Resilient Agroecosystems

How the Post-2020 EU Biodiversity Strategy and the Farm to Fork Strategy Can Potentially Support the Resilience of Farmlands

Analytical report

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Introduction

'Resilience' has become an increasingly popular term in recent years, something that the ongoing COVID-19 pandemic has just further accelerated. In the national and European Union (EU) policies that have been published so far in 2020, 'resilience' is a frequently and systematically repeated and emphasised concept, whether it refers to the financial stability of producers, the healthy ecological status of lands and forests or the overall ability of social-ecological systems to recover after major crises in general. When resilience is developed or strengthened in various systems, it often leads to their decreased vulnerability to internal or external shocks and increased stability amidst a radically changing systemic context, like the environment.

In this analytical report, we focus on the resilience of agricultural systems or more precisely that of complex agroecological systems. There is more to agriculture than just producing food. Agricultural landscapes provide multiple ecosystem services and they can also play an important role in mitigating biodiversity loss and environmental degradation. But for that to happen they need to maintain what is called a multifunctional capacity, a term used to explain how landscapes can produce food while also maintain ecosystem services such as carbon storage, water quality, soil fertility and outdoor recreation. Or at least this is the hypothesis.

In May 2020, two long-awaited strategies under the European Green Deal have been published and adopted that will significantly determine the strategic direction of European biodiversity protection and food production in the coming ten-year period. The post-2020 EU Biodiversity Strategy and the so-called Farm to Fork Strategy both include plenty of references to resilience, either in relation to the current pandemic or more connected to the uncertainties of global environmental change. This report aims to critically analyse and give a clear overview of how these two newly published strategies can potentially support the resilience of agroecosystems. What objectives, targets, proposed actions and envisioned policy instruments are intended to protect or restore essential ecosystems in a way that they become more resilient to the ever more frequent shocks of our age. We also aim to provide recommendations on how to go beyond theory and potential, and better operationalise resilience in the future. It is evident that in the times of global environmental change and emerging pandemics, resilience is essential for global societies to preserve their stability and responsiveness to changes.

1. Resilience and why it matters

Resilience refers to the capacity of a system to deal with unexpected change and continue to develop. For example, a city is resilient if it can withstand changes such as financial crises and use such events to catalyse renewal and innovation (Stockholm Resilience Centre, 2015). This means that sustainability is not a static state or an end point, but rather a dynamic process. With mass industrialisation and globalisation, humans and nature have become so strongly interconnected that they can now be conceived as one social-ecological system. Within this system, there are no natural ecosystems unshaped by people and no people without need of the resources ecosystems provide. Under resilience thinking we mean the generation of knowledge about how we can strengthen our capacities to interact with the biosphere (which includes the planet's land, water, and air) in a way that is sustainable and resilient to the stresses caused by environmental change. The fascinating paradox here is that the very innovation which led humans into our current environmental predicament is the only thing we can use to get us out of it. Humans have a dynamic relationship with the environment.

2. Farm resilience

For sustainable food production, the resilience of agroecosystems is key. Resilience corresponds to the ability of food systems to withstand shocks as well as to learn and adapt to changes in external and internal conditions. In this way, resilience represents a broader concept than mitigation of vulnerability – it's the ability of a food system to produce and distribute food under changing conditions, and, if linked to a normative framework such as the concept of food sustainability, to do so in a way that is equitable and sustainable in both the short term and the long term (Jacobi *et al*., 2018). What sets apart the changes occurring today are the rate, magnitude, and genesis of the changes, and the fact that we have the capacity to anticipate and possibly influence the trajectories of these changes. In terms of the global food system, changes in climate, increased economic disparity, political instability, and shifting consumption patterns have repercussions that are causing nearly one billion people to go hungry while one billion more suffer from obesity worldwide (Cabell & Oelofse, 2012).

Agroecosystem is essentially an ecosystem managed with the intention of producing, distributing, and consuming food, fuel, and fibre. It encompasses the physical space dedicated to production, as well as the resources, infrastructure, markets, institutions, and people that are dedicated to bringing food to the plate, fibre to the factory, and fuel to the hearth. The value of resilience thinking in relation to agroecosystems is more likely to be realized by identifying more general 'rules of thumb' for use by farmers and facilitators to guide farms, the industry sector, the national agricultural system and the interconnected parts of the international food and fibre system towards a more resilient orientation. Resilience is often difficult to operationalize because of its abstract and multi-dimensional nature. The primary purpose of assessing resilience is to identify vulnerabilities in social-ecological systems so that action can be taken to create a more sustainable future for people and the land. Essentially, building resilience gives agroecosystems the capacity to maintain the ability to feed and clothe people in the face of shocks while building the natural capital base upon which they depend and providing a livelihood for the people who make it function (Berkes *et al*., 2003).

3. Indicators to assess the resilience of agroecosystems

Cabell and Oelofse (2012) identifies thirteen behaviour-based indicators of resilience within agroecosystems, the absence or disappearance of which suggest vulnerability and movement away from a state of resilience, while the presence of which imply that the system is more capable of persisting in its ability to meet the food, fuel, and fibre needs of humans well into the future.

The below table provides an overview of the identified indicators, their definition, implications and what to look for in agricultural policies and farming practices when we wish to evaluate their ability to contribute to the resilience of the given agroecosystem.

Indicator	Definition	Implications	What to look for
Socially self-organized	The social components of the agroecosystem are able to form their own configuration based on their needs and desires	Systems that exhibit greater level of self-organization need fewer feedbacks introduced by managers and have greater intrinsic adaptive capacity	Farmers and consumers are able to organize into grassroots networks and institutions such as co-ops, farmer's markets, community sustainability associations, community gardens, and advisory networks

Ecologically self-regulated	Ecological components self-regulate via stabilizing feedback mechanisms that send information back to the controlling elements	A greater degree of ecological self-regulation can reduce the amount of external inputs required to maintain a system, such as nutrients, water, and energy	Farms maintain plant cover and incorporate more perennials, provide habitat for predators and parasitoids, use ecosystem engineers, and align production with local ecological parameters
Appropriately connected	Connectedness describes the quantity and quality of relationships between system elements	High and weak connectedness imparts diversity and flexibility to the system; low and strong impart dependency and rigidity	Collaborating with multiple suppliers, outlets, and fellow farmers; crops planted in polycultures that encourage symbiosis and mutualism
Functional and response diversity	Functional diversity is the variety of ecosystem services that components provide to the system; response diversity is the range of responses of these components to environmental change	Diversity buffers against perturbations (insurance) and provides seeds of renewal following disturbance	Heterogeneity of features within the landscape and on the farm; diversity of inputs, outputs, income sources, markets, pest controls, etc.
Optimally redundant	Critical components and relationships within the system are duplicated in case of failure	Also called response diversity; redundancy may decrease a system's efficiency, but it gives the system multiple back-ups, increases buffering capacity, and provides seeds of renewal following disturbance	Planting multiple varieties of crops rather than one, keeping equipment for various crops, getting nutrients from multiple sources, capturing water from multiple sources
Spatial and temporal heterogeneity	Patchiness across the landscape and changes through time	Like diversity, spatial heterogeneity provides seeds of renewal following disturbance; through time, it allows patches to recover and restore nutrients	Patchiness on the farm and across the landscape, mosaic pattern of managed and unmanaged land, diverse cultivation practices, crop rotations
Exposed to disturbance	The system is exposed to discrete, low-level events that cause disruptions without pushing the system beyond a critical threshold	Such frequent, small-scale disturbances can increase system resilience and adaptability in the long term by promoting natural selection and novel configurations during the phase of renewal; described as "creative destruction"	Pest management that allows a certain controlled amount of invasion followed by selection of plants that fared well and exhibit signs of resistance
Coupled with local natural capital	The system functions as much as possible within the means of the bioregionally available natural resource base and ecosystem services	Responsible use of local resources encourages a system to live within its means; this creates an agroecosystem that recycles waste, relies on	Builds (does not deplete) soil organic matter, recharges water, little need to import nutrients or export waste

		healthy soil, and conserves water	
Reflective and shared learning	Individuals and institutions learn from past experiences and present experimentation to anticipate change and create desirable futures	The more people and institutions can learn from the past and from each other, and share that knowledge, the more capable the system is of adaptation and transformation, in other words, more resilient	Extension and advisory services for farmers; collaboration between universities, research centres, and farmers; cooperation and knowledge sharing between farmers; record keeping; baseline knowledge about the state of the agroecosystem
Globally autonomous and locally interdependent	The system has relative autonomy from exogenous (global) control and influences and exhibits a high level of cooperation between individuals and institutions at the more local level	A system cannot be entirely autonomous but it can strive to be less vulnerable to forces that are outside its control; local interdependence can facilitate this by encouraging collaboration and cooperation rather than competition.	Less reliance on commodity markets and reduced external inputs; more sales to local markets, reliance on local resources; existence of farmer co-ops, close relationships between producer and consumer, and shared resources such as equipment
Honours legacy	The current configuration and future trajectories of systems are influenced and informed by past conditions and experiences	Also known as path dependency, this relates to the biological and cultural memory embodied in a system and its components	Maintenance of heirloom seeds and engagement of elders, incorporation of traditional cultivation techniques with modern knowledge
Builds human capital	The system takes advantage of and builds "resources that can be mobilized through social relationships and membership in social networks"	Human capital includes: constructed (economic activity, technology, infrastructure), cultural (individual skills and abilities), social (social organizations, norms, formal and informal networks)	Investment in infrastructure and institutions for the education of children and adults, support for social events in farming communities, programs for preservation of local knowledge
Reasonably profitable	The segments of society involved in agriculture are able to make a livelihood from the work they do without relying too heavily on subsidies or secondary employment	Being reasonably profitable allows participants in the system to invest in the future; this adds buffering capacity, flexibility, and builds wealth that can be tapped into following release	Farmers and farm workers earn a liveable wage; agriculture sector does not rely on distortionary subsidies

Biological diversity in ecosystems results in greater productivity, greater carbon sequestration, greater retention of nutrients, and greater resilience, or the ability to resist and recover from various forms of stress, including herbivorous pests, diseases, droughts, and floods. In addition to being better able to withstand and recover from disturbances due to pests, weather, and other

biophysical factors, resilient agroecosystems can be less susceptible to fluctuations in production costs and market prices (Kremen & Miles, 2012). Industrial agriculture has brought about the loss of biodiversity, for example in massive monoculture fields of corn and soybean where they dominate previously species-rich landscapes. In the U.S. Corn Belt, for instance, shallow-rooted, short-season crops like corn and soybean have replaced native, perennial species whose deep roots and long growth period more effectively hold soil in place, promote water infiltration into soil and transpiration into the atmosphere, foster carbon sequestration and nutrient retention, and provide habitat for pollinators, biological control agents, and a host of other organisms. Failure to prevent biodiversity loss under current agricultural practices penalizes other citizens and future generations dependent upon unpolluted air, clean and abundant freshwater resources, productive soils, abundant pollinators, and other components of resilient ecosystems.

Diversification of agricultural landscapes and cropping systems offers one of the best and most accessible strategies for resolving the seemingly intractable tension between agricultural production and environmental quality (Liebman *et al*., 2013). Therefore, sustaining highly functional, resilient agroecosystems is challenging but not impossible. There are many approaches we can take – like enhancing biodiversity – to ensure a highly desirable future for all.

4. How two EU strategies score on resilience: the post-2020 EU Biodiversity Strategy and the Farm to Fork Strategy

The EU Biodiversity Strategy, together with the Farm to Fork Strategy published at the same time, includes commitments to reverse the decline of pollinator insects. The Commission proposes that 10% of agricultural land should consist of 'high-diversity landscape features', for instance in the form of hedges or flower strips, and the environmental impacts of the agricultural sector should be significantly reduced by 2030. The progress towards the target will be under constant review, and adjustment if needed, to mitigate against undue impact on biodiversity, food security and farmers' competitiveness. A quarter of agricultural land should be under organic farming management by 2030, and the use and risk from pesticides should be reduced by 50%, as well as the use of the more hazardous/dangerous pesticides (European Commission, 2020a).

The 2030 EU Biodiversity Strategy sets out how the EU can achieve its headline ambition to ensure that by 2050 all of the world's ecosystems are restored, resilient, and adequately protected. The strategy notes that the pandemic has increased awareness of the links between our health and the health of ecosystems – and so, demonstrates the need for sustainable supply chains and consumption patterns, as well as the importance of biodiversity and well-functioning ecosystems in boosting our resilience and preventing the emergence and spread of future diseases (European Commission, 2020a).

A resilient and sustainable fiscal recovery from the pandemic will require natural capital investment, including restoration of carbon-rich habitats and climate-friendly agriculture. A resilient Trans-European Nature Network, will require ecological corridors to prevent genetic isolation, allow for species migration, and maintain and enhance healthy ecosystems. Nature restoration is key to reversing biodiversity loss. The Strategy calls for improving the health of existing and new protected areas, and bringing diverse and resilient nature back to all landscapes and ecosystems (European Commission, 2020a). This means reducing pressures on habitats and species, ensuring all use of ecosystems is sustainable, supporting the recovery of

nature, limiting soil sealing and urban sprawl, and tackling pollution and invasive alien species. This also creates jobs, helping to ensure the long-term productivity/value of natural capital. The Strategy, among others, proposes legally binding EU nature restoration targets, focusing most on those ecosystems with the potential to capture and store carbon and to prevent/reduce the impact of natural disasters (European Commission, 2020a).

Improving agroecosystem resilience and diversity requires working with farmers to support and so incentivise their transition to sustainable agricultural practices (i.e. moving away from practices driving biodiversity decline). It is also essential to reverse the decline of farmland birds and insects, particularly pollinators, which are vital for agricultural production and food security. This will increase the sector's resilience to climate change, environmental risks and socioeconomic shocks, while creating new jobs, for example in organic farming, rural tourism or recreation.

Improving forest resilience and health is also a central objective in the Biodiversity Strategy. Forests are hugely important for biodiversity, climate and water regulation, the provision of food, medicines and materials, carbon sequestration and storage, soil stabilisation and the purification of air and water. This requires foresters ensuring sustainable forest management and restoring, sustaining biodiversity in forests. It is essential that all remaining EU primary and old-growth forests are strictly protected, increasing the quantity, quality and resilience of EU forests (against fires, droughts, pests, diseases and other threats likely to increase with climate change) is also integral to achieve the strategy's objective on resilient forest ecosystems (European Commission, 2020a). The European Commission will propose a dedicated EU Forest Strategy in 2021, which will include a roadmap for planting at least 3 billion additional trees in the EU by 2030. The Commission will work with Member States to ensure that the EU is equipped to prevent and respond to major forest fires, which can significantly damage forest biodiversity.

The EU Biodiversity Strategy works in tandem with the Farm to Fork Strategy and later on with the new Common Agricultural Policy (CAP). The Farm to Fork Strategy promotes sustainable practices such as precision agriculture, organic farming, agro-ecology, agro-forestry, low-intensive permanent grassland, and stricter animal welfare standards. The strategy notes that the pandemic has increased awareness of the links between our health and the health of ecosystems – demonstrates the need for sustainable supply chains and consumption patterns. The strategy notes that the increasing recurrence of droughts, floods, forest fires and new pests shows that our food system is under threat and must become more sustainable and resilient. The strategy targets a reduced dependency on pesticides and antimicrobials, reducing excess fertilisation, increasing organic farming, improving animal welfare, and reversing biodiversity loss. It aims to reduce by 50% the overall use of – and risk from – chemical pesticides and the use of more hazardous pesticides by 2030 (European Commission, 2020b).

The EU's goals related to sustainable food production are, among others, to reduce the environmental footprint of the EU food system and strengthen its resilience, ensure food security, and lead a global transition towards competitive sustainability within the food system. This requires ensuring that the food chain has a neutral or positive environmental impact; making sure that everyone has access to sufficient, nutritious, sustainable food; and preserving the affordability of food, while generating fairer economic returns in the supply chain. In order to provide space for wild animals, plants, pollinators and natural pest regulators, the EU aims to bring back 10+% of agricultural area under high-diversity landscape features (European Commission, 2020b).

To ensure the successful and timely implementation of the Strategy, the Commission will make a legislative proposal for a framework for a sustainable food system before the end of 2023. Achieving sustainable food production requires transforming and optimising production methods, which calls for human and financial investment. An evaluation of the CAP shall be carried out to establish the contribution of income support to improving the resilience and sustainability of farming. The Commission will assess the resilience of the food system and develop a contingency plan for ensuring food supply and food security to be put in place in times of crisis. To enhance resilience of regional and local food systems, the Commission will reduce dependence on long-haul transportation to create shorter supply chains (about 1.3 billion tonnes of primary agricultural, forestry and fishery products were transported on roads in 2017). A zero-tolerance policy for food fraud with effective deterrents is also envisioned (European Commission, 2020b).

Promoting global transition, the EU trade policy should cooperate with and obtain commitments from third countries in key areas such as animal welfare, the use of pesticides and the fight against antimicrobial resistance. The EU will also promote international standards, encourage the food production complying with high safety and sustainability standards, and support small-scale farmers. The EU will furthermore cooperate internationally on food research and innovation, environmental policy, and resilience-building initiatives (European Commission, 2020b).

5. Implications for the new CAP

The latest proposal for the post-2020 Common Agricultural Policy notes that the pandemic has put a strain on the resilience of European farmers, who it aims to support. The CAP proposal states that it aims to play a role in managing the transition to sustainable food production systems and funding EU commitments to biodiversity. After a long period of failures and unsustainable practices, the new CAP aims to foster a smart, resilient and diversified agricultural sector ensuring food security, bolster environmental care and climate action and to contribute to the environmental- and climate-related objectives of the EU, and strengthen the socio-economic fabric of rural areas (European Commission, 2020c). All can potentially contribute to overall resilience.

Providing EU citizens with food security and guaranteeing that food is safe, ethical and sustainable requires direct payments to help keep sustainable farming viable: to support and stabilise farmers' incomes; make them less vulnerable to market volatility and more resilient to things like unpredictable weather. Instead of often harmful conventional farming practices, however, it is crucial to promote the diversification of agricultural production (agro-diversity) through, for instance, mandatory standards on crop rotation, soil protection, maintaining permanent grassland, protecting wetlands and peatlands, the Nature Directives, and protecting existing landscape features by devoting farm area to “non-productive” features.

Voluntary eco-schemes, designed by Member States in their national CAP strategic plans, shall support precision farming, organic farming, agro-ecology and agro-forestry. The Commission will need to monitor the effectiveness of these schemes and share the data. This also requires the cooperation of producers within producer organisations and associations of producer organisations. Sectoral programmes should be used to contribute to the EU Green Deal objectives, for instance, by promoting consumption of fruit and vegetables or supporting climate adaptation and resilience itself (European Commission, 2020c). An additional essential tool can be the financial support for rural development, for example, sustainability-building

investment, green infrastructure, knowledge transfer and innovation, tree planting and forest improvement.

Future CAP strategic plans will be crucial in funding the management practices and investments needed to preserve, grow and manage forests sustainably – helping to increase the absorption of CO2, enhance adaptation to climate change and resilience to threats (e.g. forest fires, droughts, pest infestations), and promote the bio-economy (European Commission, 2020c). Overall, the CAP should aim to help farmers to improve their environmental and climate performance through: a more results-oriented model, better use of data and analysis, improved mandatory environmental standards, new voluntary measures and an increased focus on investments into green and digital technologies and practices.

Conclusion

From the outlined targets, objectives and tools of both strategies, we can confirm that the ambition of the EU Green Deal has certainly reflects itself in the scope of both the EU Biodiversity Strategy and the Farm to Fork Strategy. Most of the indicators identified by Cabell and Oelofse (2012) appear in some way in both strategies, in multiple cases, even more targets and proposed actions support an indicator.

Strategies targeting the resilience of agroecosystems, however, is only the first step. Member States need to adequately commit themselves to these targets and responsible authorities need to make sure that the targets, processes and committed actions are properly enforced and monitored. It is essential for success that resilience is operationalised on a farm, as well as on a larger, regional level. For this purpose, Cabell and Oelofse (2012) recommends five categories of strategies that can be used to enhance resilience: recognising the economic as well as social value of local traditions and capacities; finding new ways to diversify rural residents' economic activities and sources of income; utilising new technologies and the scales of a globalised market economy while keeping in minds the vulnerabilities associated with it; bringing together different communities, residents, and actors in rural regions and in cities to build greater social cohesion; and finally, utilising government assistance to farmers and rural regions to maintain public goods that may otherwise fade away (Cabell & Oelofse, 2012).

When designing resilience strategies and interventions in rural and agricultural development, it is imperative, furthermore, not only to ensure that these interventions are well integrated and clearly defined, but also to keep in mind that they are situated in a particular context, understanding, and set of values and needs that will by definition change, at particular scales of time and space (Cabell & Oelofse, 2012).

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