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Species decline in the agricultural landscape: What do we know and what can we do?



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Key messages of the statement

- ▶ In summary, it can be stated at this time, from a scientific perspective, that the **biodiversity of numerous groups of species in the agricultural landscape has declined considerably in Germany in the last few decades.** ▶ [Pages 4 – 5](#)
- ▶ The loss of biodiversity is not limited to areas outside nature reserves, but is **also taking place within nature reserves.** ▶ [Page 4](#)
- ▶ The decline in animal and plant species can be attributed to a **combination of many factors**, including: increase in fertile, yet species-poor arable farming crops, preventive and extensive use of pesticides, overfertilisation, increase in farmed land, loss of species-rich grasslands, loss of the landscape's structural diversity. ▶ [Page 9](#)
- ▶ Measures to protect and promote biodiversity have to take into account the political, economic, and social aspects of agriculture. A **systemic approach with various parallel approaches** is therefore necessary. ▶ [Page 14](#)
- ▶ There is a need for action in **agricultural policy, both** at the European level and in Germany. It must be worthwhile for farmers to farm land in a biodiversity-friendly manner. The upcoming reform of the European Union's Common Agricultural Policy (CAP) should be used to provide greater funding for measures to protect biodiversity. ▶ [Page 14](#)
- ▶ **Individual municipalities** are also obliged to preserve, foster and increase biodiversity on their land. ▶ [Page 15](#)
- ▶ **Trade** can also help to increase biodiversity. Products from regional, biodiversity-friendly production should therefore be labelled accordingly. The development of infrastructure allowing for further processing of agricultural products to be carried out regionally should be promoted. ▶ [Page 15](#)
- ▶ Societal awareness of the value of biodiversity must be raised; learning environments beyond the classroom such as museums could play a vital role in this regard. ▶ [Page 16](#)
- ▶ We must be able to document and record changes for a broad and representative range of species and habitats. Furthermore, it is imperative that we are able to monitor the effectiveness of measures for preserving biodiversity. In order to do so, we urgently need **long-term, nationwide, and standardised monitoring.** ▶ [Page 16](#)

This statement is the result of three-month discussions involving 16 experts from agricultural sciences, botany, ethics, cultural sciences, nature conservation, ecosystem research, crop protection, environmental law, and zoology. The group of experts will submit further and more specific recommendations in the coming year. ▶ [Page 18](#)

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1. Status and development of species diversity in Germany

In recent years, there has been a growing number of indications that biodiversity is decreasing considerably in the agricultural landscape¹. In particular, scientific analyses have been carried out for birds, individual groups of insects, and plants (Figs. 1–4). The populations of typical bird species of the agricultural landscape such as the common skylark, starling, and lapwing fell by more than 36% between 1998 and 2009.² The population declines have been documented in many studies³ and are also reflected in the Red Lists^{4,5}. Many species living in the wild are fully dependent on the agricultural landscape. The phenomenon of shrinking populations is not limited to areas outside nature reserves—diversity is also declining within nature reserves. For example, the number of species of butterflies and burnet moths in a nature reserve near Regensburg dropped from 117 in 1840 to 71 in 2013.⁶ That not only the diversity of insects is declining, but the frequency of occurrence and biomass of the insects likewise was shown in 2017 by the Krefeld Entomological Association as part of a study in collaboration with Dutch and British scientists.⁷ The Krefeld entomologists were able to show that the biomass of flying insects in protected areas in North Rhine-Westphalia, Rhineland-Palatinate and Brandenburg fell by an average of 76 % between 1989 and 2016. The Krefeld study is the most comprehensive measurement of insect biomass in Germany to date. Its key messages are in line with Dutch monitoring data.⁸

1 The term “agricultural landscape” denotes the open and semi-open cultivated landscape which is substantially used for agricultural purposes, fields and grasslands (meadows and pastures), but also includes copses, individual trees, hedges, waysides, small bodies of water or individual houses and roads.

2 Sudfeldt et al. 2013.

3 Lemoine et al. 2007, Wesche et al. 2012, Brooks et al. 2012, Schuch et al. 2012a, Schuch et al. 2012b, Inger et al. 2015, Meyer et al. 2013, Habel et al. 2016, Hallmann et al. 2017.

4 Red Lists are directories of extinct or endangered species of animals, plants and fungi. These are scientific expert reports, in which the endangered status is shown for a specific reference area. The Red Lists evaluate the available information regarding the endangerment of certain species on the basis of clearly defined criteria. The Red Lists are mostly published by the Federal Government or by the federal states (Ludwig et al. 2009, Finck et al. 2017).

5 Haupt et al. 2009, Binot-Hafke et al. 2011, Gruttke et al. 2016.

6 Habel et al. 2016.

7 Hallmann et al. 2017.

8 Hallmann et al. 2018.

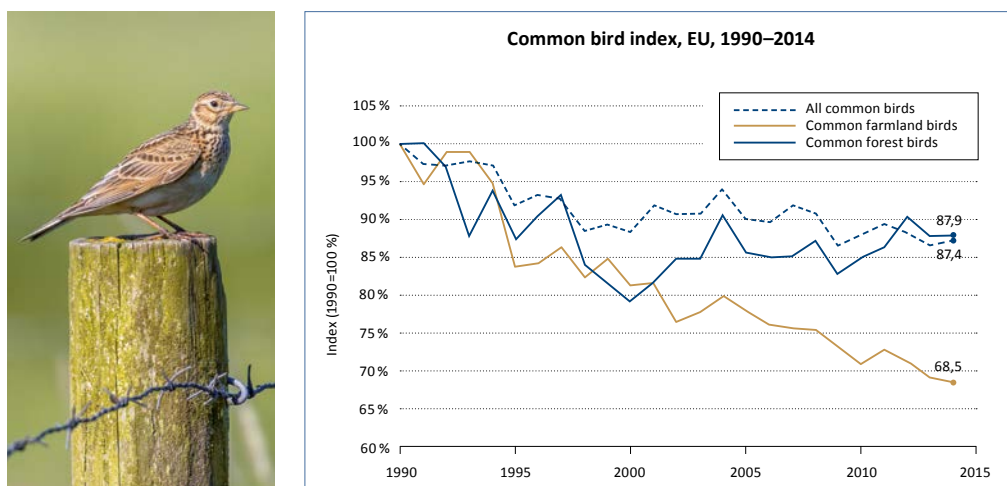


Fig. 1 (left): The common skylark (Lat. *Alauda arvensis*) is a typical bird of the agricultural landscape. Their populations have declined considerably in the last 30 years. The common skylark breeds in arable areas and meadows; it requires vegetation cover which is not dense, and it feeds its young with insects. The cultivation of high or dense crops such as corn or winter cereals, intensive and frequent soil cultivation, and the use of fertilisers and pesticides are adversely affecting the living conditions of this formerly very frequently occurring bird.⁹

Fig. 2 (right): Changes in the frequency of occurrence of 167 bird species in 26 European countries during the period from 1990 to 2014, shown as an index. In addition, the index for 39 bird species of the agricultural landscape and 34 forest bird species was calculated. The data show continual population decreases in the birds of the agricultural landscape such as, for example, the common skylark, the lapwing or the partridge¹⁰. Compared with 1990, the population of the birds in the agricultural landscape has, on average, dropped to 68.5%.¹¹

The loss of biodiversity in Central Europe and in Germany is most pronounced in the agricultural landscape.¹² Bird populations are regressing continually across Europe (Figs. 1 & 2). For example, standardised censuses of birds in the Lake Constance region from 1980 to 2000 show that there was an average decline in the frequency of occurrence of species of approximately 30% in the agricultural landscape, while the populations in forests, in wetlands, and in urban areas remained stable and, in some cases, even rose.¹³ With regard to the magnitude of the declines in population, there are differences between various groups of species and between regions.¹⁴ Nevertheless, it can be clearly deduced from an overview of the existing studies that the number of species, the frequency of occurrence, and the biomass of animals and plants in the agricultural landscape are declining considerably (Fig. 1–4).

⁹ Sudtfeldt et al. 2008, S. 18, Link: http://www.dda-web.de/downloads/texts/publications/statusreport2008_ebook.pdf (Status as at: 12.10.2018).

¹⁰ Sudtfeldt et al. 2013.

¹¹ EEBC (2017), Royal Society for the Protection of Birds, Birdlife International and Statistics Netherlands; Eurostat online data code.

¹² European Environment Agency 2015.

¹³ Lemoine et al. 2007.

¹⁴ Schuch et al. 2012a, Batáry et al. 2017.

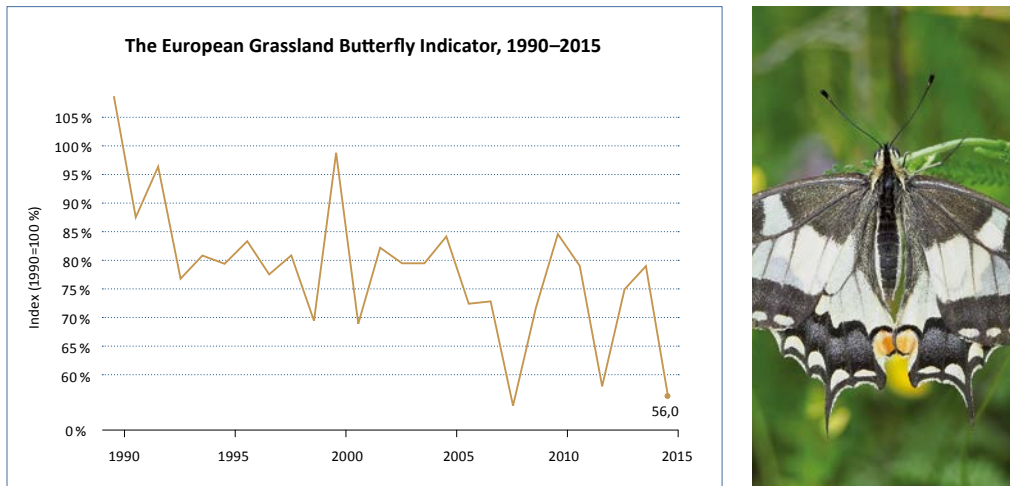


Fig. 3 (left): Changes in the frequency of occurrence of 17 butterfly species of the grassland (meadows and pastures), including the wall brown butterfly and the orange-tip butterfly, in 15 European countries during the period from 1990 to 2015, represented as an index.¹⁵ The populations fell on average to 56% of the reference year 1990 (“The European Grassland Butterfly Indicator”, modified with the kind approval of Chris van Swaay, Wageningen, The Netherlands).

Fig. 4 (right): The population of the swallow-tail butterfly (Lat. *Papilio machaon*) is declining.¹⁶ In the last 10 years, there has been a decline of 28% in Great Britain.¹⁷ (Photo: Felix Fornoff, University of Freiburg)

Only a few elements of a long-term, nationwide and standardised monitoring have existed in Germany to date (bird monitoring¹⁸, High nature value farmland monitoring¹⁹, flora, fauna and habitat monitoring²⁰, butterfly monitoring²¹). We therefore need the monitoring to be expanded substantially in order to record representative elements and functions of biodiversity as comprehensively as possible.

¹⁵ European Environment Agency 2013, van Swaay et al. 2016. A list of the 17 species considered for this index can be found on page 14. Link: https://www.researchgate.net/publication/310447552_The_European_Butterfly_Indicator_for_Grassland_species_1990-2015 (Status as at: 12.10.2018).

¹⁶ Binot-Hafke et al. 2011; van Swaay et al. 2016.

¹⁷ UK BMS 2017, Link: <http://www.ukbms.org/docs/reports/2016/Butterfly%20Ann%20Report%202016.pdf> (Status as at: 12.10.2018).

¹⁸ Mitschke et al. 2005.

¹⁹ Benzler 2009; Hüinig & Benzler 2017.

²⁰ Behrens et al. 2009; Weddeling et al. 2007.

²¹ Kühn et al. 2014.

2. The values of biodiversity

The decline in biodiversity is leading to the loss of goods, services, and values for human society (Fig. 5 as an example of pollination). Ecosystems and their living creatures often provide goods and services on which humans are essentially dependent, the value of which can also partially be economically quantified:²² For example, an increased cross-pollination of apple trees by wild bees and other insects helps fruit yields and can increase crop quality.²³ In addition, many unremarkable animal species and microorganisms, which assume tasks involving pest control and recycling of nutrients, and roles as plant eaters or seedeaters, are important for the functionality of an agricultural ecosystem.²⁴ The more diverse an ecosystem is in terms of species, the lower the prevalence of pathogens and parasites in plants and animals.²⁵ In fields, seedeaters reduce the occurrence of undesired plant species which compete with agricultural crops.²⁶ Wildflower strips and hedges prevent the erosion of the soil, which has numerous benefits including countering the loss of fertile agricultural soil. A high level of biodiversity is necessary for the stability of these benefits.²⁷



Fig. 5: In the case of apple cultivation, trees which have been pollinated by hand produce an extremely large number of small fruits with an unnaturally large number of pips (left). These apples are not suitable as merchandise. If the apple blossoms are pollinated by insects, the fruit growers obtain the desired yield and consumers obtain the desired apple quality (middle). On the other hand, the exclusion of insects results in a few large apples which do not have any pips and which are only suitable for cider (right). The example shows a frequently occurring variety organically farmed near Lake Constance. (Photo: Alexandra-Maria Klein, University of Freiburg)²⁸

²² TEEB 2010, Link: http://www.teebweb.org/media/2010/09/TEEB_D2_Local_Policy-Makers_Report-Eng.pdf (Status as at 12.10.2018), Lautenbach et al. 2012.

²³ Klein et al. 2007, Garratt et al. 2014, IPBES 2016, IPBES 2018, Wietzke et al. 2018.

²⁴ Lavelle et al. 2006, Tschardt et al. 2012.

²⁵ Civitello et al. 2015.

²⁶ Pannwitt et al. 2017.

²⁷ Tilman et al. 2006, Winfree et al. 2009.

²⁸ SWR (2018). Link: <https://www.ardmediathek.de/tv/odyso-Wissen-im-SWR/Die-Insekten-sterben/SWR-Fernsehen/Video?bcastId=246888&documentId=56810186> (Status as at: 15.10.2018).

Furthermore, biodiversity contributes to the recreational value of landscapes, which is particularly important for human well-being; an increasing number of studies have demonstrated correlations between biodiversity and both mental and physical health in humans.²⁹ Furthermore, biodiversity represents cultural and spiritual values for many humans. Protected natural monuments, e.g. ancient solitary oaks, hint at the long relationships between humans and other species.³⁰ For many humans, the value of biodiversity exists independently of its usefulness to humans. It is worth preserving for its own sake. It is also important to preserve biodiversity due to its numerous values for future generations.

In light of the complexity of ecosystems and the interactions between species and their environment as well as the many benefits biodiversity grants to humans, the consequences of the loss of this diversity differ depending on the ecosystem, time horizon and evaluation method. Furthermore, the consequences often cannot be predicted, so assessing these is fraught with uncertainties and cannot be generalised. Nevertheless, the loss of species should be countered from an ethical point of view, both from an anthropocentric perspective, that is to say a human-centred perspective which takes account of current and future generations, and from a biocentric viewpoint, i.e. a viewpoint based on the moral rights of all living creatures.³¹ This is all the more the case when one considers that the extinction of species is irreversible and individual species cannot be replaced.

The fundamental acceptance of the value of biodiversity is expressed by the fact that it is legally considered within the framework of the prevailing nature conservation law at the international, national and federal state levels. The loss of species and the corresponding reduction in biodiversity runs counter to the objectives of this nature conservation law.

²⁹ Fuller et al. 2007, Dallimer et al. 2012, Hedblom et al. 2014, Cox et al. 2017, Fischer et al. 2018.

³⁰ Schumacher et al. 2014.

³¹ Potthast 2014.

3. Causes of the decline in biodiversity in the agricultural landscape

The causes of the decline in biodiversity in the agricultural landscape are numerous. They are predominantly due to the interaction of changes in the intensity of use, ground cover, and structure of the agricultural landscape. The causes listed here are simply enumerated. Consequently, no conclusions regarding the extent and importance of their respective impact are to be drawn from the order in which they are indicated:

- ▶ Change in land use and the cultivated crops; decrease in species-rich types of land use (e.g. by ploughing grassland, increased use and fertilisation of dry or wet grassland);³² increase of fertile, yet species-poor arable farming crops (e.g. corn, rapeseed, wheat);
- ▶ Dominance of crop rotations with a few fertile field crops in arable farming (winter wheat, winter barley, rapeseed); dominance of maize cultivation, in particular in regions which have intensive livestock farming, which are frequently cultivated continually over many years; the cultivation of mixed crops consisting of several crops simultaneously is no longer part of common practice nowadays;³³
- ▶ Low use of more robust varieties or biological and mechanical pesticides; preventive and extensive application of herbicides (e.g. glyphosate), fungicides, insecticides (e.g. neonicotinoids, pyrethroids)³⁴ as well as vermicides (vermicidal means), the latter due to animal farming;
- ▶ Overfertilisation as well as spreading of slurry on grassland causes the decline in plant species and insects which are dependent on nutrient-poor soils;
- ▶ Increase in operational units and farmed land; change in farming practice in favour of large-scale field crops, which do not offer any possibilities of retreat for birds and other wild animals due to the fact that they are harvested simultaneously;³⁵
- ▶ Loss of the landscape's structural diversity due to the disappearance of rows of trees, hedges and copses, cairns or loose stone walls, extensively farmed edge strips and uncultivated lands and, therefore, loss of food, nesting sites and hiding places for birds, wild bees, spiders and other animals;³⁶

³² BMEL (2017), p. 63. Link: https://www.bmel-statistik.de/fileadmin/user_upload/010_Jahrbuch/Agrarstatistisches-Jahrbuch-2017.pdf (Status as at: 15.10.2018).

³³ Seifert et al. 2015.

³⁴ Schäffer et al. 2018.

³⁵ Batáry et al. 2017.

³⁶ Kühne & Freier 2012, Benton et al. 2003.

- ▶ Lack of size and interconnection of nature reserves in the agricultural landscape (e.g. extensively managed grassland), so that the decline of insect populations is not prevented and no repopulation is allowed; partially conventionally farmed agricultural land in nature reserves; partially lack of suitable usage concepts for extensive cultivation; introduction of fertilisers and pesticides from surrounding areas into nature reserves; lack of buffer strips around the nature reserves;
- ▶ Loss of unsealed areas in favour of constructed areas (residential and traffic areas).

Since these causes often coincide and can change in terms of their relevance over time, it is difficult to prove which measure has led to the decline in a particular species or group of species and to what extent. However, it has been ascertained that each of these causes contributes to the loss of biodiversity, the frequency of occurrence and the biomass of species in the agricultural landscape. It has also been ascertained that extensive use and organic farming can promote biodiversity, with different levels of positive effects resulting for various groups of species and regions.³⁷

³⁷ Doxa et al. 2012, Tuck et al. 2014, Schneider et al. 2014, Flade 2016, Lichtenberg et al. 2017.

4. Socioeconomic, political and legal framework conditions

The use of land in the agricultural landscape is directly in the farmers' hands. However, changes in land use have to take place within a socioeconomic, political and legal context which lies outside the immediate control of individual farmers. Ultimately, sustainable protection of biodiversity is only conceivable as a shared responsibility of all those active in agriculture, science, politics, and society. This means that a balanced way must be found to reconcile market mechanisms, political and legal framework conditions, so that farmers can help to protect biodiversity within their prevailing scope of action.

4.1 Role of the market economy in protecting biodiversity

Agricultural production in Germany is controlled by market economy mechanisms, legal regulations, and public transfer payments. Production decisions are, currently, largely governed by international prices for the goods produced and for the resources needed for production. Biodiversity is a public good which has no market value. Protecting biodiversity is immaterial in a market which is focused only on supply and demand. Therefore, it is not adequately protected under current market-based conditions. Too little emphasis is placed on preserving species diversity when it comes to solving the conflicting goals of producing reasonably priced food and protecting biodiversity. One possible way of improving the protection of biodiversity in the agricultural landscape is to increase society's appreciation of agricultural products which have been cultivated using organic farming methods and other biodiversity-friendly methods. Consumers show their acceptance of the additional value of these products by paying a higher price for them. This, in turn, makes it possible for farmers to use more expensive farming methods which are more biodiversity-friendly.

4.2 Role of agricultural policy in protecting biodiversity

Agriculture in Germany has been receiving transfer payments via the European Union's Common Agricultural Policy (CAP) since the end of the 1960s. Since 2005, the majority of these payments have been made by land-related direct payments which are independent of production (e.g. independent of which crops are cultivated or how many animals are kept). Since 2009, the direct payments have been linked to an obligation to meet certain requirements of the European Union under environmental, animal and consumer protection legislation and to maintain agricultural land in "good agricultural and ecological condition". In 2013, due to the continuing ecological deterioration in many agricultural landscapes, the European Union linked the fulfilment of additional environmental regulations to the direct payments ("greening" in the 1st pillar of the CAP), with particular requirements regarding cultivation diversity and the preservation of permanent grassland, and associated with the requirement to create

ecological focus areas.³⁸ Furthermore, in order to protect the environment and biodiversity, the European Union is promoting voluntary agri-environmental measures (2nd GAP pillar), which go beyond the mandatory environmental requirements of the 1st pillar³⁹ and which are also financed and concretised by the Member States.⁴⁰ In addition to the revenues generated on the market, the land-related direct payments (1st CAP pillar) provide a substantial contribution to the income of agricultural enterprises. On the other hand, the funds for voluntary agri-environmental measures (2nd CAP pillar), which are exclusively focussed on environment objectives, are generally of secondary importance.

All in all, the ecological effects of the measures of the CAP are inadequate in practice. The “greening” measures in the form of the accompaniment of direct payments have little effect, despite the fact that considerable budgetary resources are used.⁴¹ When viewed in terms of their costs and benefits, they are also far less efficient than measures under regulatory law.⁴² One weakness of the 2nd pillar agri-environmental measures is that there are no economic or otherwise operationally meaningful incentives to protect or promote biodiversity beyond the reimbursement of costs. Nor are the agri-environmental schemes, which form part of the EU agricultural policy, focussed on specifically protecting species and selective habitats.⁴³ The administrative outlay and complex legal framework conditions of the agri-environmental measures prevent many farmers from participating in voluntary agri-environmental measures and result in the latter ultimately having little effect in protecting biodiversity.⁴⁴ There is also a lack of scientific examinations or evaluations accompanying the agri-environmental measures, meaning that expedient adjustments and effectiveness checks are neither possible nor implemented.

4.3 Legal framework conditions in the protection of biodiversity

Numerous regulations exist at the international, European Union, and national levels regarding the preservation of biodiversity. These regulations also relate to agriculture, which influences biodiversity on the farmed land and in the surrounding landscape. Although clear rules exist regarding land management, these are frequently not sufficient to effectively protect biodiversity. The specific legal provisions are often difficult for farmers to implement in practice, and compliance with these provisions is insufficiently controlled.

In some cases, the regulations for land management also take account of the protection of the surrounding landscape: Fertilisation and crop protection measures are thus required to maintain certain distances from bodies of waters in pursuance of the Fertiliser Ordinance and Plant Protection Act. Crop protection measures have to keep certain distances to other utility systems, biotopes and nature reserves. However, in many

³⁸ Articles 43-46 of Regulation (EU) No. 1306/2013; concretised and implemented in Germany by means of the Direct Payments Implementing Act and the Direct Payments Implementing Ordinance.

³⁹ Article 28 et seq. Regulation (EU) No. 1305/2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), OJ L 347, 20.12.2013, p. 487.

⁴⁰ This is the responsibility of the federal states in Germany.

⁴¹ Pe'er et al. 2017; Schmidt et al. 2014.

⁴² Möckel et al. 2014, p. 357 et seq.

⁴³ Batáry et al. 2015; Oppermann et al. 2012.

⁴⁴ Zinngrebe et al. 2017.

nature reserves farming is allowed and carried out including the use of fertilizers and pesticides.⁴⁵ In addition, not all bodies of waters (e.g. small bodies of waters)⁴⁶ are included in the Plant Protection Act and the Fertiliser Ordinance⁴⁷, resulting in a gap in protection.⁴⁸

The rules governing biodiversity on agriculturally used land depend on whether a specific protection status is provided. As long as the various species living on agricultural land do not include any species having a particular protection status, only the rules regarding best practices remain in force. The requirements of best practices under fertilisation and plant protection law are binding and, in part, very specific, meaning they can be effectively enforced by the authorities in individual cases. In contrast, the principles of best practices under the Federal Soil Protection Act⁴⁹ and Nature Conservation Act⁵⁰ are not binding⁵¹ and vague, and therefore not very practicable. However, deficiencies in enforcement by the authorities do exist even in the drafting of best practices under fertilisation and plant protection law. This can be attributed to the sheer size of farms and agricultural land (which make up 50% of Germany's land area), also to the lack of official capacities and to the transfer of control tasks to chambers of agriculture (Landwirtschaftskammern), an organisation representing the interests of German farmers.⁵²

If a farm lies within a nature reserve (e.g. within the European Union's Natura 2000 network of nature reserves), the farmers are automatically subject to particular requirements under nature conservation and water law as well as the specific nature reserve provisions. As a general rule, the designation of protection status goes hand in hand with production restrictions. In practice, the land owners frequently complain about lower resale values for land which has protection status, even if the farming in accordance with the rules, which was previously carried out, is not restricted or is only slightly restricted, or farming restrictions are carried out and financially compensated as voluntary agri-environmental measures.

45 Federal Administrative Court judgement of 6.11.2012 – 9 A 17.11, marginal number 89 regarding agriculture and Natura 2000 areas; Möckel et al. 2014, p. 306 et seq.

46 Section 2 (2) WHG [Water Management Act].

47 Section 5 (4) DüV [Fertiliser Ordinance].

48 The gap could be closed by extending Section 12 (2) PflSchG [Plant Protection Act] and deleting Section 5 (4) DüV [Fertiliser Ordinance].

49 Section 17 BbodSchG [Federal Soil Protection Act].

50 Section 5 BNatSchG [Federal Nature Conservation Act].

51 Federal Administrative Court judgement of 1.9.2016 – 4 C 4.15 regarding Section 5 (3) BNatSchG [Federal Soil Protection Act]. In land law, the non-binding nature follows from Article 17 (1) BbodSchG [Federal Soil Protection Act].

52 Möckel et al. 2014, p. 280 et seq.

5. Recommendations for action for preserving and promoting biodiversity in the agricultural landscape

Acute need for action: There is a large number of measures which can be implemented in order to preserve and promote biodiversity in the agricultural landscape. There is a consensus among the scientists involved in drafting this paper that action is urgently required and existing knowledge is sufficient to be able to implement reasonable and justifiable measures for all involved. The next step should be to carry out a comprehensive analysis of the socio-ecological system of the agricultural landscape and its main actors, in order to clarify how the individual measures should mesh and be weighted and designed in order to effectively and efficiently promote biodiversity. Such an analysis as well as the modified recommendations for action, which are to be derived from this, are already planned and will allow this working group of experts to issue a more detailed statement.

Multiple solutions: Since the causes and consequences of the loss of biodiversity are complex and affect many decision-making and action levels (e.g. EU agricultural policy, planning decisions of federal states, districts and municipalities, individual land use decisions of farmers, consumer and eating habits of society), a combination of various measures at different levels is necessary.

Agricultural policy at European and national level: Biodiversity-friendly farming must be worthwhile. The reform of the European Union's Common Agricultural Policy (CAP) should be used to finance effective measures for protecting biodiversity.⁵³ In addition, basic funding (direct payments) should be coupled to the impacts of specific land use on the environment and biodiversity. Staggered basic funding focussed on the performance of the enterprises for the public good would be particularly suitable in this context, as this could create incentives for a more efficient protection of biodiversity and a varied landscape structure.⁵⁴ Large species diversity can strengthen natural pest control and help to reduce direct measures to control pests.⁵⁵ Such relationships should be prioritised in future when it comes to the funding of farms. The provision of funding should be more closely linked to targets and their attainment (e.g. an actual high level of biodiversity on agricultural land) and less on the basis of measures (e.g. mowing grassland areas once or twice a year). Clear criteria and regular monitoring are required in order to evaluate the measures and the attainment of targets. These should be financed as accompanying scientific examinations from the CAP funds. It is important to take advantage of the opportunities of the new regional and/or national responsibility within the framework of the CAP as of 2021, in order to protect biodiversity. An ecologically-oriented EU agricultural policy should focus to a much greater extent on direct and indirect behaviour control instruments, since farmers who do not claim direct payments do not have to meet many biodiversity-related obligations. In

⁵³ Pe'er et al. 2017, WBAEV 2018.

⁵⁴ See Neumann et al. 2017 for one possible example.

⁵⁵ Muneret et al. 2018.

addition, in order to avoid unfair competition, a new EU-wide legal framework is required for agriculture—an EU agricultural directive. In addition to the direct payment law, it should enshrine minimum standards under regulatory law,⁵⁶ limits on the stock density per hectare, taxation on fertilisers and pesticides⁵⁷ as well as state ecological management consultancy⁵⁸.

Planning decisions at municipal level: Many decisions regarding the farming of land in the agricultural landscape are made in the municipalities. Therefore, districts and municipalities are also responsible for preserving, fostering, and promoting land having a high value for biodiversity. Land owned by municipalities should be maintained such that biodiversity is preserved and increased. A biodiversity-friendly design of green areas should be predefined in ordinances for gardens, green spaces/parks and industrial areas (e.g. high proportion of meadows instead of lawns, planting of native rather than exotic species), and the employees of the public works departments should be trained accordingly. In the case of land which is not municipally owned, the municipalities could be given an opportunity under construction planning law to stipulate agricultural and forestry use (communal land use planning).⁵⁹

Nature reserves for biodiversity: Existing nature reserves must be enlarged, managed in a more biodiversity-friendly manner, and better interconnected. The goals of the Natura 2000 network should be taken into greater account in the CAP funding and within the framework of planning law. FFH management plans can improve the protection of biodiversity and, at the same time, contribute to the participation and involvement in, and implementation of, nature conservation by farmers.⁶⁰ The use of fertilisers and pesticides in nature reserves should be prohibited as a matter of principle. Buffer zones should be established around nature reserves in order to shield them from the introduction of unwanted substances.

Trade, markets: Products from regional biodiversity-friendly production should be labelled accordingly in trade. This labelling should be state-certified and awarded in line with clear criteria. The development of infrastructures for processing agricultural products regionally (e.g. mills, slaughterhouses) should be promoted. Initiatives to establish regional economic cycles and to promote biodiversity-friendly businesses (e.g. transition town movements, etc.) should be supported.

Civil society: Awareness of the importance of biodiversity should be raised in society, since people only protect what they know and appreciate. The diverse relationships between intensive land use and low species diversity, on the one hand, as well as quality, prices of food and consumer behaviour, on the other, should be communicated. The personal relationship with nature and the appreciation of species diversity must be promoted among citizens. In communicating this message, learning environments beyond the classroom such as museums, botanical and zoological gardens, national park centres or farms should play a particular role, since they are able to communicate the relationships in a particularly authentic, personal and vivid manner.

⁵⁶ Möckel 2014, S. 15–23.

⁵⁷ Möckel et al. 2015; Möckel et al. 2014.

⁵⁸ Möckel et al. 2014.

⁵⁹ Möckel et al. 2014, p. 405 et seq., p. 414 et seq.

⁶⁰ Lakner & Kleinknecht 2012.

Education and training measures: The knowledge and skills regarding biodiversity and systemic relationships should be increased for all parties working in the countryside and in gardens. This should be approached in the form of education and training measures (e.g. knowledge of species, ecological relationships, value of the benefits of biodiversity, biodiversity-friendly measures; certificate of competence for the application of pesticides).

Monitoring: We urgently require long-term, nationwide, and standardised monitoring of biodiversity in order to be able to document changes for a broad and representative range of species and habitats. Furthermore, we must have the ability to monitor the effectiveness of measures for protecting biodiversity. Only some elements of such monitoring have existed in Germany to date.

The objectives of the monitoring should be clearly defined. The monitoring should be designed such that statistically reliable conclusions can be drawn regarding the trends of individual species and groups of species, the trends within certain habitats, and regarding possible causes of the trends found. Furthermore, in-depth analyses of causes as well as specific monitoring programmes are necessary in order to evaluate measures and funding programmes. The essential characteristics of successful monitoring programmes are:

1. Uniform data collection in all federal states;
2. Consideration of a broad spectrum of groups of species; including groups where little about their population changes is yet known, but which play a significant role in the function of ecosystems (e.g. soil organisms);
3. Scientific design and accompaniment of the monitoring programme in order to guarantee the quality of data collection and evaluation;
4. Close cooperation between researchers and the Government departments involved (Federal Ministry for the Environment, Federal Ministry of Agriculture and Nutrition as well as Federal Ministry of Education and Research);
5. Public availability of the monitoring data

Research: There is a particular need for research with respect to five aspects:

1. The consequences of the loss of biodiversity for ecosystems and human society;
2. The specific causes of the loss of biodiversity, their interaction as well as the relative importance of the individual causes for individual groups of species;
3. Improving the understanding of the relationships between biodiversity and land use by means of interdisciplinary cooperation between various scientific disciplines of natural and social sciences and law, as well as experts from practice, in order to identify the scope of action;

4. Developing measures in order to improve the status of biodiversity in trans-disciplinary collaboration with farmers as well as representatives of districts and municipalities;
5. Monitoring success with respect to the impact and sustainability of the measures developed.

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