for Stockholm Resilience Centre, Stockholm University (2016)



Despite the widely recognized importance of biodiversity, our planet is flashing red warning signs of vital natural systems' failure. We are currently facing diverse and mutually reinforcing human-made crises: climate change, biodiversity loss, hunger, malnutrition, as well as the COVID-19 pandemic which is impacting the livelihoods of everyone but especially affecting the poorest and most vulnerable populations. The way we produce and consume food is central to these challenges.

The past years have seen a wave of reports such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES 2019), the Intergovernmental Panel on Climate Change (IPCC 2019), and the Living Planet Report (WWF 2020), highlighting the role of our food systems in the erosion of biodiversity and natural ecosystems. With half of the planet's habitable land occupied by agriculture, the sheer scale of land use makes it the largest cause of deforestation and loss of other precious habitats such as wetlands and grasslands. Drivers linked to food production are the greatest cause of biodiversity loss, both on land as well as in freshwater. At the same time, this makes food an important lever for positive change with great potential for reform, elevating food and agriculture to the top of the conservation agenda. Recent research shows that conservation and restoration efforts are crucial to limit the further decline of biodiversity (Dasgupta 2021), but to turn the tide of biodiversity and natural habitat loss a combination of conservation with a shift to sustainable food production and consumption is required (Figure 2) (Leclère et al. 2020).

TO TURN THE TIDE OF BIODIVERSITY LOSS, A COMBINATION OF NATURE CONSERVATION AND A SHIFT TO SUSTAINABLE FOOD PRODUCTION AND CONSUMPTION IS REQUIRED

The unified message is clear: to protect and restore nature, the very foundation of our survival, we need to radically transform our food systems to ensure reduced food waste and loss, diets that have a lower environmental impact, and sustainable agriculture that balances production and conservation objectives on all managed land. Although impacts occur across the entire food supply chain - from production to final consumption - the most direct pressures exist at production-level. The focus of this paper is therefore on transforming production practices at the farm and landscape level, as well as structural transformations at the food system level to support this. However, even radically different modes of farming will not be sufficient to reduce pressure to convert natural ecosystems if they are not accompanied by a change to a more plant-based diet and reduced food waste and loss (Benton et al. 2021).

WWF recognizes the central role that food systems play in our effort to protect, manage and restore nature and biodiversity. And by doing so, to secure the foundation of food production itself, through the crucial ecosystem services nature provides. Our goal is therefore to drive nature-positive production at scale, in an inclusive way, based on the paradigm of 'farming with biodiversity'.

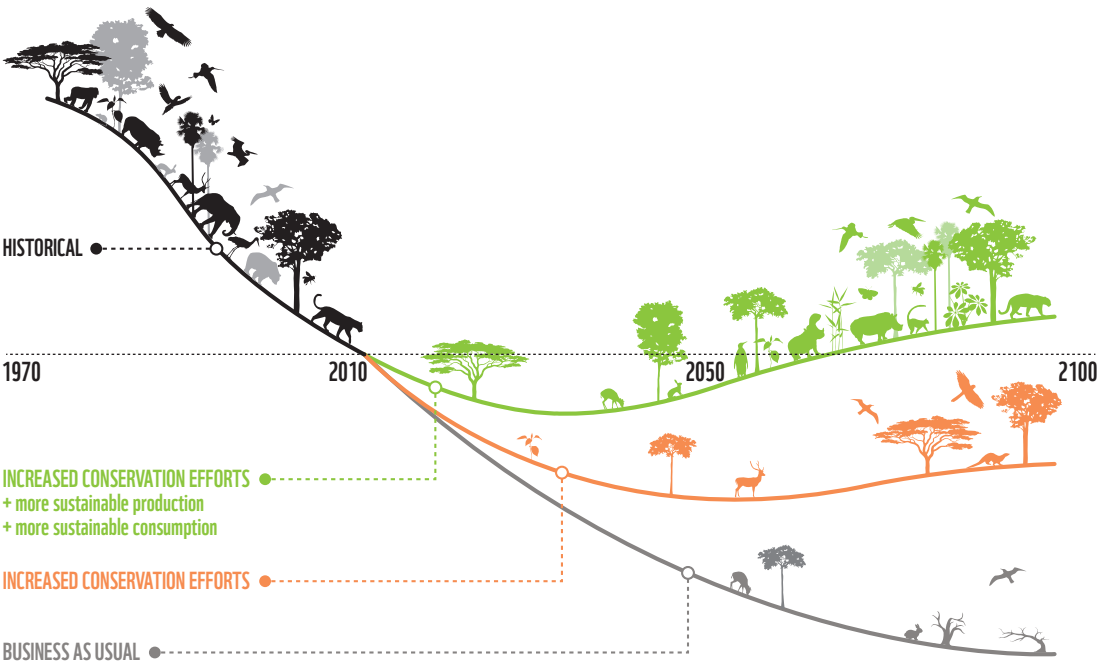


Figure 2:
'Bending the curve' modelling tells us that reversing biodiversity loss requires a strategy that combines conservation with a shift to sustainable food production and consumption (Leclère 2020). This artwork illustrates the main findings of the article, but does not represent its results. Source: Adam Islaam | International Institute for Applied Systems Analysis (IIASA)

The purpose of this paper is to outline changes needed to create such food systems that support rather than exploit nature, with a focus on agricultural production systems. It first explores the impacts of our current food production systems on nature and people, what have been the driving forces of this system and what is needed to move from nature-negative to nature-positive production. The paper then outlines how agroecological approaches provide a holistic pathway towards diversified farms, landscapes and food systems. Finally, the paper explores ways forward to accelerate this transition. Throughout the paper specific case studies illustrate what this means in practice.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FROM NATURE-NEGATIVE TO NATURE-POSITIVE PRODUCTION

OUR FOOD SYSTEMS ARE FAILING TO NOURISH THE WORLD POPULATION AND SAFEGUARD THE NATURAL CAPITAL WE DEPEND UPON

Our food systems are failing to nourish the world population while safeguarding the natural capital we depend upon. The hidden environmental, health and economic costs of the food system are estimated at almost USD12 trillion a year and are expected to rise to USD16 trillion a year by 2050 (Food and Land Use Coalition 2019). These are costs that far outweigh the monetary value the sector generates (IPES Food 2017).

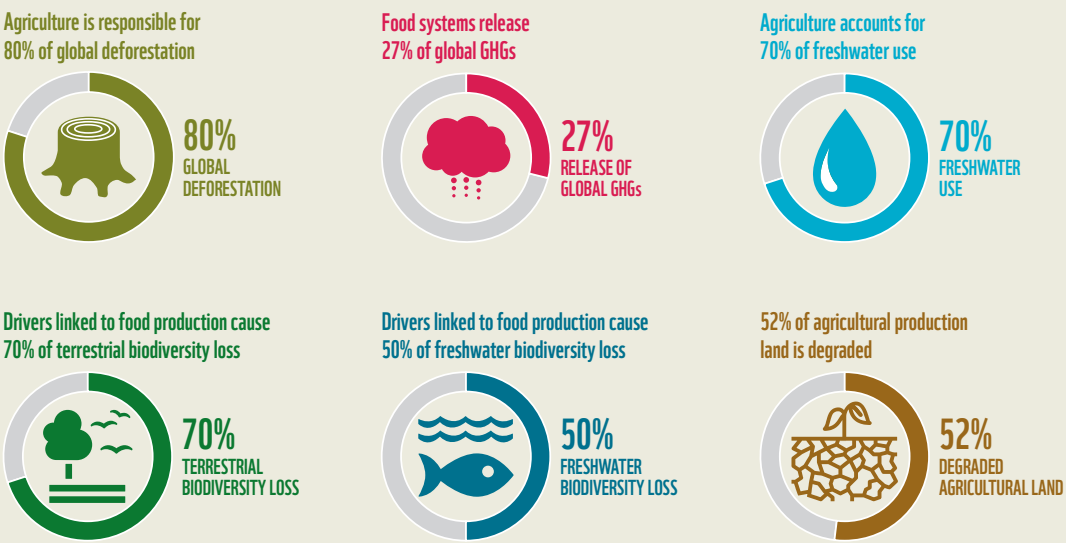
Many of the characteristics and resulting impacts that typify our globalized and increasingly industrialized food production systems, are the result of a major transformation of agriculture that took place in the 20th century during what is known as the Green Revolution. Over a period of only a few decades, intensive agricultural production methods led to unprecedented increases in yield through capital- and input-intensive technologies in many places in the world. This industrialization of agriculture - finding its expression in extensive deforestation and conversion for monocrops and industrial-scale feedlots, high chemical inputs, over-use of antibiotics and heavy tillage – was built on the premise that food production can increase exponentially by artificially and chemically enhancing and replacing nature's services indefinitely.

Although mostly large-scale farms typically engage in industrialized and homogenous production, the 'extractive paradigm' can be expressed independently of farm size. The 'cheaper food' paradigm, characterized by the growing global demand for cheap calories and resource-intensive foods such as animal products, has further shaped our globalized industrial food system over the past decades. The world's animal sector today uses the majority of all agricultural land, including 40% of our global croplands (Mottet et al. 2017). This cropland is used to produce high quality feed that humans could also eat directly, such as cereals and soy, driving deforestation and conversion and resulting in a competition for land and other natural resources between feed and food production (Van Zanten et al. 2018).

Impacts of our current food systems

On a global scale, the environmental impacts of our food production systems are well-known and severe (Steffen et al., 2015 and see infographic below). These effects are most prominently expressed at the landscape scale. As forests and other natural ecosystems are converted to agricultural land, species' habitats are lost, degraded, and become fragmented, which form the largest drivers of biodiversity loss (WWF, 2020; Dasgupta, 2021). Intensively farmed, uniform agricultural landscapes and unsustainable farming methods are a major threat to farmland wildlife such as birds and insects (e.g. Collins et al., 2020) and prevent wildlife from moving between patches of natural habitat, which is particularly problematic in light of climate change. Unsustainable agriculture also leads to environmental impacts such as pollution, soil and land degradation and over-use of freshwater, further impacting biodiversity and ecosystem health (Ramankutty et al., 2018).

Despite significant progress, almost 700 million people still go hungry every day (Herforth et al., 2020) and nearly 2 billion are overweight or obese (GBD, 2015). As agroecosystems suffer from biodiversity loss, land degradation and climate change, their capacity to provide food, feed and fibre decreases, further threatening the food security and livelihoods of local communities and small-scale producers who produce a large part of the world's food (Ricciardi et al. 2018). The current agricultural development model has also been associated with increasing economic and gender inequality (e.g. Bezner Kerr et al. 2019, De Schutter and Campeau 2018), land concentration, land grabbing and heavy debts and dependency among farmers (FAO 2017, TNI 2016). Great inequality exists particularly in access to and control over natural and productive resources as well as decision-making spaces, particularly for women and indigenous peoples (Mora and De Muro 2018, Frankema 2005).



Sources: Kissinger et al., 2012; Campbell et al., 2017; CBD, 2014; ELD Initiative, 2015; IPCC, 2019

Structural drivers, or 'lock-ins', create a set of feedback loops that keep the current food system in place. They include investments and policies that create path dependency (such as the purchasing of expensive equipment or subsidies for chemical pesticides); export orientation; the expectation of cheap food; compartmentalized and sectoral, short-term thinking; certain discourses about feeding the world focused solely on expanding production volumes; measures of success (looking at productivity of single crops instead of the farm system as a whole, including externalities) and concentration of power (IPES-Food 2016, Bakker et al., 2020).

THE INDUSTRIAL FOOD PRODUCTION SYSTEM IS ERODING NATURE'S ABILITY TO CONTINUE TO PROVIDE FOOD AND OTHER SERVICES IN THE FUTURE

The Green Revolution made it possible to grow more food on the same area of land, transforming the trade of international commodities, and making food cheaper and more accessible to many members of the global population. These positive impacts have not reached everyone, however, as Green Revolution technologies turned out not to be suitable or desirable for many farms, especially in marginalized areas. In addition, while more food, energy and other materials than ever before have become available to many people in most parts of the world, this proved, at best, to be a temporary solution. As production has boomed, so have the inputs required to maintain it, such as synthetic fertilizers, agrochemicals, machinery, with disastrous consequences for the environment. The industrial food production system is eroding nature's ability to continue to provide food and other services in the future, as we are crossing the boundaries of a safe operating space for both ecosystems and the planet. Despite its apparent efficiency, the global food system is losing resilience and is becoming increasingly unstable and susceptible to shocks and crises (Suweis et al. 2015). Since 2016, hunger and malnutrition are on the rise again (FAO 2018a).

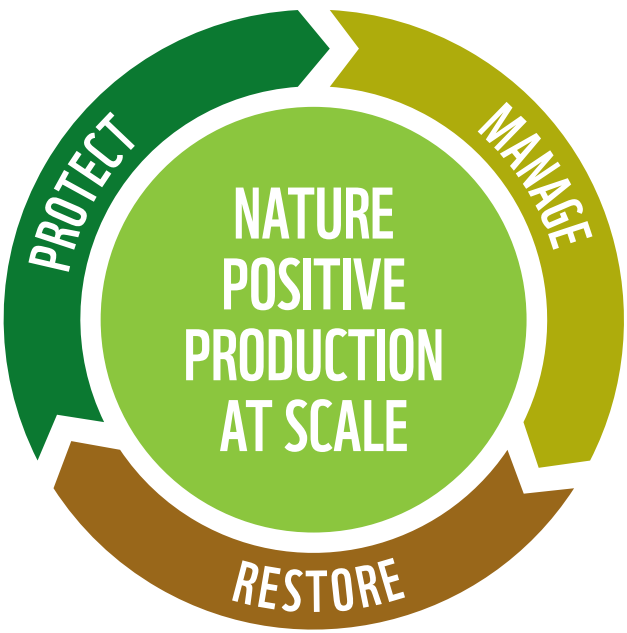
A PARADIGM SHIFT IS REQUIRED FROM MAXIMIZING PRODUCTION AT THE EXPENSE OF NATURE, TO FARMING WITH BIODIVERSITY

The challenge ahead, therefore, is to improve our food production systems without exceeding the carrying capacity of ecosystems and the planet to support the livelihoods, food and nutrition needs of current and future generations and to deliver other essential ecosystem services. This requires a paradigm shift from maximizing production at the expense of nature, to farming with biodiversity; where nature drives agriculture rather than suffering from it. Fortunately, around the world (traditional) practices and (technical) innovations in food and farming demonstrate that this is possible (see 'Enhancing livelihoods and forest conservation with Yerba Mate in Paraguay') (Willett et al., 2019; Springmann et al., 2018; Gerten et al., 2020). The potential of agricultural systems within multi-functional landscapes to provide food, feed, fuel and fibre as well as habitat and corridor functions for biodiversity, climate resilience and enhanced ecosystem services, is increasingly being recognized (OECD, 2018; HLPE, 2017; Kremen & Merenlender, 2018; Power, 2010; FAO 2019b).

Nature-positive farming is not only in the interest of conservation but is also crucial for the sustainability of food production itself (IPBES 2019). A high degree of diversity among species, varieties, breeds, populations and ecosystems can improve productivity by creating and maintaining healthy soils, pollinating plants, controlling pests, making nutrients available, purifying water, providing protection against both extreme weather events and price volatility, and delivering a range of other vital services (Dawson et al. 2019, FAO 2018a, FAO 2019a).

NATURE-POSITIVE FARMING IS ALSO CRUCIAL FOR THE SUSTAINABILITY OF FOOD PRODUCTION ITSELF

To move from nature-negative to nature-positive production, we must protect nature, manage agriculture in ways that enhance the richness of biodiversity and restore the functionality of degraded agroecosystems. In landscapes that consist predominantly or to a large extent of intact natural ecosystems, the first priority should be to protect the remaining natural habitats, including indigenous territories, from conversion to agriculture. Land that is used to produce food needs to be managed in such a way that agriculture enhances the richness and abundance of biodiversity and ecosystem functions, reduces greenhouse gas emissions, and enhances resilience to climate change. Abandoned or degraded agricultural land and soils need to be restored to healthy natural habitat or rehabilitated to support sustainable food production. To protect nature, manage agricultural landscapes and restore degraded land, the aspirations, needs and rights of vulnerable groups must be respected so that we can build a future in which people and nature can thrive (HLPE 2019).



Enhancing livelihoods and forest conservation with Yerba Mate in Paraguay

The Atlantic Forest in eastern Paraguay is one of the world's top five biodiversity hotspots and one of South America's highest priorities for bird conservation. It is home to important species such as the jaguar and the harpy eagle. But the Atlantic Forest is also one of the world's most threatened tropical forests. In the 20th century over 90% of the forest was logged for soy plantations and meat production. Agriculture constitutes a major economic sector of Paraguay, exporting a variety of agricultural commodities such as soybean, sugar, mate tea, stevia and beef. Large-scale deforestation and fragmentation associated with this export-oriented agriculture model are causing land degradation, loss of livelihoods and climate vulnerability. The high demand for agricultural areas also increases the pressure on small-scale farmers. Many have sold and left their property.

Realizing something had to be done, a group of landowners (many of them women) formed an association, capturing the attention of their local government and WWF Paraguay. Together, they created an action plan to combat deforestation, revitalize the landscape and alleviate poverty. In a large-scale reforestation effort, they have already planted 250,000 Yerba Mate trees as well as 90,000 other native trees. Yerba Mate is a native shade-grown tree that thrives in the vicinity of natural water sources. The landowners built on design principles of agroforestry systems which mimic the natural environment of the mate tree. This is aided by agroecological practices such as the use of natural processes for pest management instead of pesticides. Using artisanal processing methods, women in the communities convert raw Yerba Mate leaves into a variety of nutritious products, such as the very popular teas, and sell them on the market. In addition, a range of newly created community gardens provide a nutritious diet for the families. The women run a cooperative to organize cultivation and sales jointly, providing a strong organizational basis and allowing them to take advantage of market opportunities.

The responsible tea beverage company Guayaki, for example, is working with the communities to enhance their agroecological practices and to sell high-quality nature-friendly mate ice tea beverages to the world. At the same time, the environmental programme of one of the most powerful hydropower corporations, Itaipu Binational, is collecting seeds and learning how to scale up Yerba Mate cultivation, in close collaboration with the communities. As the Yerba Mate tree grows near waterways and springs, this provides a clear incentive to keep the water clean and protect biodiversity hotspots. In addition to the improvement of socio-economic conditions, the agroecological practices therefore help to protect and restore the Atlantic Forest, its watersheds and its species. To date, Yerba Mate agroforestry has resulted in the protection and restoration of over 40,000 hectares of forests and watersheds in the Atlantic Forest region in Paraguay.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AGROECOLOGICAL APPROACHES

AGROECOLOGICAL APPROACHES CAN PROTECT, MANAGE AND RESTORE NATURE, WHILE PROVIDING HEALTHY FOOD AND SECURING LIVELIHOODS

Agroecological approaches have gained prominence as a way to protect, manage and restore nature, while providing healthy food and securing the livelihoods of the people that produce it (e.g. FAO 2019b, Gliessman 2014). These involve applying ecological and social concepts and principles to the design and management of food and agricultural systems, and actively conserve, use, improve, and sustain biodiversity at different scales, from genetic to ecosystem diversity. By nourishing interactions between plants, animals, humans and the environment they are beneficial to people and nature, for example by simultaneously enhancing biodiversity and soil fertility, the production of healthy foods and the well-being of producers (FAO, 2019b). Agroecological approaches combine participatory processes that develop knowledge and practice through experience, with science. In Mozambique for instance, coastal communities co-designed experiments that compare agroecological with conventional practices. Through the Farmer Field Schools, over 3000 people contributed to the spread of agroecological practices. As a result, communities became less dependent on marine resources, reducing pressure on fragile marine ecosystems (see 'Farmer Field Schools spread agroecological practices in coastal Mozambique').

Agroecology's holistic perspective is evident from the interlinked and interdependent 'Ten Elements of Agroecology' developed by FAO (FAO, 2018b, Barrios et al., 2020) which present the central ecological and social characteristics of agroecological approaches (see 'Ten Elements of Agroecological Approaches'). Others have developed similar sets of principles (e.g. HLPE 2019, Cidse 2018).

The elements are universal and can be promoted and applied across geographies, production systems and scales, to guide the transition towards nature-positive production systems. However, in practice, they are locally adapted, generating a diversity of agroecological strategies suited to local circumstances. As such, agroecological approaches are not defined by a prescribed set of practices, but rather by an ongoing transition towards sustainable food and agricultural systems. They can be classified along a spectrum, according to the extent to which they rely on socio-ecological resources and processes (as opposed to purchased inputs); they are equitable, environmentally friendly, locally adapted and controlled; and they maintain a systems approach focused on interactions rather than specific technologies (HLPE 2019).

Ten Elements of Agroecological Approaches

- **Diversity:** diversification is key to food system transitions to ensure food security and nutrition while conserving, protecting and enhancing natural resources.
- **Co-creation and sharing of knowledge:** innovations in food production (in land and water) respond better to local challenges when they are co-created and contextualized through participatory processes.
- **Synergies:** building synergies enhances key functions across food systems, supporting production and multiple ecosystem services.
- **Efficiency:** innovative practices that rely on regenerative food production systems or agroecology produce more using fewer external resources.
- **Recycling:** more recycling means agricultural and fisheries production with lower economic and environmental costs.
- **Resilience:** enhanced resilience of people, communities and ecosystems is key to sustainable fisheries, food and agricultural systems. Resilience is the capacity of socio-ecological systems to maintain key aspects of their biological, social and functional identity, in a context of constant internal and external change.
- **Human and social values:** protecting and improving rural and coastal livelihoods, equity and social well-being is essential for sustainable food systems.
- **Culture and food traditions:** it is necessary to support healthy, diversified and culturally appropriate diets, thus contributing to food security and nutrition while maintaining the health of ecosystems.
- **Responsible governance:** sustainable food production requires responsible and effective governance mechanisms at different scales – from local to national to global.
- **Circular and solidarity economy:** circular and solidarity economies that reconnect producers and consumers provide innovative solutions for living within our planetary boundaries while ensuring the social foundation for inclusive and sustainable development.

Source: FAO 2018b

THE TEN ELEMENTS OF AGROECOLOGY CAN PROVIDE CRITICAL GUIDANCE FOR POLICYMAKERS, PRACTITIONERS AND OTHER STAKEHOLDERS

A wide range of other approaches exist, that rely on agroecological principles to different degrees. These include, for instance, organic farming, agroforestry and regenerative farming, which share a focus on specific biodiversity-enhancing practices such as nutrient cycling, natural pest management, soil and water conservation, the reduction of synthetic pesticide and mineral fertilizer use, and the inclusion of landscape elements such as hedgerows and flower strips (Oberc & Arroyo 2020). Other approaches, such as Community Supported Agriculture, emphasize social aspects like participation, transparency or food cultures. In practice, a varying combination of these can often be found on a farm or in a landscape.

Together, the ten elements of agroecology can provide critical guidance for policymakers, practitioners and other stakeholders in planning, managing and evaluating agroecological transitions.

Production, food security and livelihoods

AGROECOLOGICAL PRACTICES CAN PRODUCE ENOUGH FOOD AND PROVIDE A VIABLE ALTERNATIVE TO INDUSTRIAL FARMING

Supporting the adoption of agroecological approaches towards nature-positive production at scale often raises the question whether these types of farming systems can provide food and nutrition security to the global population. While yields of industrial farming are, in general, higher than those that use smaller amounts of external inputs in the form of fertilizers and agrochemicals, this does not mean that a carefully managed large-scale shift to agroecological approaches would compromise global food security. Access to nutritious food is a complex issue that is not necessarily connected to the volume of food produced, but more often linked to poverty, food distribution and market dynamics. Various studies, research pilots and modelling exercises have shown that, in time, it is possible to transition the entire farming sector to agroecological practices while still producing enough food and providing a viable alternative to industrial farming in both developed and emerging economies, as well as job opportunities due to its knowledge-intensive nature (Poux & Aubert, 2018; Larbodière et al., 2020, SystemIQ).

A growing body of research is corroborating these findings, showing that agroecology can be as productive as other models of production (e.g. Biovision, 2020a; IPES-Food, 2016; HLPE, 2019; Van der Ploeg et al. 2019, d'Annolfo et al. 2017, Pretty et al. 2018) while enhancing ecosystem services (Tamburini et al. 2020). For some crops, the yield gap decreases as soil fertility improves, and farmers are often compensated by lower input costs (e.g. fuel, nutrients, pesticides, irrigation) and more stable yields (EEA, 2020). Technologies and innovations can help to further close any remaining yield gaps.

Agroecology and resilience

Agroecosystems are increasingly prone to external shocks such as those resulting from climate change: changes in temperature and rainfall patterns affect crop growth and productivity, which may be further aggravated by climate-induced changes in the occurrence of pests, diseases and weeds. Strengthening ecological resilience of agricultural systems is key to increasing their ability to recover from such disturbances and limiting the negative effects of climate change on food security, and social and economic stability.

Studies have shown that biodiversity at the farm and landscape level is the foundation of productive and resilient agricultural systems (Rockström et al. 2020, DeClerck et al. 2021, IAASTD 2008). Agroecological approaches enhance biodiversity and increase resilience through practices such as polycultures, agroforestry systems, mixed crop-livestock systems, and sustainable soil and water management (Altieri et al. 2015, Barrios et al. 2018). Many biodiversity enhancing measures in agroecology are inspired by traditional farming systems and can also be applied to improve the ecological resilience of industrial agricultural systems.

These practices enhance not only ecological but also socio-economic resilience. By cultivating a diversity of crops and livestock, producers are less dependent on a single commodity, making them less vulnerable to total harvest failure and economic risk (Van der Ploeg 2008). In addition, by relying on natural pest management and healthy soils, farmers become less dependent on external inputs such as pesticides and fertilizers. Agroecological approaches further enhance institutional resilience by emphasizing the use of farmer knowledge, creativity and resources. This reduces the dependency on genetic resources and knowledge controlled by external institutions, improving the capacity to adapt to changing circumstances (Van den Berg 2018).

To assess agroecological resilience, including its ecological, socio-economic and institutional aspects, the following criteria can be applied (Tittonell, 2020): self-regulation, connectivity, functional diversity and redundancy, response diversity, space and time heterogeneity, building of natural capital, social self-organization, reflective learning and human capital, autonomy and local interdependency. Together, these criteria provide a tool to steer transition efforts and monitor how they impact the resilience of agroecosystems over time.

Farmer Field Schools spread agroecological practices in coastal Mozambique

One of the largest marine protected areas in Africa, the Primeiras and Segundas Environmental Protection Area (PSEPA) consists of biodiversity rich ecosystems such as extensive coral reefs, seagrass beds, mangrove forests, coastal dunes and coastal forests. It provides habitat to a variety of animals, such as marine turtles, sharks, rays, seabirds, crustaceans, molluscs and others. Communities living in the coastal areas of PSEPA fish, collect crustaceans and molluscs and engage in other activities that support their livelihoods such as subsistence agriculture. However, with 340,000 people living within PSEPA (2007 estimate), population growth is putting pressure on marine and coastal resources. This pressure is further increased by a high poverty rate, extreme weather events and increasing demand for seafood from foreign and national markets.

Protecting the critical biodiversity areas, such as Community Sanctuaries and Integral Natural Reserves, and promoting sustainable fishing and mangrove management are considered important ways to reduce the pressure on coastal and marine ecosystems. In addition, sustainable farming makes a key contribution. In this coastal area, agriculture is subsistence oriented, practiced in sandy, poor soils and dependent on unpredictable rainfall.

Agroecological approaches were promoted in PSEPA by WWF and AENA, a local civil society organization. The principles and practices that have been promoted include minimum tillage, permanent soil cover, crop rotation and diversification, the use of natural fertilizers, intercropping, mulching and green manure among others. Farmers experiment with these practices through Farmer Field Schools (FFS) in PSEPA. In an FFS, a group of 10 to 30 farmers and a trained facilitator meet in the field. Together they design experiments to compare conventional and agroecological practices. Throughout the experiment they measure plant development, take samples of pests, count plants with diseases, monitor crop yield and soil characteristics amongst others. Farmer Field Schools have been crucial in ensuring the successful development and spread of agroecological practices in PSEPA. By emphasizing practical experimentation, observation and joint reflection, crucial processes of knowledge development have been facilitated that combine new ecological concepts with local experience. The strong engagement of farmers in these processes ensure that resulting practices align with their values and needs.

Between October 2015 and March 2020, almost 3000 people have participated in Farmer Field Schools. Through the FFSs, various agroecological practices that enhance farm production have been developed and spread, making coastal communities less dependent on food and income from coastal and marine resources. This has led to higher yields, especially of cassava, the major staple crop in the region. Crops grown for mulching and intercropping provided additional sources of nourishment and income. The new practices also improved soil fertility and water retention capacity. Moreover, increasing soil fertility led to a major reduction of slash and burn practices. As a result, the initiative had a crucial impact on conservation efforts through the reduction of both deforestation and uncontrolled forest fires.


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Agroecology, technology and scale

Agroecology is often associated with small scale or subsistence farming, and with being low-tech. Yet, agroecological approaches can be applied across production systems and scales, and be supported by both high- and low-tech innovations (Figure 3).

AGROECOLOGICAL APPROACHES CAN BE APPLIED ACROSS PRODUCTION SYSTEMS AND SCALES, AND BE SUPPORTED BY BOTH HIGH- AND LOW-TECH INNOVATIONS

Even in the case of highly mechanized, commercial, large-scale cropping and livestock systems, agroecological approaches can be an important means to improve environmental performance, while at the same time reducing costs and risks and promoting a new generation of large-scale sustainable farmers. Research shows that agroecology can be effectively integrated in such systems through five areas of change (Tittonell et al., 2020). They include an orientation towards breeding for diversity instead of monocultures and the related need to scale up complexity management. Other areas of change are connected to the required landscape approach and focus on managing cycles beyond fields and farms, and sharing the cultivated landscape with other land users. And lastly, developing agroecological approaches in highly mechanized, large-scale farming through co-innovation between farmers, value chain actors and policy makers.

Although successful examples show that it is possible (Kleijn et al., 2019; Sukkel et al., 2019), systemic changes are needed to overcome some of the lock-ins, such as commercial and value chains impediments, and production subsidies or taxes, that prevent wide-scale adoption of agroecological approaches among large-scale industrial farmers. In addition, co-innovation and technology development are needed to address the lack of appropriate knowledge, management practices and technologies adapted to large field sizes and mechanized farming.

ADVANCED TECHNOLOGIES CAN SUPPORT AGROECOLOGICAL APPROACHES WHILE CORRESPONDING TO THE NEEDS OF FARMERS IN TERMS OF ADAPTABILITY, PERFORMANCE, AND ACCESSIBILITY

An example of agroecological co-innovation in large-scale agriculture can be seen at the Farm of the Future in the Netherlands (Wageningen University, 2020). On more than 100 hectares, farmers and researchers of Wageningen University are working together to test new methods of cultivation and technologies such as GPS, sensors, satellite imagery, drones, ICT and robotics to reduce the use of artificial fertilizer and pesticides and to contribute to the restoration of nature, plant- and animal species, and soil life. On the Farm of the Future, different types of crops are cultivated together, increasing diversity in space and time (Ditzler et al., 2021). On many large farms, this is currently difficult to implement, because mainstream agricultural technology is suited to large fields with a single crop. The Farm of the Future seeks to build on both scientific and farmer knowledge to test,

adjust and improve the building blocks to facilitate the transition. Technologies used range from tailored watering, sowing, pest-control and fertilization, to planning thoroughfares, strip cropping, mixed tilling and automatically monitoring plant growth. All results and data from the project are made available through open source technology.

Similarly, when technologies are part of a responsible innovation system – co-created solutions that address farmers' needs – and are inspired by and harmonized with ecological processes, they can also make an important contribution to the development, adoption and scaling of agroecological approaches in small scale or subsistence farming systems (Ajena 2018). Such technologies may include for instance drip irrigation, fertilization through mycorrhizal funghi, and bokashi composting, but also agro-equipment adapted to mixed crops, such as specialized machines for sustainable weed management or composting. There are sensors that help measure plant or animal needs, tools to quickly share information among a farming community, and new apps that enable farmers to sell their products directly. Digital tools can also be used in agroecological approaches by sharing open-source information such as crowd-sourced soil data. These advanced technologies can support agroecological approaches while corresponding to the needs of farmers in terms of adaptability, performance, and accessibility (Ajena 2018). Putting technology at the service of agroecology provides a real opportunity to enhance farming with biodiversity, through the sharing of data and knowledge development (Bellon Maurel and Huyghe 2017).

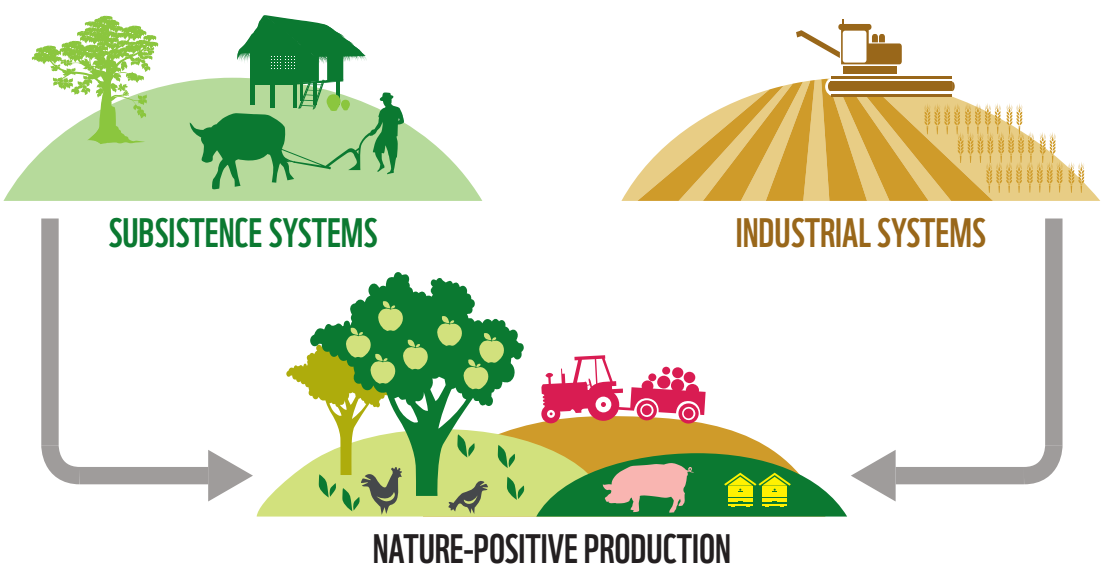
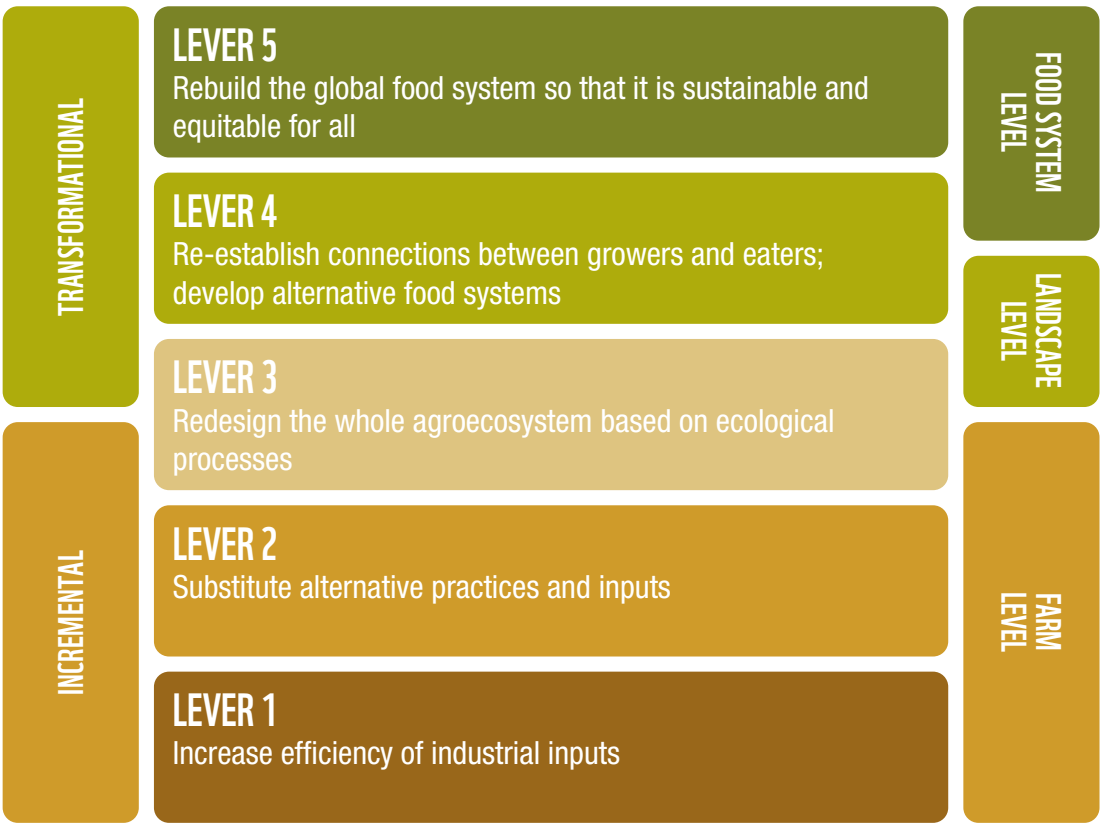


Figure 3:
Agroecological approaches can be applied across geographies, production systems and scales, to guide the transition towards nature-positive production
Source: WWF, 2016 (adapted from: IPES Food, 2016; FAO 2018b)

THREE LEVELS OF ACTION

Agroecological approaches can be expressed as farm level practices that use few external inputs but high agrobiodiversity, at the landscape level to include landscape scale processes and encompassing landscape ecology, as well as at the systems level, through social and political processes that support the development of equitable and sustainable food systems (HLPE, 2019). A series of interconnected levers can support agroecological transition across these different levels of action to progress from incremental to transformational change (adapted from Gliessman 2014, 2016, Figure 4). A transition can start at farm level, landscape level or at systems level with conducive policies, technological or institutional innovations enabling farmers to change (Tittonell 2014, Mier y Teran et al. 2018).

Figure 4:
Agroecological approaches operationalized in five levers at three levels of action. Source: adapted from Gliessman 2014, 2016



Farm level

At the level of the farm, agroecology is mainly concerned with the establishment of sustainable production practices. Many of these practices enhance biodiversity while improving food production. They include minimizing soil disturbance and tillage, nutrient cycling, natural pest management, water conservation, mulching, the use of (green) manures, crop rotation, cover and companion cropping, the reduction of synthetic pesticide and mineral fertilizer use, lower livestock densities, managed and free-range grazing, crop diversification, nutrient balancing, recovery and reuse, and the inclusion of landscape elements such as hedgerows and flower strips (Oberc and Arroyo, 2020).

In addition to ensuring that agricultural land is used sustainably, agroecological practices can also be used to rehabilitate degraded land (e.g. Bruil and Gubbels, 2019). This is critically important given that there are 500 million hectares of abandoned agricultural land and more than half of our current farmland is considered to be degraded and thus underperforming as both an economic and environmental asset (UNFSS 2020). Restoring soil health through agroecological practices boosts sustainable food production, reducing the pressure to convert more natural areas into agriculture. Diverse agroecological systems can also provide nature-based solutions to the impacts of climate change. Such systems have shown to be much better able to withstand the impacts of droughts, frost or instances of heavy rainfall or even hurricanes (e.g. Felix and Febles 2020) in comparison to monocropping systems, thereby reducing the risk of harvest failure and food and income insecurity (Wezel 2016, IPES 2016). This is illustrated by the case of Hurricane Mitch in Central America in 1998. Agroecological farms that practiced agroforestry, contour farming and cover cropping retained 20–40 percent more topsoil, suffered less erosion and experienced lower economic losses as a result of the hurricane than neighbouring farms practicing conventional monocultures (Holt-Giménez 2002, Felix and Febles 2020).

DIVERSE AGROECOLOGICAL SYSTEMS CAN PROVIDE NATURE-BASED SOLUTIONS TO THE IMPACTS OF CLIMATE CHANGE

Farm level action is expressed through the first three agroecological transition levers in Figure 4. The first lever is resource use efficiency through practices that reduce or eliminate the use of costly, scarce, or environmentally damaging inputs. The second lever entails the substitution of conventional inputs that have negative impacts on the environment with the use of co-existing biota (such as the plant microbiome or natural enemies of pests) to improve plant nutrient uptake, stress tolerance and defences against pests and diseases (El Mujtar, et al; 2019; Kebede et al. 2018). The third lever relates to the full redesign of the farm to improve soil and animal health,

enhance diversification and recycling, reduce inputs, and increase synergies on farms and across landscapes. An example is the enhancement of on-farm agrobiodiversity through rotation, multi-cropping, agroforestry and the (re-)integration of animals and crops. There is a strong focus on managing interactions amongst components, for example through the strategic use of crop residues as mulch or animal feed. Mixed farming systems, where crop and animal farming are closely integrated, as well as grazing-based livestock farming based on the sustainable use of natural or semi-natural grasslands, are well recognized agroecological practices.

Landscape level

MORE SYSTEMATICALLY ENHANCING THE POSITIVE AND REDUCING THE NEGATIVE IMPACTS OF AGRICULTURE ON BIODIVERSITY, REQUIRES A LANDSCAPE PERSPECTIVE

A landscape is a socioecological system; the outcome of the interaction between nature and culture within a geographical space. More systematically enhancing the positive and reducing the negative impacts of agriculture on biodiversity, requires a landscape perspective (e.g. Dawson et al. 2019, Sayer et al. 2012, Morse et al. 2014; Kebede et al., 2019). Integrated, multifunctional, 'mosaic' landscapes can provide food, feed, fuel and fibre while enhancing biodiversity, climate resilience, the provision of ecosystem services and supporting the needs and identities of local communities (OECD 2018, HLPE 2017, Kremen & Merenlender 2018; Power, 2010). This is of particular importance in marginal areas that are subject to environmental degradation and extreme climatic events.

Agroecological approaches aimed only at incremental improvement of management practices at the farm or commodity level, rather than taking the ecosystem's carrying capacity as a contextual reference, may not be sufficient to realize nature-positive outcomes at the landscape scale. For example, if water use is reduced at farm level, natural water flows may be still threatened if total water abstraction for agricultural use exceeds the ecological limits of a river basin (WWF et al., 2017). Nature-positive production therefore requires looking beyond the farm gate to manage the landscape matrix in a more integrated way. This is also related to the third transition lever in Figure 4: the redesign of farming systems and promotion and support of a widespread uptake of agroecological practices in the entire landscape. In this way, agroecological approaches enhance biodiversity and resilience at the landscape level by integrating sites of production, conservation and consumption.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THE INTEGRATION OF PRODUCTION AND CONSERVATION IN LANDSCAPES CAN PROVIDE HABITAT AND CORRIDORS FOR WILDLIFE

In addition, taking a landscape scale perspective allows for management of the land use matrix to provide optimal connectivity between areas of natural habitat and to manage agricultural land within the mosaic to provide habitat and corridor functions for wildlife. Well-connected, biologically diverse ecosystems tend to be more resilient to disturbances than fragmented and degraded ecosystems. The integration of production and conservation is sought in managing landscape components of agricultural systems - from hedges, woodland patches and clearings in forests, to waterways, ponds or other biodiversity-friendly features of the production environment – that can provide habitat for specific species (Kremen & Merenlender, 2018; Wright et al., 2012). These elements can facilitate species dispersal through corridors and along migratory routes, which is especially important in light of climate change (Driscoll et al., 2013; Fagan & Holmes, 2006). In Central India for instance, farms make up an important element of the landscape mosaic, allowing tigers to move from one protected reserve to another. This corridor function was strengthened by agroecological practices which, apart from adding biodiversity to the corridors, contributed to the viability of farming, reducing production costs by 75%. Thus, it became less likely farmland would be taken up by other, less corridor friendly land uses such as mining or industry (see 'Farms and forests: connecting landscapes in India').

The emphasis that agroecology places on farmers' breeding of plants and animals, community seed exchanges and food fairs also give rise to the diversity of varieties, breeds, cultural identities, traditional dishes and other characteristics that enrich the landscape (Escobar, 2010). This includes the use of indigenous breeds and varieties that are adapted to climatic conditions. For instance, in a municipality in the north-eastern part of Brazil, 67 varieties of beans with different characteristics were found (Petersen et. al. 2014). While some varieties were cultivated for their resistance to drought or pests, others were selected because of their taste and acceptance in the market. Conserving the traditional varieties, or agrobiodiversity, is also important as a living germplasm bank for the future challenges of agriculture, including climate change. Another way in which agroecological approaches foster landscape resilience is by reducing the dependency of food systems on externally derived (chemical) inputs, instead making use of resources available in the landscape, for instance, by sourcing cattle manure from neighbours (van der Ploeg 2008).

Agroecological approaches also support closer relationships between the people who grow food and the people who eat it, promoting values of local biodiversity and healthy landscapes (van den Berg et al. 2018). Pathways for these relationships are the development of direct sales and new alternative food networks (Figure 4, lever 4), from farmers' markets, to community supported agriculture and other direct marketing arrangements that not only strengthen biodiversity but are also fairer and more just (e.g. Pahnke 2015). A recent study illustrates how alternative food markets in Latin America are instrumental in coping and adapting to COVID-19 challenges (Tittonell et al. 2021). It shows that these markets are less dependent on inputs from outside the region, which in times of a COVID-19 induced lack of or reduced mobility of goods and services is an advantage. Because of their proximity to consumers and the limited number of intermediaries they are also quick to adapt to COVID-19 measures, thereby ensuring that people continue to have affordable and healthy food.

AGROECOLOGICAL APPROACHES SUPPORT CLOSER RELATIONSHIPS BETWEEN THE PEOPLE WHO GROW FOOD AND THE PEOPLE WHO EAT IT

The landscape is also the site where farmers and communities are confronted with other land-use interests, including, for example, those of mining, tourism and nature reserves (WWF 2015). Territorial governance arrangements for agroecology can help to strengthen biodiverse landscapes (Anderson et al. 2020, Van den Berg et al. 2019). The arrangements ensure that participatory decision-making processes for people living in these landscapes are in place and strengthen their negotiating position against powerful agents such as governments or multinational corporations. This is crucial for achieving positive outcomes for ecosystem conservation, food production and livelihood improvement (Estrada-Carmona et al., 2014; Perfecto et al., 2009; Polasky et al. 2012). The focus of interaction is then likely to move from emphasizing competing demands to creating mutual interest for landscape management (Chatterton et al. 2016, WWF et al. 2015). It requires farmers to be able to design and voice their own solutions, protect their rights, improve livelihoods and promote equity, justice and social well-being, particularly for women. As such a landscape approach can help to prevent and resolve potential conflicts between conservation, food production and other socio-economic interests (Estrada-Carmona et al. 2014, Perfecto et al. 2009, Polasky et al. 2012).

A LANDSCAPE APPROACH CAN HELP TO PREVENT AND RESOLVE POTENTIAL CONFLICTS BETWEEN CONSERVATION, FOOD PRODUCTION AND OTHER INTERESTS

Farms and forests: connecting landscapes in India

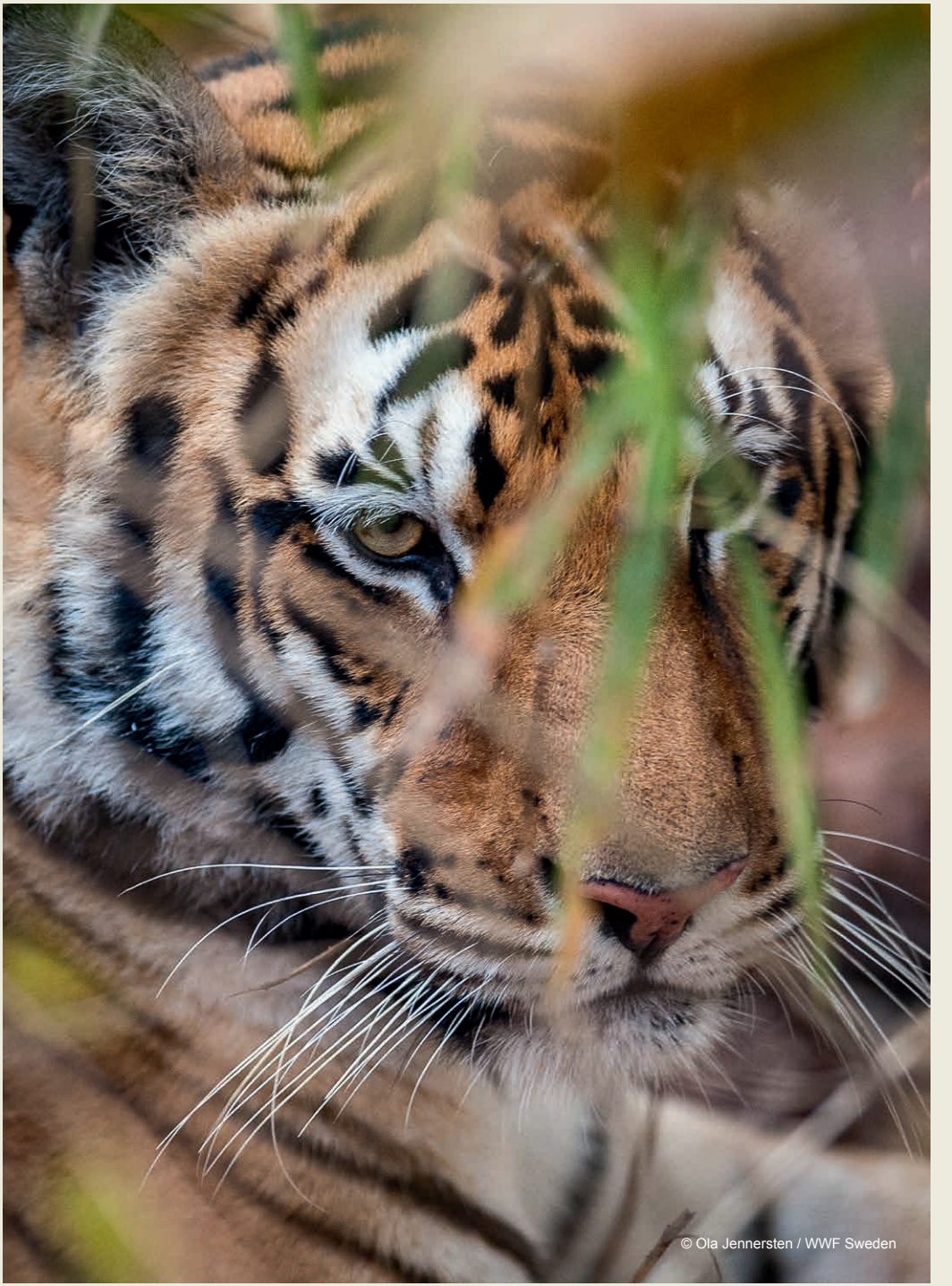
Holding close to 20% of the global tiger population, the Central Indian Landscape is one of the most important tiger conservation areas in the world. It is a forest-agriculture mosaic landscape, mostly made up of small and medium scale, relatively diverse agriculture systems. These farms play a crucial role in providing ecological connectivity across the landscape, allowing tigers and other large mammals to disperse.

However, the ecological corridors of the Central Indian landscape are threatened by diminishing returns in farming. For many farmers, yields are stagnating while the cost of inputs remain high. As a result, agriculture fields are being replaced by mining, tourism, urbanization and industry. To counter this trend, and contribute to the viability of agriculture, WWF India worked with civil society organizations, community institutions and local governments to promote agroecological practices in cotton cultivation and create new markets. Efforts were focused on one of the key corridors in the landscape: the Satpuda-Pench tiger corridor.

Practices such as the growing of farmers' own seeds and the application of organic manure, bio-fertilizers and bio-pesticides were promoted. Farmers established chemical-free cotton production systems and used nitrogen-fixating pulses as a fertilizing intercrop. In addition, market linkages were created for organic cotton. Local farmer organizations were connected directly to organic brands, retailers and certification agencies, thereby avoiding intermediaries.

These efforts reached about 6000 farmers in the corridor. The organic market gave farmers a price of 10% above the prevailing market price for conventional cotton. The premium price for organic cotton and a reduction in input costs of almost 75% contributed to improving farmers' livelihoods, while creating conditions for maintaining the corridors and farmlands that form part of an agroecological landscape integrating conservation and production.

Community based institutions and (grassroots) civil society organizations were crucial in ensuring that agroecological practices and the organic market became embedded in the landscape. They were important in stimulating a deep engagement with the local community, facilitating collective action and involving farmers in decision making processes. They also played an important role in ensuring that external support from development aid agencies, philanthropic institutions and local government was steered by the priorities of the community. One of the challenges ahead is to establish and broaden market opportunities for products grown using agroecological approaches, beyond cotton.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Food systems level

FOOD SYSTEM TRANSFORMATION REQUIRES A SHIFT TOWARDS A MORE HOLISTIC UNDERSTANDING OF AGRICULTURE, FOCUSING ON ENHANCING AND SUSTAINING THE PROVISION OF MULTIPLE SERVICES RATHER THAN MAXIMIZING YIELDS AT ALL COSTS

It is important to recognize that farming practices and landscape management exist within wider economic and political contexts, which have evolved over time and can be hard to change. Supporting the transition to sustainable food and agricultural systems requires a long-term perspective and holistic approaches such as those embedded in agroecology. Rather than tweaking the practices of unsustainable agricultural systems, these approaches seek to transform food and agricultural systems, addressing the root causes of problems. This is expressed in lever 5 of the transition model in Figure 4.

A transformation of the food system is global in scope. It requires rethinking values and building new environmental and social relationships around and beyond food (Gliessman, 2016). Feeding the world and safeguarding the natural capital we depend upon primarily means improving the efficiency of the whole system, including fair access to and distribution of food, promoting healthy and sustainable diets and reducing food loss and waste, rather than increasing food production. Such a system must be created through a new discourse, other models of knowledge development, secure access to natural resources, greater equity, appropriate trade, markets and systems of exchange (Anderson et al. 2020). This requires tackling systemic lock-ins of the current system, which is challenging but not insurmountable.

An important prerequisite for food system transformation is a shift towards a more holistic understanding of agriculture, focusing on enhancing and sustaining the provision of multiple services rather than maximizing yields at all costs. These multiple services include healthy food, fertile soils, clean water, landscape management and biodiversity, in addition to providing a livelihood for millions of rural people. It also requires a rethinking of economic success, which should not be measured as maximizing revenue but optimizing profitability, taking into account reduced risks, cost savings, continuity of yields and income diversification. Changing the way we measure success in agriculture should be a priority as this affects the quality of research and knowledge, how subsidies and investment are distributed, and how companies are rewarded and evaluated (e.g. Buck et al. 2006, Sayer et al. 2017).

Food system change should be based on participation, fairness and justice, which are important human rights and 'building blocks' of food security and nutrition. This means addressing the crucial challenge of agriculture and food governance, so that decisions that shape the food system are influenced not only by the vested interest of a few powerful actors, but involve broad participation, including that of agroecological practitioners and beneficiaries. This is illustrated in the political debate on seeds, which are largely bred to obtain high yields. These varieties are supported by seed legislation which sets norms for stability, uniformity and homogeneity thereby excluding many indigenous seeds that carry high genetic variability, which is exactly what makes them so resilient to environmental stress. In the state of Paraíba, Brazil these lock-ins were addressed to foster systemic change when seed legislation not only prohibited farmers from selling seeds but also denied farmers who use indigenous varieties the benefit from various public support programmes. A coalition of civil society organizations first mobilized farmers around local, culturally and environmentally adapted varieties, to counter the conventional seeds discourse. A network linking 230 seed banks in 61 municipalities and involving 6,500 family farms acted as decentralized farmer-driven seed selection and distribution systems. Finally, they mobilized pressure on decision makers and managed to get indigenous seeds recognized under seed law and to enlist public support for seed banks (Petersen et. al. 2014).

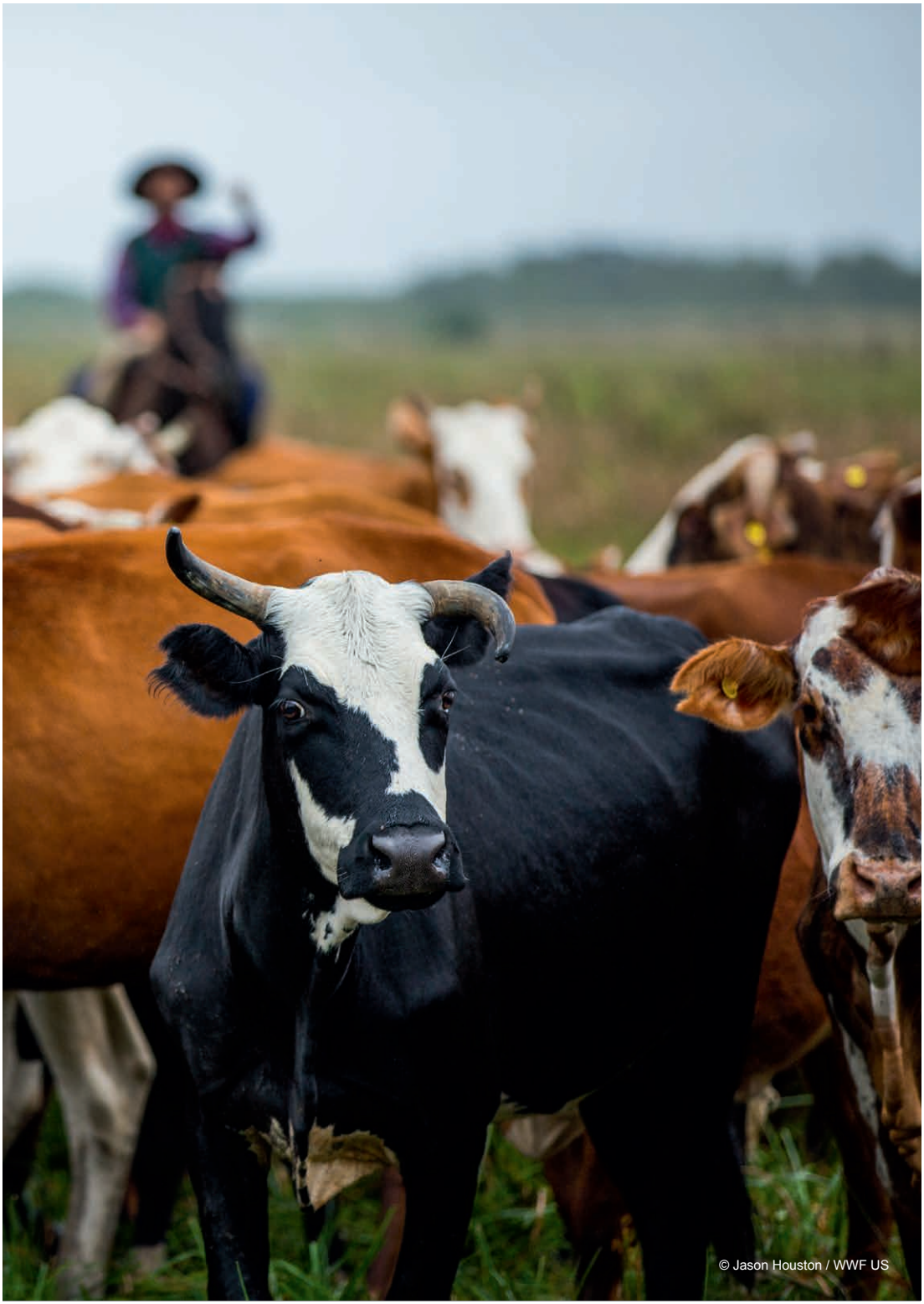
FOOD SYSTEM CHANGE SHOULD BE BASED ON PARTICIPATION, FAIRNESS AND JUSTICE

Secure access to natural resources, land tenure and property rights for agroecological food producers is also key. An important part of this challenge is to address the competition for land and other natural resources between production of feed for livestock and production of food for people. By transitioning towards a system where livestock is predominantly converting by-products from the food system and grass resources into valuable food and manure, livestock can contribute significantly to human food supply, while at the same time reducing the environmental impact of the entire food system. By converting these so-called low-opportunity-cost feeds, farm animals recycle biomass and nutrients into the food system that would otherwise be lost. Rearing animals under this circular paradigm requires a transition from our current linear food system towards a circular one (Van Zanten et al. 2019). This will involve tackling several lock-ins of the current system by introducing, for example true pricing, abolishing subsidies that permeate the current unsustainable practices in the livestock sector and increasing taxes on use of finite resources and feed that competes with food.

AN IMPORTANT CHALLENGE IS TO ADDRESS THE COMPETITION FOR LAND BETWEEN PRODUCTION OF FEED FOR LIVESTOCK AND PRODUCTION OF FOOD FOR PEOPLE

A food system transformation further requires strengthening the enabling environment for farmers to transition towards agroecological approaches and piloting and fostering new business models that support agroecological practices and secure markets. Transition and investment costs are often an important barrier to farmers. It takes time before the transformed system provides sufficient returns to balance investments. To bridge this transition period, alternative business models need to be developed and supported by enabling policies, market incentives and market regulations. Especially while transitioning from an intensive agriculture system, applying agroecological approaches might result in a (temporary) decrease in yields or income and additional risks and costs, while the ecological and economic benefits will take time to achieve. In Romania, policy advocacy work, as well as strong networks and partnerships, have been identified as priority strategies for enabling and scaling agroecology (see 'Landscape conservation and sustainable development in Romania').

TO BRIDGE THE TRANSITION TOWARDS NATURE POSITIVE PRODUCTION, ALTERNATIVE BUSINESS MODELS NEED TO BE DEVELOPED AND SUPPORTED BY ENABLING POLICIES, MARKET INCENTIVES AND MARKET REGULATIONS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Landscape conservation and sustainable development in Romania

The Romanian regions of Transylvania and Maramures are characterized by longstanding traditional small-scale farming systems. Situated in and around the Carpathian Mountains, their agricultural landscape is fragmented, with mosaic patches of small plots of cultivated land and semi-natural grasslands created and maintained by traditional extensive livestock grazing systems. The Transylvanian Highlands represent the second largest protected area in Romania, housing 60% of the total number of bird species in Romania and harbouring various UNESCO Cultural Heritage sites. In Maramures, around 40% of the land is protected because of its ecological corridors and wilderness areas that are crucial for the survival of large carnivores. Ironically, the largest threats to the rich biodiversity in Romania lies in both the intensification and the abandonment of traditional farming practices and corresponding skills and knowledge.

In this context, WWF Romania analyzed the socio-economic drivers of and barriers to agroecological approaches in these two regions. The analysis revealed that the main challenges include a lack of rural infrastructure, such as processing and storage facilities, and market access for local and small producers. There is also low access to knowledge and information and current agricultural education is not adapted to today's reality of climate change and biodiversity loss. In addition, certain policies and (subsidy) regulations at national and EU level are highly complex, creating barriers to market participation by small-scale farmers. Moreover, the rural workforce in Romania is diminishing due to migration to cities, worsened by a lack of public policies and facilities that could motivate people to remain in the countryside.

There are also several opportunities to strengthen agroecological approaches in Romania. One is the adoption of an integrated policy approach: combining a focus on creating a healthy environment with the strengthening of local communities. This could be done through the implementation of nature-based solutions, and using local resources to build community self-reliance, resilience and empowerment. Collaboration between local communities and grassroots organizations is key to advancing agroecology at a bigger (territorial) scale and in an integrated manner.

It became clear that what is required, is both bottom-up change, for example through community participation in governance and decision-making processes, as well as top-down change, such as new regulations and incentives. With this new evidence to hand, WWF Romania is engaging in several initiatives to ensure that farming contributes to the conservation of typical landscapes and vibrant rural communities. One of these initiatives is focused on supporting communities through sustainable rural tourism in the Transylvanian Highlands and Maramures, in partnership with other NGOs and tourism businesses. WWF Romania also advocates for legislation on public procurement, for example by schools and public institutions, of more healthy and local food produced by agroecological farmers.


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ACCELERATING THE TRANSITION

AGROECOLOGICAL PRACTICES AND INNOVATIONS NEED GREATER SUPPORT AND AN ENABLING ENVIRONMENT TO OVERCOME EXISTING CHALLENGES TO EXPAND AND SCALE UP

Many farmers around the world have already (re)designed their production systems based on agroecological principles (Biovision and IPES-Food, 2020). But while the multiple benefits of agroecological approaches are increasingly being recognized, adequate education, extension, research, market sector and policy support are still largely absent. Even in places where transitions are taking (or have taken) place, agroecological practices and innovations need greater support and an enabling environment to overcome existing challenges to expand and scale up. A plethora of recent publications points at ways agroecology can be effectively scaled up towards a transformation of the food system (e.g. Anderson et al. 2020, Molina et al. 2020, Van den Berg 2020, HLPE 2019, Mier y Teran et al. 2018, FAO 2018b, Parmentier 2014).

From this literature, several drivers of change emerge to take agroecology to scale. These are critical sites of intervention, or 'domains of transformation' (Anderson et al. 2020). The drivers of change include access to land, water and seeds, a gradual transition that starts with (initially) simple and effective farming practices, strong social organization and networks, participatory learning processes and knowledge exchange, new discourses and narratives, favourable markets, and equitable governance. Once change in these areas starts to overlap in a given landscape, they become more aligned, enhancing the potential for scaling agroecological approaches to sustainably manage agro-ecosystems, restore and rehabilitate degraded agricultural land and avoid conversion of natural ecosystems.

CIVIL SOCIETY PLAYS A KEY ROLE IN CHANGING THE NARRATIVE AND STRENGTHENING MOVEMENTS IN SUPPORT OF AGROECOLOGICAL APPROACHES

Key actors and sectors each have a role to play in accelerating the transition towards farming with biodiversity. Collectively, through different channels and through interventions in the domains mentioned above, they should reduce the burden on farmers to manage the environmental impacts of production on their farms and at the landscape level and enable them to transition towards agroecological systems (see 'Promotion of agroecology to combat forest conversion in Thailand').

Civil society plays a key role in changing the narrative and strengthening movements in support of agroecological approaches. Advocates of diversified agroecological systems should join forces to create a powerful voice to counter the 'feed the world' and 'cheap food' narratives that keep the current unsustainable food system in place, challenge the industrial food system and raise the profile of agroecological approaches in the international policy arena.

This includes deconstructing myths and raising awareness about the multiple benefits and potential of agroecological approaches, including their contribution to protect, manage and restore nature, their economic viability and contribution to food and nutrition security, resilience and livelihoods. Civil Society Organizations such as agroecological community-based organizations, cooperatives, farmer organizations and NGOs, should continue to collaborate to encourage the spread of agroecological practices and advocate for the transformation of financial flows, governance structures and food systems from the ground up. It has recently been estimated that this could mobilize up to USD4 trillion towards support for agroecological approaches (IPES-Food & ETC Group 2021).

Governments need to recognize agroecological approaches as a key solution for building sustainable food systems and addressing climate change, e.g. through the integration of agroecology into countries' Nationally Determined Contributions (NDCs) to the Paris Agreement, the post-2020 Biodiversity Framework and National Biodiversity Strategies and Action Plans. UN fora such as the UN Food Systems Summit provide a unique opportunity to adopt game changing solutions that accelerate the transition to agroecological approaches, especially when commitments of Member States are aligned with outcomes of the conventions of the UN Framework to Combat Climate Change and UN Convention on Biological Diversity. Recognition of its importance should lead to the development and adoption of effective policy instruments to mainstream biodiversity in agriculture. This includes the design of agriculture and trade policies that support agroecological approaches; repurposing agricultural subsidies to support the transition to sustainable production; enshrining the "polluter pays" principle within the relevant legal and regulatory frameworks, promoting true pricing, issuing environmental permits and sanctioning environmentally damaging activities; providing incentives for the supply of environmental goods and services and encouraging the sustainable and equitable management of natural resources (including tenure rights to land, water and biodiversity, the avoidance of food-feed competition). Furthermore, governments can provide public incentives to scale up agroecological approaches, e.g. through credit schemes, public procurement or providing technical assistance and investments in agroecological research and science.

GOVERNMENTS NEED TO RECOGNIZE AGROECOLOGICAL APPROACHES AS A KEY SOLUTION FOR BUILDING SUSTAINABLE FOOD SYSTEMS AND ADDRESSING CLIMATE CHANGE

Market actors such as retailers, traders, processors and distributors both locally as well as well as internationally, are faced with a host of nature-related risks from unsustainable food systems (WWF 2019). Many such risks are already materializing at production level, such as climate change induced crop failure, with knock-on effects that can disrupt supply chains or emerge as systemic risks (WWF 2021).

STAKEHOLDERS IN THE VALUE CHAIN CAN SUPPORT FARMERS TO DEVELOP BUSINESS AND FINANCIAL PLANS TO INCORPORATE AGROECOLOGICAL INTERVENTIONS

It is therefore in the interest of both nature and the economy to transform business models and measures of success in order to align long-term profitability and conservation of biodiversity, ecosystems and the ecosystem services they depend upon themselves. Stakeholders in the value chain can support farmers to develop business and financial plans to incorporate agroecological interventions over a given period. This helps identify and quantify risk associated with transitions due to short-term losses in productivity so that external funding and support can be targeted here to minimize this risk. Such considerations and measures of success should be mainstreamed into financial incentives and in the way companies are rewarded and evaluated. Re-establishing a closer connection between producers and consumers of food, for instance through networks of farmers' markets, community supported agriculture schemes, consumer co-operatives, and other more direct marketing arrangements that shorten the food chain, can also support the transition towards diversified agroecological systems. The development of appropriate storage and processing facilities has been identified as another crucial way the scaling of agroecological approaches can be facilitated.

FINANCIAL INSTITUTIONS SHOULD FULLY INTEGRATE NATURE-RELATED CONSIDERATIONS IN THEIR DECISION-MAKING PROCESSES AND CHANNEL INVESTMENTS TOWARDS DIVERSIFIED AGROECOLOGICAL PRODUCTION SYSTEMS

Financial institutions also have an interest, and a duty, to identify, understand and prevent risks and negative impacts associated with their agricultural investments. They can do this by fully integrating nature-related considerations in their decision-making processes and channelling investments towards diversified agroecological production systems (Dasgupta 2021). This also includes reducing the risk profiles of landscape scale approaches that transcend farm boundaries and connect them to some of the vast new pools of financial capital available for leverage and investment in diverse agroecological landscapes. At the same time, it is important that the financial sector supports government initiatives to scale up agroecological approaches and to level the playing field for those producers who are transitioning towards such systems. A wide range of tools exist to both help farmers assess their impacts and financial institutions to measure their biodiversity footprints and channel investments towards what is sustainable (WWF 2021).

Research investments show a strong bias towards industrial agriculture compared to agroecological approaches, which has resulted in significant and persistent knowledge gaps (HLPE, 2019). Unlocking research, including systems-oriented, transdisciplinary and long-term field projects, and technology and innovation to prioritize agroecological approaches is key. In doing so, we cannot rely on the expertise of researchers and extensionists alone but need to build on farmers' experiential and contextualized

knowledge. Co-creation of tangible and viable agroecological alternatives to industrial agriculture by academics and farmers is key for buy-in, adoption and scaling of agroecological practices. This requires a participatory action-research agenda as well as the development of performance indicators around the multifunctionality of agricultural systems, instead of yields of a single crop, and the addition of landscape scale considerations to ensure production within the carrying capacity of ecosystems. Tools such as the Tool for Agroecology Performance Evaluation (TAPE) and the Agroecology Criteria Tool (ACT) aim to measure the multi-dimensional performance of agroecological systems across the different dimensions of sustainability and from the farm to the landscape scale (FAO, 2019c; Biovision, 2020). In addition to increased research efforts, knowledge about agroecological approaches needs to be better integrated into the curricula of universities, extension workers, and farmer schools and networks.

CO-CREATION OF TANGIBLE AND VIABLE AGROECOLOGICAL ALTERNATIVES TO INDUSTRIAL AGRICULTURE BY ACADEMICS AND FARMERS IS KEY FOR BUY-IN, ADOPTION AND SCALING OF AGROECOLOGICAL PRACTICES

Concluding remarks

In spite of great conservation efforts, climate change is a reality and biodiversity continues to be lost at an alarming rate. Likewise, despite increased attention, technological advances and innovations, and many commitments from both the public and private sector, we have not succeeded in delivering nature-positive food systems.

WWF firmly believes that agroecological approaches are key to achieving nature-positive production at scale and tackling some of the most pressing issues of the 21st century. They provide a critical pathway to truly integrating nature and agriculture in a functional and mutually beneficial way, and to designing more resilient food systems in the face of current and future crises.

The case for urgent action is well established and solutions have already been identified. However, barriers and lock-ins are preventing them from being adopted. Only with concerted efforts can we effect the necessary system transformation and it requires all stakeholders to collaborate – as a matter of urgency and on a scale not yet seen. We must overcome these barriers and accelerate action now.

Nature-positive food production at scale must be at the heart of conservation and climate agendas. It will not only benefit nature, but will advance sustainable development overall. Agroecological approaches are good for nature and people and are thus an integral element of WWF's mission to halt the degradation of the earth's natural environment and build a future in which humans live in harmony with nature.

NATURE-POSITIVE FOOD PRODUCTION WILL NOT ONLY BENEFIT NATURE, BUT WILL ADVANCE SUSTAINABLE DEVELOPMENT OVERALL

Promotion of agroecology to combat forest conversion in Thailand

The north of Thailand is abundant in forests and a stronghold for tigers, elephants, and other endangered wildlife. Over the past decades large agri-businesses have pushed for the expansion of chemical-intensive monocropping systems. As a result, at least 800,000ha of watershed forested areas have been lost in Thailand. In addition to deforestation, the adoption of monocropping systems have also negatively impacted agriculture and the environment. In the past, sustainability was maintained by "local wisdom agriculture", which centres around self-sufficiency, ecological practices, agrobiodiversity, indigenous varieties, nutrient recycling and healthy soils. With the shift to monocropping, agrobiodiversity diminished and soils degraded. Farmers also became more vulnerable as they had to make high investments in farm inputs while being dependent on the market price of a single crop. As a result, many have become stuck in a cycle of debt.

To reduce forest conversion and help empower smallholder farmers and local communities, WWF Thailand worked with smallholder farmers, community-based organizations and local social enterprises to promote agroecological approaches. Efforts were focused on the Dawna Tenasserim Landscape and the watershed of Chao Phraya river basin. Over 57 trainings were organized on agroecological production and distribution. Farmers also received financial support for six years to leave one part of the land to reforest and diversify, and to stop using agrochemicals and implement agroecological practices on the other part. Farmers began to grow perennials, fruit, vegetables and herbs, using diverse local varieties and mixing crops and trees in agroforestry systems. Local food markets were created, for farmers to sell their produce to schools, hotels, hospitals and restaurants in the area. And an organic value chain was set up, allowing farmers to gain higher prices at retail markets at the national level.

Since the start of the initiative in 2018, nearly 1940 farmers have been reached, 107 hectares of land reforested and 600 hectares of monocropped land turned into diversified, agroecological systems. Agroecological practices and markets improved farmers' wellbeing and agency as they now have a sustainable source of income and subsistence food crops all year round. These practices also enhanced soil fertility and supported the return of wildlife, including pollinators, and the restoration of habitats and ecological corridors for endemic species such as red goral, big head turtle and sun bird.


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OUR MISSION IS TO STOP THE DEGRADATION OF THE PLANET'S NATURAL ENVIRONMENT AND TO BUILD A FUTURE IN WHICH HUMANS LIVE IN HARMONY WITH NATURE.

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