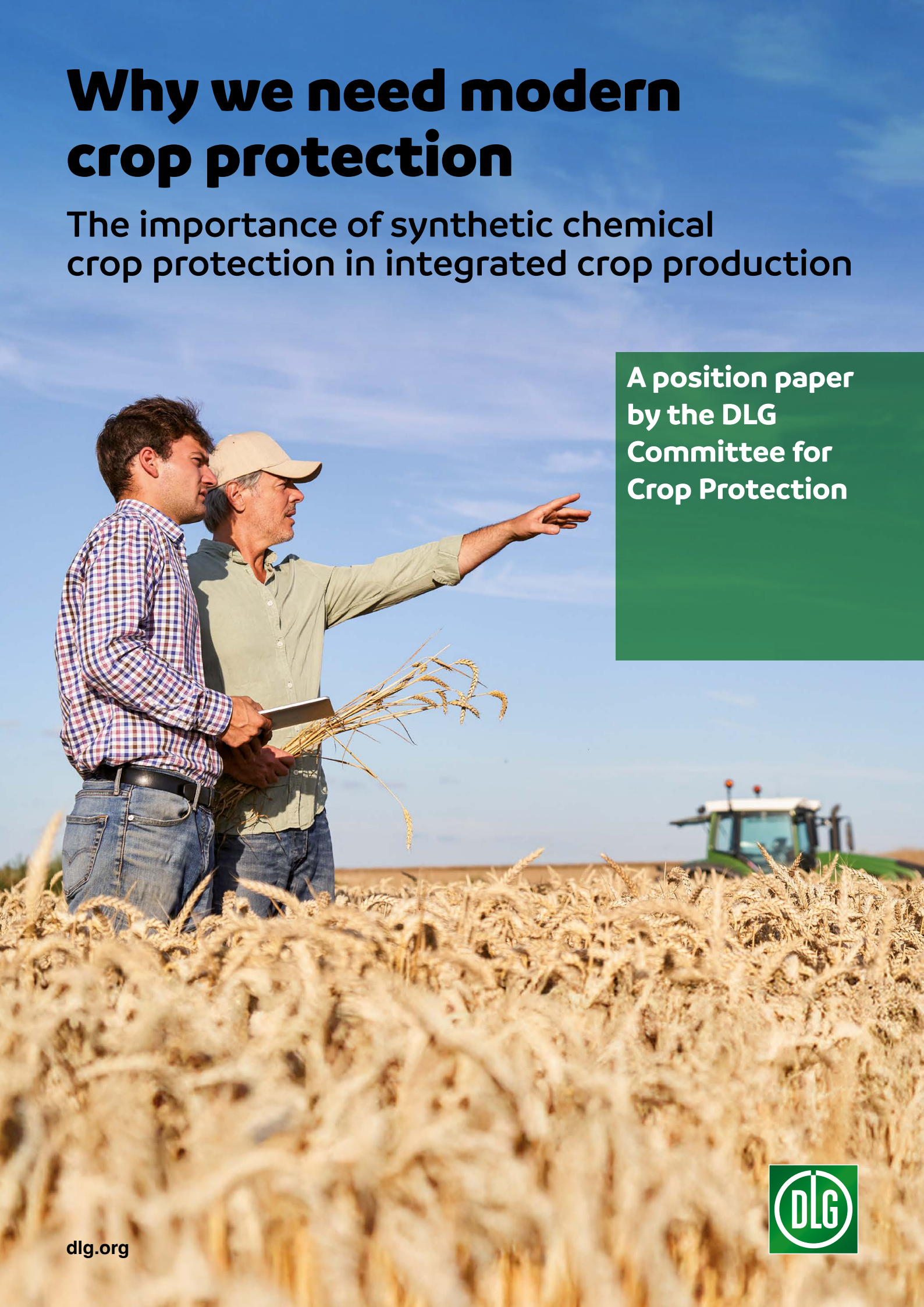
Why we need modern crop protection

The importance of synthetic chemical crop protection in integrated crop production

A position paper by the DLG Committee for Crop Protection



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Objective of the position paper

In Germany, perceptions of the use of synthetic chemical pesticides are increasingly diverging among politicians, society, scientists, and the agricultural sector. Discussions about the effects of pesticides on the environment and health are becoming more intense, and calls for a general reduction in their use are growing. Reservations towards agriculture are growing and often affect the entire spectrum of modern agricultural production methods. In this position paper, the DLG Committee for Crop Protection advocates an appropriate assessment of modern crop protection and recognition of its function as a systemically important technology in integrated crop production.

Whether grain or potatoes, rapeseed or beets, fruit or vegetables: When weather conditions are favourable, crops are attacked by harmful organisms. This is true even when farmers use all available (natural) preventive measures. To protect their plants from infestation and limit potential damage to their crops, they therefore resort to biological and synthetic chemical pesticides. However, there is widespread scepticism in society toward modern synthetic chemical plant protection. This is reinforced by current political initiatives. For example, with its Farm to Fork Strategy as part of the European Green Deal, the European Commission is calling for a 50 percent reduction in the use and risk of synthetic chemical pesticides by 2030. Before discussing the implications of these policy guidelines, let us first take a look at the reservations themselves. Where do they come from? And are they justified?

The current state of the debate

In Germany, around 1.5 percent of the population currently works in agriculture. Most people know very little about everyday life on farms and the challenges farmers face. In addition, media reporting largely functions according to the old maxim “only bad news is good news”. When it comes to sensitive issues such as the use of crop protection products, this can quickly lead to uncertainty and fear among the population.

In fact, highly toxic crop protection products were used extensively worldwide until the 1960s. However, much has changed since then. Not only has increasing agricultural yields long since ceased to be the main objective of agricultural policy, as was still the case in the post-war years. There has also been a shift in thinking on farms, and knowledge about the interaction between agricultural production and ecosystems is being incorporated into daily work processes. In addition, today’s active substances are significantly more environmentally and health-friendly than their predecessors from the early days of synthetic chemical crop protection. However, despite the scientifically proven advances in this area, the debate surrounding their use is becoming increasingly intense and emotional.

And it is not uncommon for it to be directed against the entire profession. Farmers are confronted with accusations that their economic activities cause environmental damage. What is often overlooked is that nature, with its finite resources, is the basis for agricultural work. Deliberately destroying these resources would result in farmers depriving themselves of their own livelihood. The use of crop protection products is also costly, as in addition to the products themselves, farmers must invest in the technology to apply them and in labour – either their own or that of employees. In addition, the use of crop protection products is closely monitored by authorities and scientific institutions not only in Germany but also at the EU level. Farmers rely on the relevant facts and analysis results. Accordingly, policymakers should also base their crop protection policies on scientific evidence.

It is important and correct to discuss how the risks associated with the use of chemicals can be reduced. In the general political debate, however, there is talk of everything from a mere reduction in quantity to a complete renunciation or abolition of synthetic chemical crop protection. This does not do justice to the complex issue and falls short in light of the challenges facing agriculture today. The DLG Committee for Crop Protection therefore advocates that the debate on synthetic chemical crop protection should be based on the actual risks involved.

Why crop protection products are important

Crop protection products help to protect crops against diseases, pests and weeds, thereby safeguarding the harvest. A large number of weeds in the crop means, for example, that the cultivated plants must compete with them for water, nutrients and light. Fungal diseases and insect damage destroy plant tissue. All this means that the plants produce less yield overall. This not only reduces the productivity and profitability of farms, but also means that less locally produced food is available. In order to compensate for the loss of production, additional land would have to be cultivated. This would then no longer be available for other social objectives, such as nature conservation.

Crop protection products also play a crucial role in producing healthy, high-quality and safe food. Numerous studies have shown, for example, that mould on cultivated plants can pose a significant risk to human and animal health. Two types of mould are particularly relevant in cereal crop cultivation: Fusarium (see photo) and Alternaria. Fungal toxins (mycotoxins) caused by Fusarium species can, among other things, lead to fertility problems and impair the immune system, thereby increasing susceptibility to disease. And they can cause irreparable organ damage in humans and animals. Alternaria species also produce toxins, although their effects have not yet been fully investigated. However, it is certain that they can cause skin irritation.

Various weeds, such as ragwort and thorn apple, also produce toxins. These so-called alkaloids can cause severe poisoning in both humans and animals. To prevent them from entering the food chain, the relevant weeds must be consistently controlled.

Research conducted by the Food and Agriculture Organisation of the United Nations (FAO) in 2019 has shown that around a quarter of all food and animal feed worldwide is contaminated with mycotoxins. One of the reasons for this is the lack of access to crop protection products.

Photo above: Wheat ears infected with Fusarium during grain development (June/July).

Photo below: Wheat grains with severe to mild Fusarium infection (grains 1–5 from left) compared to a healthy wheat grain (far right).

Effective crop protection strategies therefore not only ensure that sufficient food is produced. They are also crucial in preventing the contamination of food with harmful toxins and in safeguarding agricultural productivity and farm profitability.

What risks are associated with synthetic chemical crop protection?

Concerns about the possible negative effects of pesticide use relate, on the one hand, to potential health risks from residues in food/feed and water/drinking water and, on the other hand, to negative consequences for the environment. For example, according to the latest consumer monitor survey conducted by the German Federal Institute for Risk Assessment (BfR), just over two-thirds of respondents stated that they were concerned about residues of crop protection products in food in 2024. However, all institutions that monitor and assess the health quality of food in Germany (including the BfR and the Federal Office of Consumer Protection and Food Safety (BVL)) have come to the conclusion that food (including) from conventional agriculture poses no risk to consumer health.

The same applies to drinking water, which in Germany is largely obtained from groundwater. According to the Federal/State Working Group on Water (LAWA), the contamination of groundwater with active substances in crop protection products and relevant degradation products has decreased significantly over the past three decades. A recent evaluation by LAWA shows that only 3.6 percent of the measuring points used for the investigations exceeded the legal threshold value of 0.1 µg/litre (by comparison, the figure for the period 1990 to 1995 was 9.7 percent). And the German Federal Environmental Agency writes: "The quality of drinking water in Germany is generally very good in almost all samples reported to the Federal Environmental Agency."

Not only drinking water and the resources from which it is obtained are strictly controlled and regulated in Germany and throughout the EU. Strict requirements also apply to the approval of crop protection products. The first Crop Protection Act was passed in Germany in May 1968. It stipulated that crop protection products must undergo an approval process. In addition, maximum permissible levels of active ingredient residues in crops were defined. Since the law was revised in 1986, environmental aspects must also be taken into account during the approval process.

The testing of active substances in crop protection products in Germany and Europe is among the most stringent approval procedures worldwide. The focus is on the safety of people and the environment. In the latest revision of the EU Regulation on the Authorization of Crop Protection Products from 2009, it was stipulated that substances must not be authorized for use, regardless of the dose or exposure. They may not be authorized if they are carcinogenic, mutagenic, or toxic to reproduction, if they have hormonal effects, or if they are persistent in the environment, bioaccumulate in organisms and therefore in the food chain, or are toxic to humans or organisms in the environment These substances are therefore no longer available on the market.

Any form of agriculture involves interference with the natural balance. This also applies to the use of crop protection products. In order to fulfil their purpose, i.e. the control of pests and/or weeds, the products must be effective. Crop protection products have therefore attracted criticism, particularly in the search for the causes of the decline in biodiversity, which has been identified in numerous studies involving many organisms, including insects. As part of the National Action Plan (NAP) for the sustainable use of crop protection products, Urs Niggli and colleagues therefore compiled a literature overview in 2019 that summarises the current state of knowledge. This shows that it is not possible to determine the exact influence of individual factors or the indirect complex effects that contribute to the loss of biodiversity. One of the main reasons is that habitats for many organisms adapted to the agricultural landscape (e.g. hamsters, partridges) are disappearing. This is partly due to changes in agricultural production methods. Over the past several decades, fields have been enlarged

A strip of flowers (at the back of the photo) in the area of the driving track in a wheat field. Flower strips are specially created areas planted with a mixture of flowering plants that serve as habitats and food sources for beneficial insects such as bees and other insects, thereby promoting biodiversity. They are often used as part of agri-environmental programmes. The photos are from the Measures Workshop as part of the FInAL (Promotion of Insects in Agricultural Landscapes) project. In this project, agricultural laboratories are being set up in representative agricultural landscapes across Germany, where innovative measures to promote beneficial insects and other insects are being developed, demonstrated and evaluated.

and crop rotation, fertilisation and crop protection – and therefore the entire cultivation system – have been simplified. Grazing livestock farming has also declined. Overall, there are fewer marginal structures today that can, for example, serve as habitats for insects or nesting sites for birds. In addition, climate change and weather fluctuations are not without consequences for insect populations.

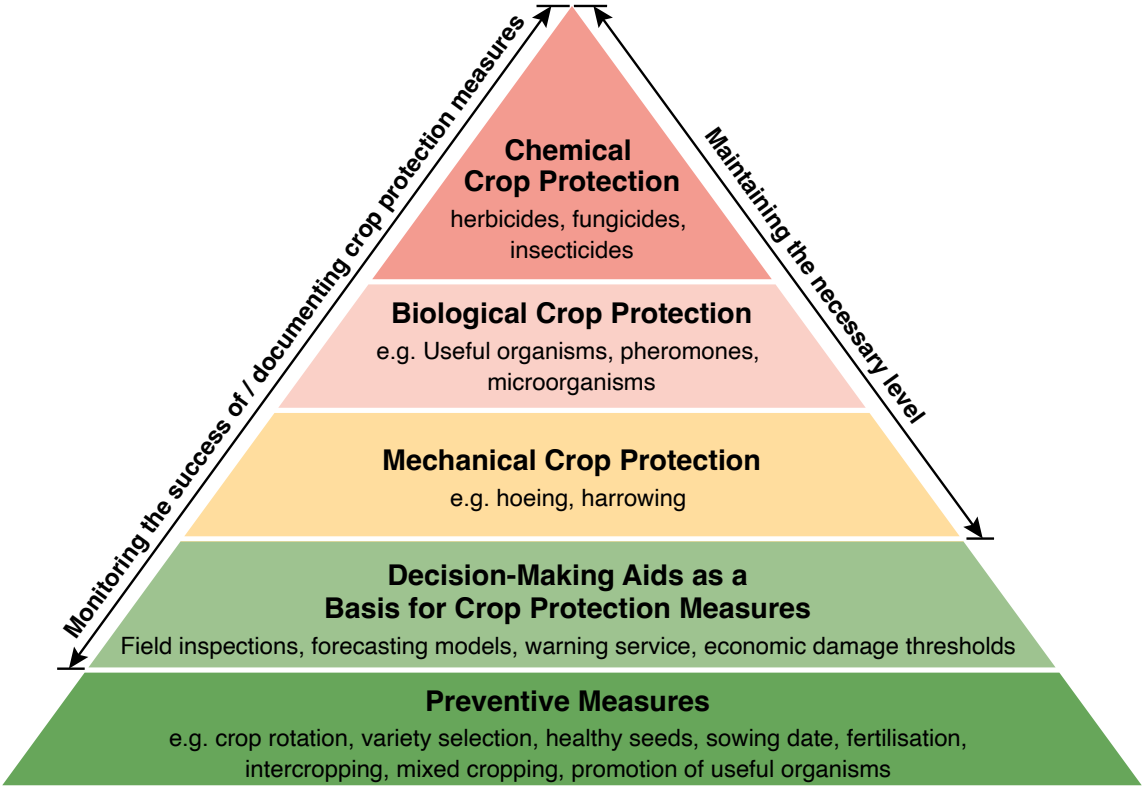
Numerous factors are responsible for the actual changes in the range of species. It is clear that humans have an influence on changes in the range of species in many ways. It is clear that humans influence changes in the range of species in many ways. Overall, crop protection products play a role in the composition of the range of species; however, this must always be viewed in the context of the crop production system. For example, a cultural landscape system with diverse structures (e.g. edge structures and flower strips) has a positive influence on species diversity, and many farmers are now voluntarily implementing measures to improve biodiversity on their farms or participating in agri-environmental programmes.

Furthermore, the risks identified in connection with the use of crop protection products have been declining for many years. In Germany, for example, over the past two decades it has been found that the environmental risk posed by fungicides, insecticides and herbicides to terrestrial organisms and aquatic life has decreased (available in the Julilus Kühn Institute's Pesticides Trends Database Explorer These substantial reductions in risk demonstrate that the current strict authorisation and application conditions are having an effect.

What exactly is modern crop protection?

Modern crop protection encompasses a wide range of measures and activities, all of which pursue a single goal: Preventing or reducing damage to crops and harvested produce. Since 1987, integrated crop protection has been embedded in **German crop protection legislation** as the guiding principle of modern crop protection. This is a systemic approach that combines preventive measures with direct regulatory options (see figure on the next page). Preventive measures include, for example:

Yellow traps are used in agriculture – especially in rapeseed cultivation – to monitor the influx of harmful insects. They serve as an early warning system and therefore help in deciding whether treatment with a synthetic crop protection product is necessary. Treatment is only carried out once a damage threshold has been exceeded and the weather permits plant protection measures to be taken.



Decision/action pyramid for integrated crop protection. Chemical crop protection is the top of the pyramid and the last option in integrated crop protection.

- Extensive crop rotation: Over the years, as many different crops as possible are grown in succession in order to minimise natural predators of the plants, for example.
- Variety selection: Varieties are cultivated that are resistant to pathogens and pests or that thrive even in adverse weather conditions.
- Cultivation of catch crops: The plant mass of the catch crops builds up humus, providing more nutrients for the subsequent crop.

Direct regulatory options include, for example:

- Biological crop protection measures such as promoting useful organisms (i.e. insects that destroy the crop's natural enemies), for example by planting flower strips.
- Mechanical control measures such as treating weeds with a hoeing machine or harrow.

The use of synthetic crop protection product is the third direct regulatory measure. As the diagram shows, it represents the last resort and should only be used if preventive measures and mechanical and/or biological measures have not been sufficiently effective or if there are no suitable alternatives. However, there have been and still are farmers who have not taken or do not take the "pyramid of measures" into account and who have always given or still give priority to synthetic crop protection products. This is evident, for example, in developments towards close winter crop rotations, early sowing dates with inappropriate sowing quantities and susceptible varieties, and the constant use of the same mechanisms of action within a crop. This should be counteracted with targeted advice.

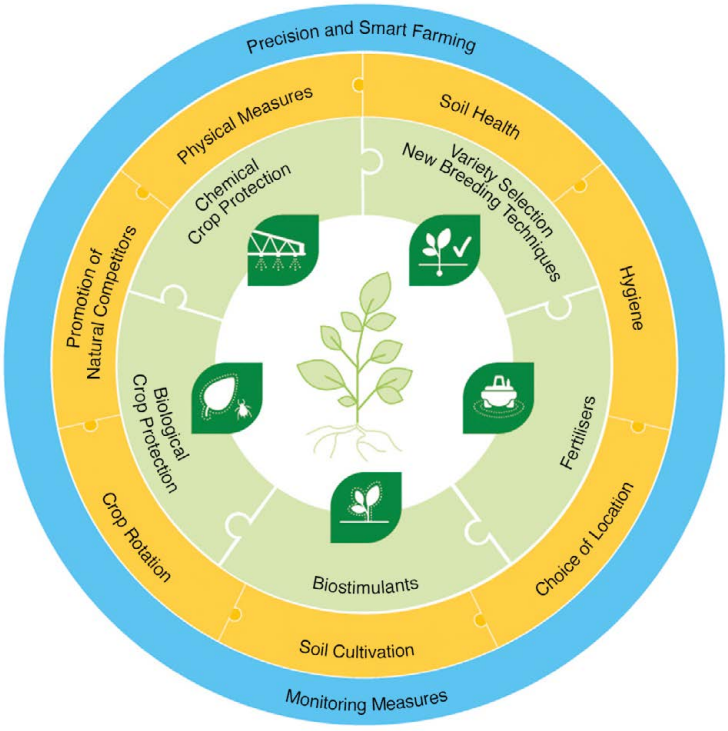
An important element of integrated crop protection is the monitoring of crop populations. It serves to identify and assess at an early stage whether pests or weeds are occurring at a level that could affect yields. Based on this risk analysis, a decision is then made on whether to implement direct combative measures. The decisive factor here is the so-called economic damage threshold: The pest or weed is only controlled when the infestation is so severe that the damage (e.g. crop losses) is likely to exceed the cost of treatment.

The EU has also obligated its member countries to implement specific principles of integrated crop protection through the Plant Protection Framework Directive of 2009 (Directive 2009/128/EC) (see summary in table). In Germany's amended Plant Protection Act of 2012, these principles are laid down in Section 3 as part of "good professional practice".

Principles of integrated crop protection	Example from cereal cultivation
1. Preventive measures	• Choose wide crop rotations with summer and winter crops as well as leafy and stem crops • Do not choose sowing dates for winter crops too early (helps, for example, against fungal diseases such as mildew, aphids as carriers of viruses, and weeds such as blackgrass). • Use robust types (e.g. with low susceptibility to yellow rust pathogen)
2. Pathogen monitoring	Select the most effective period for treatment, carry out regular field checks, use spraying slots and forecasting models (e.g. ISIP – Information System for Integrated Plant Production).
3. Apply thresholds	Use specific damage thresholds (e.g. for pests such as aphids and cereal leaf beetles) and forecasting models.
4. Favour non-chemical methods	Mechanical weed control, electronic seed pickling
5. Use target variety-specific crop protection products	Choose insecticides that are harmless to useful insects
6. Maintaining the "necessary level"	Use as few chemical crop protection measures as possible as a preventive measure
7. Performance monitoring/documentation	Inspect fields before and after application of the products
8. Strategies for avoiding resistance	Use different active substances and increase the intervals between applications of the same active ingredient.

Principles of integrated crop protection, explained using examples from cereal cultivation.

As already explained, synthetic crop protection products should be the last option in the mix of measures. They do not necessarily have to be applied over the entire area: Under certain circumstances, it may be sufficient and sensible to treat only the edges of the field (e.g. in the case of invading slugs) or parts of the area (e.g. directly above the sugar beet row in combination with mechanical weed control between the rows). New technologies in precision farming are increasingly enabling the more targeted application of crop protection product (see the section "What will crop protection look like in the future?" on page 9).



Integrated crop production taking into account ecological and economic requirements. Paying attention to various pieces of the puzzle serves to counteract negative effects on the environment.
(Note: The size of the puzzle pieces does not correspond to the importance of the measure).

This means that the amount used can be significantly reduced depending on the intensity of infestation. Ultimately, the application of synthetic crop protection products is one of many measures used in integrated crop production – similar to a well-stocked toolbox that has the right tool for every job. The interrelationship between the various measures is illustrated in the diagram on page 7.

Why a wide range of active substances is needed

There are crop varieties that are resistant to infestation by specific pathogens or pests – either naturally or through targeted plant breeding. However, there are also numerous pests that have become resistant to crop protection agents, meaning that they can no longer be controlled using the standard and approved quantities of a particular active ingredient. Resistance is promoted when crop protection products with the same effective mechanism are used repeatedly. Biotypes of the pathogen that are insensitive to the active ingredient are selected, enabling them to spread further. In order to prevent or slow down the development of these resistances, it is crucial to maintain a diversity of active substances or groups of active substances for all areas of crop protection, i.e. for the control of fungi (fungicides), weeds (herbicides) and pests (insecticides). For many common crops, adequate resistance management is still guaranteed for the majority of pests today. In some cases, however, control is only possible to a limited extent, for example in the case of the most important disease currently affecting barley, Ramularia leaf spot, which is caused by a fungus. The political guidelines, which stipulate that the number of approved substances within the EU should be continuously reduced, are therefore causing farmers great concern.

While more than 1,000 active substances were listed in the EU in the 1980s, today's agricultural sector must meet the challenges of crop protection with only 420 active substances. In addition to chemically synthesised substances, these also include microorganisms, pheromones (messenger substances) and plant extracts. An additional 49 active substances will no longer be available or will only be available to a limited extent in the medium term. The number of listed biological active substances is increasing, however only slowly. One reason for this is the complex approval process, as is the case with synthetic crop protection products. Furthermore, biological crop protection products currently cover only a very small proportion of the approximately 5,600 applications for crop protection products. They cannot – and are not intended to – replace synthetic chemical crop protection; however, they may serve as an additional module in the integrated plant protection toolbox in the future.

Around 1,000 crop protection products are currently authorised in Germany. At first that sounds like a lot. However, these products are based on 278 (June 2025) synthetic active substances (EU Pesticides Database, 10/2024) from a limited numbe of active substance groups that have the same effective mechanisms or effective areas in plants, fungi or insects. Since 2011, significantly stricter requirements have been in place for the approval of active substances with a view to protecting people, nature and the environment. This means that fewer proven plant protection solutions are available to combat fungi and pests.

If gaps arise in the control of pests, as is already the case with fruit and vegetables, so-called emergency authorisations for crop protection products are increasingly being used. This may be issued by an EU Member State for a specific period and for a specific use. The number of these emergency approvals has more than quadrupled since 2011. The problem that arises here: The growers do not know what product will actually be available to them in the coming year. However, in order to maintain crop protection in the long term and provide farmers with planning security, a reliable, comprehensive solution in the form of integrated pest management is required. Incidentally, not only conventional agriculture is affected: Organic farming accounts for 25 percent of all emergency approvals in Germany.

Political pressure to make crop protection measures even safer and to further reduce the use of these products as part of the European Farm to Fork Strategy must not lead to the loss of further active substances and groups of active substances in Germany and Europe. Otherwise, there is a risk that many crops will no longer be adequately protected against diseases and pests, and that crops such as potatoes, grapes, hops, sugar beet, rapeseed and strawberries may eventually disappear from our fields. This means they would have to be imported from other regions of the world. A sufficient number of active substances with good biological performance and a modern environmental profile also makes it possible to replace old active substances with a less favourable environmental profile. This helps to prevent unwanted active substances from entering the environment.

What will crop protection look like in the future?

Crop protection is constantly evolving. Enormous progress has been made in recent years, with the development of numerous new methods and procedures and the expansion and refinement of existing procedures. Some examples:

Targeted use of crop protection products (smart spraying)

The targeted use of crop protection products (smart spraying) will be an important pillar of agricultural technology in the future (see photo). These methods can reduce the amount of crop protection products used and the proportion of land treated without compromising the effectiveness of the products or the quantity and quality of the harvests. Technologies that were considered visionary just a few years ago have now proven their practical maturity, such as satellite or drone-based application maps in conjunction with the use of high-resolution cameras and artificial intelligence (AI). It is already state of the art to reduce the application rate of crop protection products when cornering or to dose the products into the spray liquid with pinpoint accuracy shortly before application. The basic prerequisite here is also the availability of appropriate, highly effective synthetic chemical crop protection products.

In contrast to conventional area spraying, where the plant protection product is applied to the entire field, spot spraying involves activating individual nozzles or sections of the sprayer only in those areas where it is actually needed. For example, herbicides can be applied specifically to weed patches or individual problem plants, while the rest of the area remains untreated. This reduces the use of synthetic chemical crop protection products.

New biotechnological processes

New methods of crop protection are currently being developed. This applies, for example, to substances that use a natural mechanism in cells (known as RNA interference, or RNAi for short) to regulate harmful organisms by specifically switching off genes. Another focus of future crop protection strategies could be breeding using new technologies such as genome editing. The CRISPR/Cas gene editing tool can be used to selectively silence genes or introduce resistance genes into the genome of plants. The plants produced in this way do not differ from natural or bred varieties, as these mutations could also occur through conventional breeding methods or naturally. The decisive advantage of genome editing lies in the comparatively rapid breeding progress it enables. This could mean that in the future, for example, tolerant or resistant varieties could be used to respond much more quickly to new pathogens. An interesting development here is the creation of varieties with a broad resistance to both animal and fungal pests as well as viruses.

Biological active substances

Due to the discontinuation of important synthetic plant protection agents in recent years, interest in biological control methods and so-called biologicals has increased significantly. Biologicals include substances that are produced using materials of biological origin. These include agents based on plant extracts, microorganisms (such as fungi, bacteria, viruses), or semiochemicals (communication and messenger substances such as pheromones and repellents). Macroorganisms (e.g. parasitic wasps against corn borers) are not classified as biological agents, but represent another option for non-chemical crop protection.

The use of biological and biotechnological control methods is well established in integrated crop protection, particularly for special crops (such as wine and fruit) and in greenhouse cultivation. One example from the field of micro-organisms is the use of Bacillus thuringiensis preparations against the larvae of various butterfly caterpillars. In arable crops (such as cereals and sugar beet), biological control methods have so far played only a minor role for various reasons (availability and effectiveness of the agents).

The main advantages of biological crop protection products are their comparatively high selectivity and specificity (e.g. species-specific effect of pheromones). The risk of negative effects on so-called non-target organisms (such as useful organisms) is significantly reduced in many cases, and the products are usually rapidly degraded in the environment.

While synthetic chemical crop protection products generally demonstrate a very reliable effect even under changing environmental conditions, the effect of biological crop protection products is significantly more heavily influenced by the environment. This significantly impairs their effectiveness. In the event of a high intensity of infestation, biological products therefore quickly reach their limits. The period of effectiveness is also limited compared to synthetic preparations, which means that the products must be applied more frequently.

Mechanical weed control

Mechanical crop protection measures (see photo), which are common in organic farming, are also increasingly being used in conventional agriculture. The success of these measures depends on numerous factors such as weather conditions, soil type, soil condition, weed species and their stage of development. For example, it is important that the weather is sunny and dry during and after mechanical weed control so that exposed or pulled-out weeds can dry out quickly and do not grow back. The correct machine settings and the use of a harrow for weed control are equally important.

Use of a harrow for weed control.

The working speed and scheduling of measures. Despite modern, functional technology, the desired success may not always be achieved. It must also be taken into account that mechanical measures in hilly terrain can lead to soil erosion being intensified. Ground-nesting bird species and wild animals such as hares may also be adversely affected.

Why we need modern crop protection

The development of modern crop protection products has made a decisive contribution to the safe cultivation of healthy food crops. Healthy, high-quality food is an important prerequisite for high food safety and therefore for preventive consumer protection. Potential residues of crop protection products must therefore be weighed against possible mycotoxin contamination of food or feed due to a lack of or insufficient crop protection measures.

The proposed 50 percent reduction in the use of plant protection products in the EU would have far-reaching consequences. For example, it would lead to a massive decline in grain production in the EU and EU countries would have to import more grain. Further tightening of the approval process for crop protection products would likely increase the gaps in the control of important diseases and pests in numerous crops. This not only jeopardises the productivity of agriculture and the economic security of farms, but also leads to global changes in land use, as new areas would have to be used for growing food and feed.

Without targeted crop protection, it is not possible to cultivate crops productively in the long term. The development of harmful organisms is progressing: New strains of pathogens are emerging (e.g. yellow rust), invasive species are arriving (e.g. cherry fruit fly and corn rootworm), and completely new pests are suddenly appearing (e.g. Trichoderma ear rot in maize, SBR/Stolbur in sugar beets, potatoes and other vegetables). And last but not least, climate change is causing the habitats of harmful populations to shift. Effective crop protection that can respond quickly will therefore be needed more rather than less in future. Preventive measures and the cultivation of resistant plants are essential, but they have limitations in terms of response time and efficiency. Resistance breeding against insect infestation, for example, is severely limited because there is a lack of suitable genetic source material.

Biological crop protection products (biologicals) and digital crop protection techniques already represent important developments in modern crop protection. Other promising technologies are either still in their infancy (RNAi technology) or the use of an already promising technology is only just being discussed (CRISPR/Cas). For the foreseeable future, therefore, there will be no alternatives available that could take over the tasks of synthetic chemical crop protection in their entirety. For agriculture that follows the concept of progress as sustainable productivity growth, which takes productivity and resource conservation into account in equal measure, modern synthetic chemical active ingredients will therefore continue to be needed in the future as essential components of integrated crop protection. When approving crop protection products, the focus should once again be placed on the benefits – as is the case in human and veterinary medicine.

A wheat field that has been treated with synthetic crop protection products. In the section of the field that was not treated with fungicides for control purposes (known as the spraying window, at the back of the photo), there is clear evidence of yellow rust infestation.

There is no question that mistakes have been made in the past in the area of crop protection. For a long time, chemical synthetic agents were used uncritically – without sufficient consideration of the risks to humans and the environment. It is also true that in the past, the principles of integrated crop protection were by no means respected by all farmers. This has also contributed to the agricultural sector being viewed increasingly critically by some sections of the public. But times have changed. On the one hand, there is an awareness that we all need to move away from silo thinking and promote the exchange between different players through harmonisation of the interests of people, nature and the environment. On the other hand, both knowledge and technical capabilities have advanced considerably. Modern crop protection products are more efficient and have fewer undesirable side effects than previous generations of active substances. In view of increasing challenges posed by pathogens and climate change, effective crop protection remains essential to ensure the production of healthy food. This requires a toolbox with a wide range of instruments, including a sufficient variety of modern plant protection products.

The DLG Committee for Crop Protection sees itself as an expert committee composed of representatives from a wide range of interest groups – practitioners, consultants, scientists, authorities and industry – which discusses the technical principles of sustainable and future-proof crop protection and critically observes and evaluates progress.

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