Biodiversity in European agricultural landscapes - transformative societal changes needed

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10 Abstract

11 Reversing the decline of biodiversity in European agricultural landscapes is urgent. We suggest
12 eight measures addressing politics, economics and civil society to instigate transformative changes
13 in agricultural landscapes. We emphasize the need for a well-informed society and political
14 measures promoting sustainable farming by combining food production and biodiversity
15 conservation.

The rationale behind biodiversity conservation in agricultural landscapes

European agriculture has a long tradition of arable and livestock farming, with a rich biodiversity specifically adapted to agricultural landscapes. Agricultural practice has continuously increased in efficiency, producing more crops or livestock per unit area while reducing the diversity of non-target species. At the same time, sustainable agricultural production relies on biodiversity providing fertile soils and regulating ecosystem services [1]. Beyond the value that biodiversity has in sustaining food production, multiple other values motivate the conservation of biodiversity, and these values are the foundation of well-developed ethics of conservation. Accordingly, protecting biodiversity has been a commitment on the national and international political agenda for decades, but farmland biodiversity is still severely declining [2]. By considering societal commitments, in particular recent civil society initiatives, such as 'Save the bees' on an EU-wide level, we ask with new urgency how policy-making can achieve the dual objectives of food production and conservation in agricultural landscapes.

Drivers of biodiversity decline

Direct drivers leading to species declines in agricultural landscapes are generally linked to decreasing habitat quality and quantity. Drivers are, for example, the reduced number of crop varieties grown, the area-wide use of pesticides, more intensive fertilization due to changed livestock farming, the loss of structural diversity through increased field size, and a lack of well-connected protected areas [e.g. 3].

Indirect drivers are the scope and context in which direct drivers in agricultural practice are embedded. Farming activities depend on subsidies, market prices, legal frameworks and societal acceptance. Subsidies in many countries are organized by agricultural policies. In the EU, the Common Agricultural Policy (CAP) is still largely focused on increasing productivity, supporting farm incomes, and stabilizing agricultural markets[19]. Support of environmental objectives is an established part of the CAP, however, the protection of biodiversity remains insufficient to halt biodiversity declines [4]. The global market steers agricultural production and is influenced, amongst others, by subsidies, supply and demand. Biodiversity is an external effect and has thus no market value. At the same time, it is a public good, and external benefits of pollinators, for example, sum up to several thousand US dollars per ha at the global scale [5]. Biological diversity is legally protected at international, European, and national levels by agreements, such as the

[19]The CAP-objectives are defined in Article 39 of the Treaty of the Functioning of the European Union (TFEU). Initially, these objectives were determined in the Treaty of Rome 1957 and reconfirmed in the Treaty of Lisbon 2009.

Convention on Biological Diversity (valid for all signatory states worldwide), the EU Habitats Directive, and national nature conservation laws. In many cases, however, these laws miss concrete implementation measures, and there is a lack of enforcement. Further, the societal acceptance of, and public perception supporting, specific agricultural practices and conservation measures can have a large influence on the political actions needed to overcome such deficits.

Measures instigating transformation to mitigate biodiversity decline

The use of various leverage points from policy and society is required to mitigate the impacts of direct and indirect drivers simultaneously and reverse biodiversity declines. There is evidence that food security can be achieved, even with the expected growth in demand in agricultural commodities, while at the same time preserving biodiversity and even reversing biodiversity loss [6]. Given the fact that national and international food systems are complex interacting systems, a transformative approach, meaning a fundamental and system-wide reorganization across technological, economic, and social factors [1], should address the complex and conflicting targets and trigger changes addressing several leverage points simultaneously [7]. In the following, we give key recommendations for eight action areas that can together enable such a transformation (Figure 1):

1. Agricultural policies are the most powerful tools to support conservation measures in agriculture. The CAP currently dedicates most of its budget to direct payments solely depending of the size of the agricultural area and aiming at an income support for farmers. Shifting the focus of subsidies from direct payments to agri-environment-climate measures and biodiversity conservation is necessary. Subsidies need to target not only conservation measures, such as planting flower strips, intercropping or reducing pesticides [9], but also the delivery of measurable environmental outcomes, such as a continuously high biodiversity. Farmers could be rewarded both for the environmental outcomes of their activities or for implementing conservation measures. Outcomes and measures can be assessed together by a points system [8]. Additionally, linking funding to specific, regionally meaningful conservation targets, such as those defined in the Birds or Habitats Directives [8], will further increase the effectiveness of subsidies in conserving local biodiversity.
2. An improved legal framework is needed to strengthen the obligation to protect nature while practicing agriculture. This could be achieved by introducing a comprehensive agricultural law that includes an obligation for agriculture to operate in a biodiversity-friendly way. It should cover all agricultural aspects which are currently scattered across several laws, such as those for soil and water protection, but also more specific aspects such as location-

specific livestock-density guidelines, and regulations on the application of pesticides. To avoid competition and offsite effects between national states, this would need to be regulated on international level, e.g. EU-wide, and implemented in national legislation, as already in the case of the Birds and Habitats Directives. Further, protected areas in the agricultural landscape need a better legal protection status, including protection from edge effects from adjacent agricultural areas. The existing laws must be sufficiently enforced, and control instances need to be strengthened, to avoid law violation and to counteract existing deficits in law-enforcement.

3. Landscape management**.** Biodiversity conservation requires planning on a landscape or regional level, to guarantee that sufficiently large areas and structural elements are protected to provide refuge for, and sustain resilient populations of, species from different taxonomic groups. As agricultural land is often in private ownership, this can be achieved by financially incentivizing bottom-up initiatives, such as regional farm associations, supporting communication among multiple stakeholders such as farmers, nature conservation agencies and citizens [10].
4. Communities and local authorities have the responsibility to sustain biodiversity on their communally managed areas. This means revising green-space management, e.g. mowing and planting, from a biodiversity-friendly perspective. This is implemented, for example, in a German initiative making use of communally-owned areas to establish flower strips [11]. More importantly, such community initiatives serve as multiplicators for biodiversity-friendly approaches on local levels, such as providing native, diverse flower patches on other public and private land.
5. Trade and global markets need to internalize the external effect of biodiversity for example by incentivizing biodiversity-friendly produced goods with standards fixed in international agreements. Local markets can be encouraged to brand products from regional and biodiversity-friendly production. A label will inform consumers about biodiversity-friendly products, such as, for example, encouraged in UNESCO biosphere reserves [12]. Local market initiatives branding regional and biodiversity-friendly products have to be financially supported by building up the necessary infrastructure.
6. Farmers' motivation to conserve biodiversity is vital, as they are the ones who manage agricultural land. Farmers are usually willing to implement measures if no severe financial losses occur, or if they are compensated [13]. To maintain farmers' motivation and encourage knowledge sharing about successful conservation measures, meeting platforms and further training have to be offered about successful biodiversity-friendly developments. Farmers' commitment to the protection of biodiversity should be rewarded via subsidies for

investments in farm-scale measures supporting biodiversity. Farmers can provide the most important contributions to sustain biodiversity.

7. Societal acceptance and understanding of the value of farming and its role in protecting biodiversity can be promoted by demonstration farms offering practical experiences and by schools and museums extending their educational programs on cultural landscapes and their biodiversity. This can ideally shift consumption patterns by appreciating biodiversity-friendly food production, lowering meat consumption, and reducing food waste. Consumption patterns can also be changed by raising awareness in other settings, for example with an indicator evaluating the sustainability of food sold in the hospitality sector [14].
8. Research and monitoring are required to support all steps, and improve biodiversity conservation while sustaining the best possible agricultural production. There is a need for more transdisciplinary research including farmers in the co-development of innovations. Monitoring biodiversity trends requires the integration of people and organizations from various disciplines. In particular, the effectiveness of measures taken to preserve biological diversity has to be monitored at different scales. In addition to the further development of agroecology, new cropping concepts, and other innovations in fertilization and pest-control measures, the use of artificial intelligence, remote sensing data, and autonomous robots are required [15].

Figure 1

Fig. 1 To sustain and increase biodiversity, the agricultural landscape needs to change. Here we demonstrate a past, present, and future vision (from left to right) for a landscape supporting biodiversity with no net area loss to roads and a small-scaled and diverse landscape structures with polycultures such as corn-bean (blue semi-circle). Modern technology will support this development as exemplified by the drone. Eight overarching recommendations (blue boxes) will instigate the changes.

There is consensus that biodiversity in agricultural landscapes will continue declining under current management practices. Sufficient knowledge exists for immediate, informed action. Given the complexity and scale of the challenge, it will not be sufficient to change single components in the agricultural system; a transformative change addressing biodiversity decline from multiple leverage points is required. Here, we have highlighted interventions necessary to instigate societal and political transformations promoting biodiversity conservation. Agricultural production and biodiversity conservation are, and will remain, a societal and political challenge, requiring continuous learning and adaptation of objectives and activities.

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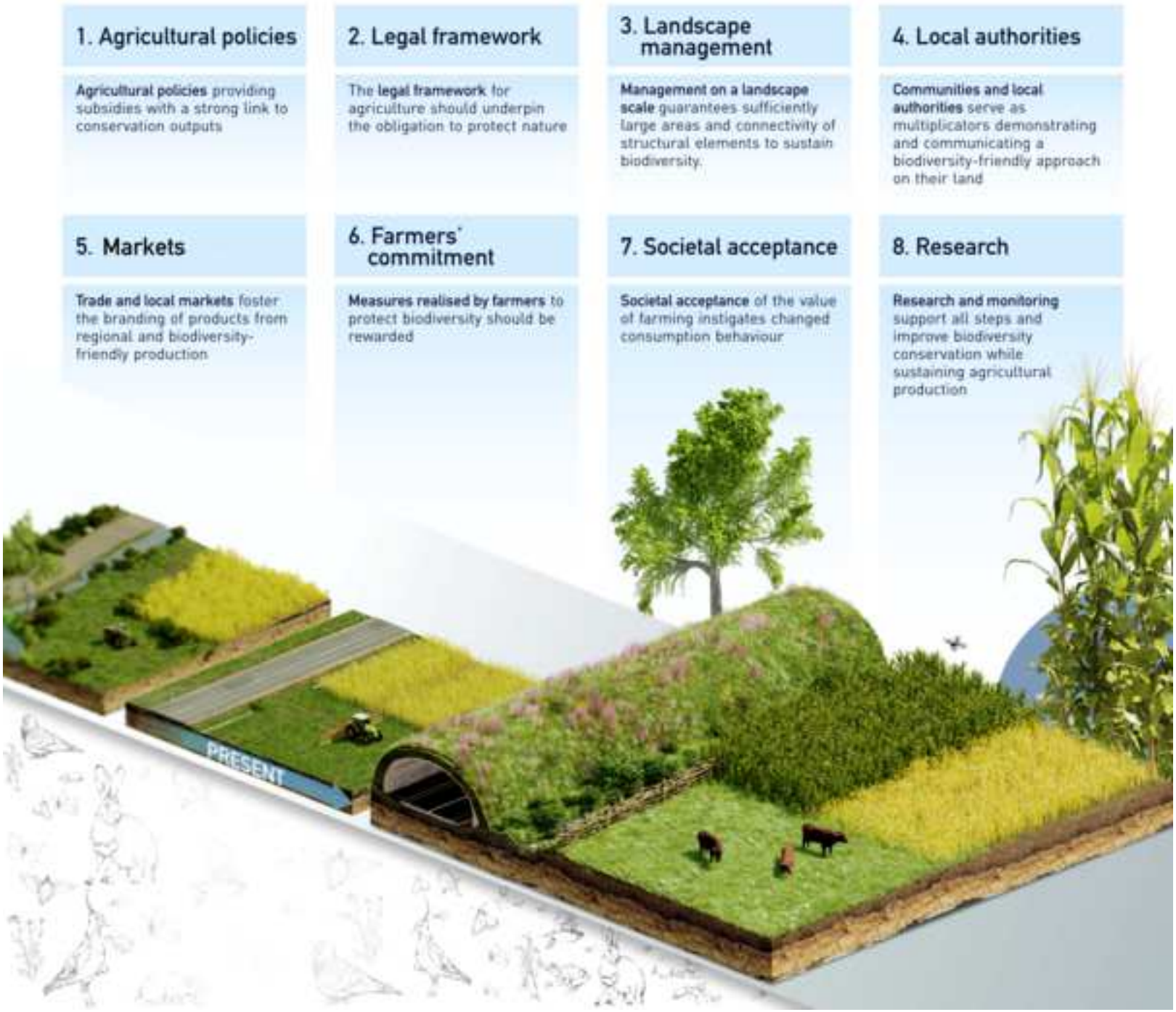
Figure


1. Agricultural policies
Agricultural policies providing subsidies with a strong link to conservation outputs
2. Legal framework
The legal framework for agriculture should underpin the obligation to protect nature
3. Landscape management
Management on a landscape scale guarantees sufficiently large areas and connectivity of structural elements to sustain biodiversity.
4. Local authorities
Communities and local authorities serve as multiplicators demonstrating and communicating a biodiversity-friendly approach on their land
5. Markets
Trade and local markets foster the branding of products from regional and biodiversity-friendly production
6. Farmers' commitment
Measures realised by farmers to protect biodiversity should be rewarded
7. Societal acceptance
Societal acceptance of the value of farming instigates changed consumption behaviour
8. Research
Research and monitoring support all steps and improve biodiversity conservation while sustaining agricultural production
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