

Crop protection in Germany

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The current state of agriculture in Germany

In 2025, about half of Germany's total land area is used for agriculture (16.6 million ha). This consisted of just over 70% arable land (11.7 million ha), 28% permanent grassland (4.7 million ha), and 1% permanent crops (194,500 ha) such as fruit orchards (59,200 ha) or vineyards (102,100 ha). The area under organic farming has increased in recent years. In 2025, it accounted for about 11.4% of the total agricultural land (1.9 million ha). More than half of all organic farms are located in Bavaria (38%) and Baden-Württemberg (17%).¹

A good half of the arable land is used for growing cereal grains (6.03 million ha in 2026). The most important cereal grain in Germany is winter wheat (5.0 million ha, 82.9 % of cereal cropping area in 2026), followed by barley. The second most common crop after cereal grains is silage maize (1.93 million ha in 2026), primarily used as animal feed, followed by rapeseed (1.14 million ha in 2026). Root crops such as sugar beets and potatoes follow far behind. The cultivation of legumes has increased significantly in recent years, but they still account for only a relatively small portion of arable land. For example, the area planted with soybeans increased by 174.1% from 2016 to 2025, yet the share of the area under soybean cultivation in 2025 in the total agricultural land area was 0.3%. In 2020, legumes accounted for the largest share of organic farming among all crop types, making up 29% of the total area devoted to legume cultivation. In contrast, only 6% of cereal grains were grown organically in 2020.²

In 2025, vegetables were grown on approximately 130,400 ha of open-field land. The largest open-field cultivation areas were in North Rhine-Westphalia (22%) and Lower Saxony (20%). Compared to the average for the years 2019 through 2024, there was a 17.3% increase in the area under organic vegetable cultivation and a 33.7% increase in harvest volume.³

The most widely grown tree fruit in Germany are apples (32,700 ha). The two leading apple-growing federal states, Baden-Württemberg (11,600 ha) and Lower Saxony (8,400 ha), account for 61.1% of Germany's apple-growing area. In 2024, the largest wine-growing areas in Germany were in Southern and Western Germany. Since 2010, the area of organically grown perennial crops such as pome and stone fruits and for berries has expanded significantly. The share of organic cultivation in the total area devoted to tree fruits and berries increased from 12% in 2010 to 21% in 2020. Vineyards have also seen an increase in the organic share between 2010 and 2020, rising from 5% to 10%.^{3,4}

Traditional soil management using plow tilling is losing its importance. In 2022/2023, only 40% (4.6 million ha) of arable land was plowed, compared to 2015/2016, when 53% (6.3 million ha) of arable land was tilled using the conventional method. In contrast, Farms more frequently employ conservation tillage methods using cultivators or harrows (49% in 2022/2023 vs. 40% in 2015/2016). In the Eastern federal states, the proportion of arable land cultivated using conservation tillage was significantly higher in the 2022/2023 crop year than the national average (82% in Thuringia vs. 56% in Bavaria). No-till methods are used on only 1% of arable land, with no increase compared to 2015/2016.

Since 2009/2010, cover crops have been steadily gaining in importance. In 2022/2023, cover crops were grown on 2.2 million ha of arable land, corresponding to just over 18% of arable land. In 2022/2023, approximately 90% (1.9 million ha) of the cover crops remained in the fields as green manure. About 7.5% (162,000 ha) were used for forage production, while the remaining 2.5% percent (53,000 ha) were used for energy production.⁵

¹ https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Flaechennutzung/_inhalt.html

² https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Feldfruechte-Gruenland/_inhalt.html

³ https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Obst-Gemuese-Gartenbau/_inhalt.html

⁴ https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Wein/_inhalt.html

⁵ <https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Feldfruechte-Gruenland/Tabellen/zwischenfruechte.html?templateQueryString=zwischenfruchtanbau>

Situation of crop protection and pesticide use

Plant protection is of great importance to society as a whole. Its primary purpose is to protect crops from diseases, pest insects, and weeds (collectively called pests) in order to prevent harvest or storage losses and to ensure the quality of plant-based products. In Germany, plant protection and IPM are regulated by national law via the Plant Protection Act of 6 February 2012. In addition, there are a number of ordinances under this Act, dealing with the relevant technical standards. Germany has worked to promote sustainable use of PPPs for over thirty years through a range of measures, including to minimise the risks associated with PPP use, promote innovation and the advancement of integrated plant protection (IPM) in agriculture.

In Germany, official state advisory services play a vital part in providing farmers with independent high quality and region-specific technical advice.

ISIP⁶, the Information System for Integrated Plant Production provides farmers with independent advice on plant protection by bringing together pest monitoring data collected by the Länder's official advisory services. Combined with weather data from around 600 stations, scientifically established pest thresholds and forecasting models developed by ZEPP. This information supports timely, needs-based plant protection decisions. The results feed into the weekly pest warnings and recommendations, helping farmers determine when control measures are necessary.

In Germany, plant protection is comprehensively regulated in accordance with EU law and is based on a high level of protection for humans, animals, and the natural environment.

Domestic sales figures for crop protection products across various areas of application have remained relatively stable since 2018, apart from annual fluctuations caused by the availability of active ingredients, current weather conditions, the annual occurrence of pests, the emergence of new pests, emergency authorizations granted, and declining crop resistance (Figure 1).⁷

In addition to domestic sales figures, the Treatment Index (*Behandlungsindex* BI) serves as a quantitative measure to describe the intensity of chemical plant protection (Figure 2). The BI represents the number of plant protection product applications on a farm's land area, for a specific crop type, or on a single farm. It takes into account reduced application rates and partial field treatments. When tank mixtures are applied, each plant protection product is counted separately. Data from the Network of Reference Farms (*Netz Vergleichsbetriebe Pflanzenschutz*) and the *Panel Pflanzenschutzmittel-Anwendungen* (PAPA⁸) are used to analyze the annual intensity of pesticide application in Germany. Each year, pesticide application data are recorded in detail within the crop-specific networks of survey farms and analysed by the Julius Kühn Institute.

https://www.destatis.de/DE/Presse/Pressemitteilungen/2024/05/PD24_212_41.html

⁶ www.isip.de

⁷ https://www.bvl.bund.de/SharedDocs/Downloads/04_Pflanzenschutzmittel/01_meldungen_par_64/meld_par_64_2024.html
<https://www.nap-pflanzenschutz.de/service/informationsmaterial/jahresbericht-2025>

⁸ <https://papa.julius-kuehn.de/>

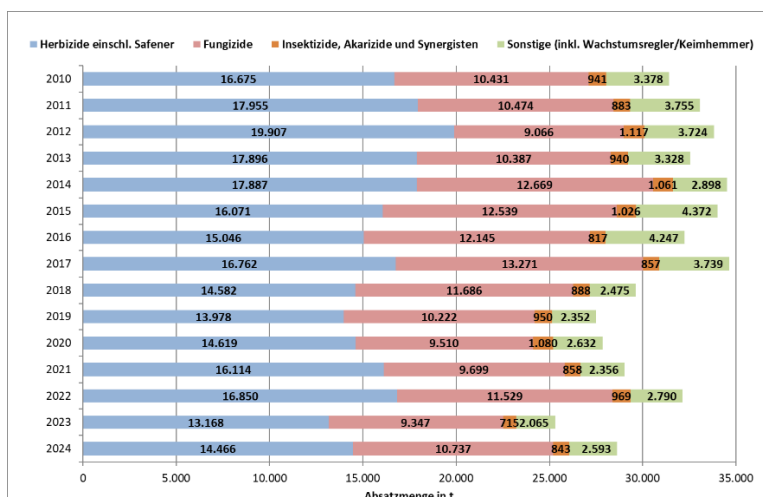


Figure 1: Domestic sales figures of active ingredients in pesticide by area of activity (excluding inert gases) in metric tons for the years 2010 through 2024 (figure kindly provided by Dr. Jürgen Schwarz, JKI)

On average for the years 2011 through 2024, the BI for field crops range from 1.9 for maize to 12.8 for potatoes. For winter wheat, the most widely cultivated crop in terms of area, the average is 5.3. The average BI for perennial crops from 2011 to 2024 is 12.0 for hops, 18.7

for grapes, and 30.5 for apples. Changes in the BI values over the past few years are primarily due to weather-related fluctuations in the occurrence of fungal and animal pests.⁹

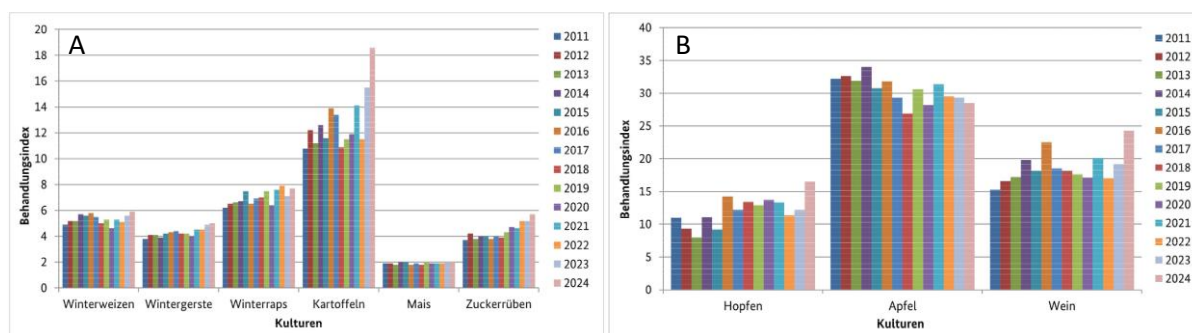


Figure 2: Trends in the BI for selected arable crops (A) and perennial crops (B) for the years 2011 to 2024 (figure taken from the annual report 2025 of the National Action Plan on Sustainable Use of Plant Protection Products)

Neither the annual domestic sales figures nor the BI indicate a sustained decline in the use of chemical-synthetic pesticides. In particular, the low reliability of non-chemical plant protection products under fluctuating weather conditions, as well as the dependence of many preventive methods on prevailing environmental conditions and the resulting lack of pest control—including associated crop losses—currently make it difficult to phase out chemical-synthetic pesticides on a large scale.

However, the recent Status Report on Biological Plant Protection (*in press*) shows that biological methods are well established in Germany, particularly in protected cropping, fruit and wine production, and organic farming, but remain less widely used in arable farming. In arable farming, their use remains concentrated on a relatively small number of methods and applications. One notable example is the increasing use of *Trichogramma brassicae* for the control of the European corn borer. The data demonstrate that adoption varies considerably between crops and methods. For some methods and crops, they account for a very high proportion of the treated area, including *Bacillus thuringiensis* products in vegetable production, codling moth granulovirus in fruit production, and pheromone-based mating disruption. The range of available microbial and nature-based active substances and plant protection products has expanded considerably over recent decades. This is particularly evident for natural substances and bacterial and fungal biocontrol agents targeting plant pathogens. New species of beneficial organisms and new approaches to their application have also become available. However, because biological methods often act against specific target organisms, their use is frequently limited to particular pests, crops and application conditions.

⁹ <https://papa.julius-kuehn.de/>
<https://www.nap-pflanzenschutz.de/service/informationmaterial/jahresbericht-2025>

Levers and barriers for more use of agroecology and preventive approach in crop protection

IPM methods provide well-proven measures that lead towards a more integrative agroecological approach and a preventive strategy in plant protection. The need for change is not justified solely by political reduction targets or (socio-)economic constraints. For years, stricter environmental and health protection regulations have reduced the number of available active ingredients through non-approval, revocation, and failure to renew registration. Resistance to pesticides is already forcing the adoption of non-chemical measures and the combination of a wide range of agronomic practices. Added to this are changes in crop production due to climate change. The emergence of new pests, combined with longer growing seasons, reinforces the need for intact ecosystems and the ecosystem services they provide. A survey of stakeholder groups, including national growers' associations and plant protection services conducted as part of the National Action Plan on the Sustainable Use of Plant Protection Products (NAP) indicated that German farmers often face high operating costs and lack incentives to adopt preventive measures when implementing the preventive measures of Integrated Pest Management (IPM). Economic conditions play a decisive role, given farmers' structurally limited market power. Furthermore, for many applications and some crops, no practical non-chemical curative methods are available. Existing non-chemical measures in conventional systems often demonstrate lower or less reliable efficacy than synthetic chemical measures. The increasingly precarious situation regarding the availability of effective plant protection products leads to problems in ensuring crop protection if preventive and non-chemical methods are not sufficiently effective. The risk of yield and quality losses when synthetic-chemical pesticides are not used acts as a deterrent, even though experience clearly shows that positive economic effects can be achieved by reducing pesticide use and optimizing efficacy. However, practical implementation is complicated by various factors such as environmental and site conditions, sensitive crops, and the frequent lack of reliable threshold values.

The following levers and barriers for preventive crop protection approaches were identified in stakeholder interviews and surveys:

Agronomy and Technology - The use of non-chemical measures, such as biological plant protection products (where available!) and mechanical weed control, is highly dependent on weather conditions, vegetation, and site-specific factors, and therefore results in highly variable reliability of effectiveness. Preventive plant protection is time-consuming (field inspections, use of damage thresholds, application of forecasting models, documentation), and in times of limited labor capacity, time pressure and tight time windows exacerbate these problems even further. Well-functioning forecasting models and warning services exist for numerous pests, but by no means for all of them. Most of these systems run in parallel, which is why integration with existing operations management software via standardized interfaces is required. A range of effective measures and techniques is available to address this. Digitalization (application maps) and modern machinery (precision application) are already an important part of agriculture. Digital support systems reduce the workload on farmers and are making more and more decisions (spot spraying, camera-guided weeding). Better-processed data opens up new possibilities in crop management. Optimized nutrient supply and precise seeding, combined with modern resistant and tolerant varieties, ensure effective preventive plant protection. Another barrier are tight crop rotations, which on the one hand generate lucrative contribution margins but simultaneously cause pest problems that must be controlled with synthetic chemicals. The expansion of crop rotations, has enormous potential as a lever for change, is hindered by the lack of marketable alternative crops with guaranteed off-take and pricing. The solution, establishing processing and marketing structures for diversification crops, particularly grain legumes, is hindered by a lack of guaranteed demand.

Economics and Markets - Immense transaction and information costs were associated with the measures mentioned. From a business perspective, there are real costs (time) involved, but these can only be partially taken into account. The introduction of results- and goal-oriented support can provide incentives here and reduce free-rider effects. Similarly, risk mitigation when applying non-chemical

measures offers meaningful opportunities if chemical plant protection is viewed as a form of insurance. Possible options include crop yield insurance for production with reduced use of synthetic chemical plant protection products or subsidies for the transition during the first years of production. There is no price signal for production methods with reduced pesticide use outside of certified systems. Consequently, at the market level, the costs of using synthetic chemical pesticides are externalized, and relative prices are distorted in favor of the synthetic chemical option. Furthermore, the food retail sector insists on zero tolerance for visual quality and stricter standards for maximum residue limits. These requirements run counter to applicable safety standards and regulations and cannot be reconciled with the principles of resistance management, placing the sole risk on producers. Added to this is an asymmetrical distribution of costs when changing production methods. Long-term investments in the purchase of machinery, in knowledge, in soil fertility or in continuing education and training are incurred immediately but, in some cases, do not pay off until after many years of use, and involve significant risks associated with changes in regulations and requirements.

Knowledge Transfer and Advisory Services - The linear transfer of knowledge from research through advisory services to practice, when supported by well-structured advisory formats, provides an effective and meaningful mechanism. Advisory services are a central component and must be integrated independently into the value chain. New participatory formats such as on-farm trials, demonstration farms, demonstration networks, and cross-farm learning groups demonstrate more effective adaptation to local conditions and foster trust when leading farms or peers apply the knowledge in practice. In combination with scientific support for researching systemic issues, such as long-term crop rotation trials, breeding and cultivation of alternative crops, mixed cropping, and landscape experiments at the ecosystem level, the foundations are laid for systemic approaches that can transcend the logic of project-based funding.

Institutions and Regulatory - Furthermore, political volatility pose challenges for the direction of EU policy and, consequently, for the binding legal frameworks of the member states. The prospect of the SUR and its subsequent repeal, followed by the omnibus package on the CAP, creates uncertainty regarding long-term investment decisions, as market participants tend to adopt a wait-and-see approach in response to regulatory uncertainty. Transparent and binding objectives are necessary for the creation of regulations to promote organic farming and integrated production systems based on long-term, stable financing and transparent funding targets. Policy levers must move away from a purely efficiency-based approach (more precise application, reduced application rates, spot spraying) and a substitution-based approach (biological active ingredients instead of chemical ones) toward a redesign approach that addresses and transforms fundamental changes in farming systems. At first glance, efficiency and substitution approaches offer solutions that can be implemented quickly and are politically effective; however, efficiency gains are eroded by the development of resistance and the loss of active ingredients. The substitution of active ingredients often fails due to the comparatively lower reliability of biological methods. For these reasons, the system must be redesigned to facilitate a transparent transformation that is planned for the long term.

Projects and programs nationally funded in the domains of crop protection

The BMLEH supports projects aimed at developing biological and non-chemical alternatives:¹⁰

- over 23 million euros (2017–2023) for research projects on alternatives
- approximately 14.5 million euros for projects aimed at reducing the use of pesticides,
- an additional 17 million euros through the Federal Program for Organic Farming (BÖL), e.g., for the use of crop protection nets in vegetable farming.

¹⁰ <https://www.bmleh.de/DE/themen/landwirtschaft/pflanzenbau/pflanzenschutz/pflanzenschutzmitteleinsatz-reduzieren.html>

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Project/Program	Short description
National Funding: Agricultural Pilot Projects (Link)	Through 14 “digital experimental fields,” the Federal Ministry of Agriculture, Food, and Home Affairs (BMLEH) is promoting digitalization in agriculture to make the most of the sector’s potential. The experimental fields are digital test sites on farms where, for example, researchers will investigate how digital technologies can be optimally used to protect the environment, improve animal welfare and biodiversity, and make work easier. Gibt es hier Ergebnisse, die kurz berichtet werden können? Oder Informationen zu Themenfeldern, die bearbeitet werden und potentiell alternative Pflanzenschutzverfahren stärken können?
Funding „Plant Breeding Research for the Bioeconomy“ (Link)	The goal of the funding initiative “Plant Breeding Research for the Bioeconomy” is to lay the foundation for sustainable food security and to contribute equally to the provision of high-quality products made from renewable raw materials—with particular attention to biodiversity, environmental protection, and climate protection. Hier auf die Rolle und Bedeutung hinweisen. Was kann mit der Züchtung erreicht werden?
Funding for research projects aimed at developing and testing alternative and new plant protection methods in cropping systems that utilize conservation tillage and erosion-reducing soil management practices, as well as in permanent crops under changing plant protection conditions (Link)	As part of the 2035 Arable Farming Strategy and the program to promote innovation in research projects, the goal is to develop and test new and alternative plant protection methods that incorporate conservation tillage and erosion-reducing soil management practices in arable farming, vegetable production, and perennial crops. These projects will focus primarily on field crops and field vegetables and offer solutions for reducing the use of synthetic chemical pesticides in cropping systems that employ conservation tillage and erosion-reducing soil management practices.
Protein Plant Strategy (Link)	Through the Plant-Based Protein Strategy (EPS), the Federal Ministry of Agriculture, Food, and Home Affairs (BMLEH) has been promoting the cultivation and utilization of legumes as domestically produced plant-based proteins since 2012. • Increase the production of domestically grown legumes and improve supply and demand, • increase the supply of protein for humans and animals from domestic production using non-genetically modified protein sources, • strengthen regional value chains, • and positively influence ecosystem services and resource conservation.
Arable Farming Strategy 2035 (Action Area: Plant Protection) (Link)	The crop production strategy is intended to identify options and approaches for more sustainable crop production. The Federal Ministry of Agriculture, Food, and Home Affairs (BMLEH) is implementing the crop production strategy through various research and development projects, as well as pilot and demonstration projects.
Model and Demonstration Projects (MuD) on Sustainable Crop Production (Link)	Model and demonstration projects (MuD) bridge the gap between science (research and development) and practice. The focus is on linking the main components of the Arable Farming Strategy 2035. Farms in seven federal states implement and demonstrate agronomic measures in e.g. diversified crop

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	rotations and new crops (e.g. lupine, poppy), resistant and site-adapted varieties, digital decision-support and warning systems, mechanical weeding, precision application and robotics, field margins and flower strips, nutrient-efficient fertilisation, and adaptation to climate change and drought (e.g. water-retention concepts).
Federal Organic Farming Scheme (Link)	Through the Federal Program for Organic Farming (BÖL), the Federal Ministry of Agriculture, Food, and Home Affairs (BMLEH) supports the expansion of the organic agriculture and food industry in Germany, making it an important tool for the sustainable use of plant protection products.
Model and Demonstration Farms for Integrated Pest Management (Link)	A main effort of the National Action Plan for the Sustainable Use of Plant Protection Products is the consistent implementation of IPM practices in the field. To this end, the Federal Ministry of Food and Agriculture (BMEL) funded the project "Demonstration Farms for Integrated Pest Management." The project promoted horizontal and vertical knowledge transfer between research, state advisory services and farmers and policymakers. 67 demonstration farms across Germany (arable, apple, viticulture, field vegetables, hops) participated for a 5-year period and implemented IPM with intensive support from the state plant protection services. Reductions in pesticide use intensity (treatment index) were achievable, but relied on substantial pest-monitoring effort and advice, and were dependent on individual farm types and production sectors.
NOcsPS – Agriculture 4.0 without synthetic chemical plant protection (Link)	A modern agricultural system of the future that does not rely on synthetic chemical pesticides (csPSM) but instead harnesses the yield benefits of the targeted and responsible use of mineral fertilizers. The vision is to develop a farming system that ensures a high supply of healthy food while simultaneously addressing key aspects such as promoting biodiversity, soil fertility, ecosystem resilience, and climate protection.
Model and Demonstration Farms for Integrated Crop Production in outdoor vegetable cultivation (Link)	The Federal Ministry of Agriculture, Food, and Home Affairs (BMLEH) is funding the model and demonstration project "Demonstration Farms for Integrated Crop Production in Open-Field Vegetable Farming" (IPB-FG). In four federal states, demonstration farms implement and demonstrate new practices in fertilisation, plant protection and irrigation, and consider synergies and trade-offs between these areas. Regional advisors support the farms, and the regional knowledge-exchange the wider audiences.

National initiatives for interaction with stakeholders, especially groups of farmers, and policy makers

The National Action Plan on the Sustainable Use of Plant Protection Products (NAP) aims to further reduce the risks and impacts on human health and the environment that may arise from the use of plant protection products. This objective is consistent with the EU Directive 2009/128/EC on a framework for the sustainable use of pesticides. The NAP takes into account the health, social, economic, and environmental impacts of its measures, as well as specific national, regional, and local conditions and all relevant stakeholders. Its measures complement the existing comprehensive legal regulations on plant protection. Furthermore, the NAP aims to promote the (further) development of

IPM as well as alternative methods and procedures. The successful implementation of IPM depends on many interrelated factors. In addition to technical and scientific challenges, economic conditions and the transfer of knowledge are particularly crucial to its success.

The NAP was developed by the federal government in cooperation with the federal states, national authorities and with the participation of agricultural/horticultural stakeholders and associations. Federal, state, and local authorities, the relevant associations and companies, the retail sector, and the scientific community are working together to implement the NAP.

The NAP Forum reviews the progress of the National Action Plan for Plant Protection and develops proposals for its further development, bringing together representatives from the above-mentioned areas. Working groups were formed within the Forum to address various topics relevant to the NAP. These working groups discuss subjects related to the implementation of the NAP and develop recommendations. Depending on their content, the recommendations are adopted by the Forum and are directed at the federal government.¹¹

¹¹ <https://www.nap-pflanzenschutz.de/>