



Federal Ministry
of Food
and Agriculture

Discussion Paper

2035 Arable Farming Strategy

Prospects for Productive and
Diverse Crop Farming



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Dear Readers

Agriculture is and remains a constant. At the same time, agriculture also represents change. Seventy years ago – the year in which the Federal Ministry of Agriculture was founded – agriculture looked different from how it did during the peaceful revolution of 1989 or at the start of the new millennium. It makes important contributions to protecting the environment, nature and climate. It adapts to social demands, it continues to evolve. Today, a farmer supplies food that meets the highest quality standards to 155 people. In 1900 a farmer fed just under 10. General quality standards were still largely unknown at that time.

With our Arable Farming Strategy we wish to highlight new perspectives: what the future of crop production could look like, how we can facilitate the supply of safe, sufficient and high-quality food, feed and renewable resources from Germany, how we can make arable farming fit for the future. We outline the framework that policymakers need to put in place to give our farmers planning certainty. We likewise touch on the responsibility that consumers must also assume in order to remunerate the services of agriculture fairly, and how they can be empowered to do this.

So what does our **picture of agriculture in 2035 look like?**

German agriculture is economically and environmentally efficient

In 2035 the humming and buzzing in German fields will have grown louder again. More than 20 percent of our arable land is farmed organically – the goal formulated by the Federal Government has been met. More consumers are willing to pay higher prices for organic produce. They mainly eat regional and seasonal products. Organic farming has injected important momentum into conventional farming – and vice versa. Organic farming has come close to the productivity of conventional farming. The two forms of farming complement each other perfectly and are no longer at loggerheads.

We have established measurable sustainability indicators. They help to guide farmers when it comes to implementing targeted measures to promote species diversity and to improve biodiversity. The pollution of water, air and soil has fallen considerably, and the principle of closed-loop recycling has once again taken on greater significance. At the same time, yields continue to develop positively thanks to gains in efficiency and optimisation.

Digital agriculture improves biodiversity and species protection

In 2035 – our agriculture is **smart and digital**. We have fast Internet access from each field. There are sensors in the ground. Drones hover overhead. Based on the harvest data from the previous year, they detect early on where the farmer can, for example, create “lark windows” (areas in fields set aside for larks) in future where they can achieve a very high level of nature conservation and environmental protection and nonetheless secure high yields.

We still have a **mix of large and small farms**. They market their high-quality products directly, in the farm shop, at the weekly market and online. Many of them are successful on the world market, too. This is because the policy framework has been established in such a way that digitalisation secures advantages for all sizes of farms and has made them more competitive. Smaller farms join forces in order to lower the costs of digitalisation and the use of state-of-the-art production technology.

We still see farmers out and about on their tractors but they are **backed up by** autonomous driverless **vehicles**. The latest data are sent to their smartphone in real time. Small robots move over the fields, as information aids. They analyse the soil and crops, intervene proactively when necessary. Digitalisation helps the farmer to use resources more efficiently and, by extension, to conserve

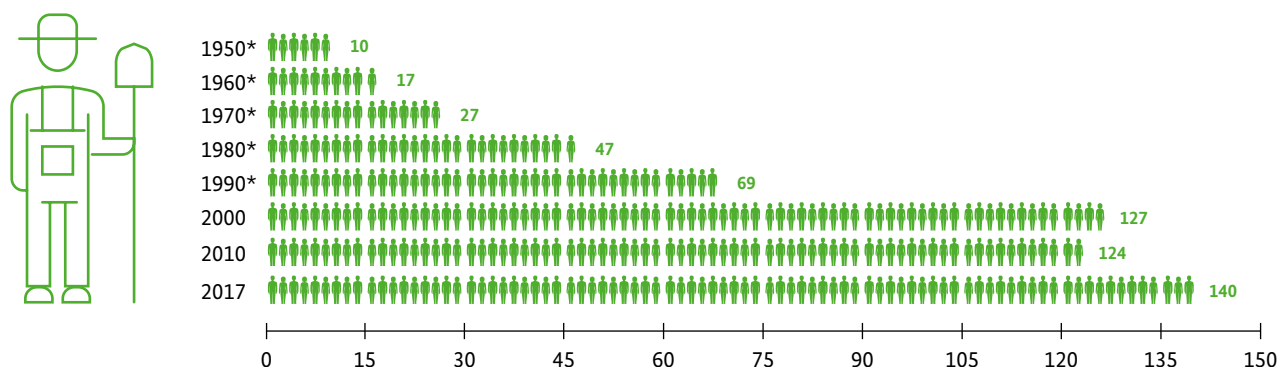
them. At the same time, it is easier to achieve **environmental goals**. Because the farmer can determine precisely and specifically where there is a pest infestation and can then get a drone to offload beneficial insects exactly where they are needed. Because small autonomous units reduce the pressure exerted on soils. Because the plants get exactly the amount of nutrients they need to grow. The results from our digital trial fields have become established in practice.

Crop rotations have been extended – there is greater diversity

In 2035 Germany is more colourful. The **diversity in our fields** has increased. Anyone who travels through our countryside in spring will notice the variety in our fields. This is because in the years after the publication of the Arable Farming Strategy, the **crop rotation** in our fields has been significantly extended. There are fewer resistant weeds on arable land. We have increased the resistance of our plants and consequently we need far **fewer plant protection products** than ten years ago. We have reduced our dependency on protein imports by growing protein plants adapted to the site. *Leguminosae* help us to more effectively sequester natural nitrogen in the soil. That's why we need less energy-intensive mineral fertilisers. In this way we have improved our **climate footprint**. The **humus content** in our soil is increasing, and this forms the basis for fertile soil and **intergenerational agriculture**.

Services provided by agriculture

How many people a farmer feeds



*Former territory of the Federal Republic

Source: Federal Office for Agriculture and Food (2017)

Soil and plants are protected more effectively

In 2035 our **soil** enjoys even greater **protection** from erosion caused by wind and water. It is covered all year round because we have fine-tuned our minimum soil tillage methods. The number and diversity of soil organisms have increased markedly.

Overall we have **reduced** chemical **plant protection** by more than half but still safeguard our harvests. In the fields it is obvious that plant protection products are applied in a highly targeted manner using extremely precise technology and only to plants that are sick or infested with pests. This precision usage has likewise become less frequent because we have reduced the pressure of disease through broader crop rotations and our plants have become more resistant thanks to innovative breeding. All these factors result in more insects, birds and animals being out and about on our fields. More weeds are growing but the **yields** and the **income** of our farmers are **secured**.

New breeding techniques protect nature and safeguard yields

In 2035 the use of **New Plant-Breeding Techniques (NBTs)** enables us to quickly adapt our crops in terms of improved use of water, drought stress and heat tolerance. We have achieved this by 2035 because we adapted the European requirements in such a way that, for example, CRISPR/Cas methods can be used in Europe in a climate of legal certainty. Thanks to **climate-smart cultivation concepts**, our crop production has become far more robust when exposed to aridity or heavy rainfall. This is yet another building block to reduce the use of plant protection products whilst ensuring that yields remain stable and of a high quality.

Our Arable Farming Strategy: A policy driver – not a manual

We wish to demonstrate where we provide support, where we as policymakers can drive investment, where we can create scientific foundations in order to open up new prospects for our farmers' families for the future. We want agriculture in Germany to continue to be a **diverse sector** in which our farmers happily go about their work in the fields, in the vineyards or in the livestock sheds so they can secure the foundations for our existence. We want consumers to appreciate the services provided by our farmers. Because our farmers not only pursue an occupation but are active simultaneously in many different contexts: they are breadwinners and service providers, they are climate activists and environmentalists. They are role models and a lifeline for vital rural areas.

Our Arable Farming Strategy does not claim to be a manual for each individual farm or for each individual farmer. We have every faith that our well-qualified farmers will use their knowledge and their experience to take the right decisions for their individual farms and to keep pace with changing conditions. With this Arable Farming Strategy we wish to create a framework, to offer fresh encouragement to look courageously to the future. On this basis, on-site advisors can work together with farmers to develop sustainable and site-specific crop growing recommendations. This Strategy will serve as a guiding principle for the further development of initial and continuing education and training.

But please read about it for yourself.

Julia Klöckner

Federal Minister of Food and Agriculture

A. Introduction

1. Why this strategy?

Arable farming supplies by far the largest share of staple foods and feed. It is the **bedrock of our nutrition**. In recent decades farmers have massively improved their performance in arable farming thanks to research and innovations. As a result, feeds 155 people today; in 1900 it was about ten. In Germany this enables us to offer safe, high-quality food at affordable prices.

The very high productivity in arable farming can also, however, have side effects in terms of environmental protection, nature conservation, further climate change and society's attitudes towards agriculture. There are conflicting goals between economic arable farming and the goals of environmental protection, nature conservation and climate change mitigation. The **conflicting goals must be named and solutions put forward**. This is the joint task of farmers, policymakers, science, research and consumers. As a rule, changes for the purpose of greater environmental protection, nature conservation and climate change mitigation lead to higher costs or lower yields for farms. The goal must, therefore, be to take a holistic look at the three dimensions of sustainability: the economic, the environment and social factors. In addition, the further development of good professional practice is to be ensured.

If our goal is the supply of safe, sufficient and high-quality food, feed and renewable resources from Germany and if agriculture is to meet as far as possible the demands of the 21st century for sustainable agriculture (in terms of the environment, the economy and future

social viability), then additional and joint efforts are required that go beyond the services already provided by farmers, particularly when it comes to species protection. In this context, beside the willingness of consumers to pay for **additional services of general interest provided by arable farming**, public funds will also be needed to drive change and make it possible. Farmers must be able to provide the contribution to the common good that society expects.

From the perspective of the supply of food, feed and raw materials and environmental, nature-related and climate policy challenges, this Arable Farming Strategy aims to **offer prospects for arable farming over the next 15 years** in which:

1. The **basic supply** of food, feed and biogenic raw materials can be secured on a domestic basis in the long-term.
2. Farmers can make a **decent living**.
3. Conventional and organic farming have overcome their mutual reservations and are learning from one another and endeavouring to tap into **synergies**.
4. The **diversity of crops** in fields is markedly increasing once again.
5. **Fertilisation** is being adjusted even more to the nutritional needs of the respective crops.
6. Plant protection is again being seen to a greater degree within the **overall system of** arable farming.
7. **Digital technology**, particularly in the above-mentioned two areas is contributing to a marked and lasting increase in efficiency.
8. Biodiversity in agricultural landscapes is increasing substantially thanks to **regionally coordinated measures**.

9. **Plant breeding** and crop production are being systematically optimised for the purpose of adaptation of agriculture to climate change and climate change mitigation.
10. Agriculture and **consumers** are growing closer.

The Arable Farming Strategy aims to identify options and ways that should be used in future by sustainable, i. e. environmentally compatible, economically viable and socially oriented, agriculture, also from the perspective of greater social acceptance. An ecological balance and economic incentives should go hand in hand.

2. Background and procedure

Given the challenges outlined above, the scientific community, associations and civil society are currently engaged in an intensive debate about the future strategy for arable farming. The Federal Ministry of Food and Agriculture is now inputting its own proposal into the debate. In this way, the BMEL is also complying with the requirements of the **coalition agreement** of the 19th legislative period.

Excerpt from the coalition agreement between the CDU/CSU and the SPD of the 19th legislative period:

“We will undertake the implementation of the Arable Farming Strategy for, amongst other things, environmentally friendly and nature-compatible uses of plant protection products together with agriculture, and provide adequate funding for the implementation of the National Biodiversity Strategy and, more particularly, insect protection. Against this backdrop, the protection of bees is especially important to us. We will submit this strategy by the middle of the legislative period”.

The Arable Farming Strategy is to encourage a **consensus for society as a whole** for sustainable and resource-conserving arable farming in Germany in terms of food, feed and raw material supply on the one hand and complex climate and environmental policy challenges on the other.

In this Strategy the limits to change are identified. German arable farming is embedded in global markets. An isolated strategy oriented solely towards Germany would be doomed to failure.

The EU is the biggest importer of food and feed in the world. An arable farming strategy must not forget this. **European law and the international obligations of a competitive, market-oriented agricultural sector** must be taken into account. Thus, the current Common Agricultural Policy (CAP) of the European Union and its further development set out the main framework for European and German arable farming for the period after 2020. It is intended not least to promote its sustainable orientation and, amongst other things, to remunerate the social services provided by agriculture which are not paid for by the market.

The Arable Farming Strategy is **interwoven with existing strategies**, action plans and programmes of the BMEL and/or the Federal Government. They include more particularly:

1. The German Sustainability Strategy.
2. The German Strategy for Adaptation to Climate Change and the Climate Action Plan 2050.
3. The Climate Action Package to achieve the 2030 climate goals.
4. The National Policy Strategy on Bioeconomy.
5. The Strategy on Agrobiodiversity.
6. The National Action Plan on the Sustainable Use of Pesticides – with the goal, amongst others, of markedly reducing the risks associated with the use of plant protection products for the natural balance by 2030.
7. The Plant Protein Strategy by means of which the attractiveness of growing protein plants such as soya in Germany is increased.
8. The Strategy for the Future of Organic Farming with the goal that 20 percent of land is being farmed organically in Germany by 2030.
9. The National Programme on Plant Genetic Resources.
10. The BMEL Livestock Husbandry Strategy.
11. The Insect Protection Action Programme by means of which the Federal Government would like to protect species diversity and curb the decline in insects.

Measures from these strategies and policy areas are taken into account and interlinked in this Arable Farming Strategy. In this way the Arable Farming Strategy also contributes to the use and strengthening of synergies.

Furthermore, recent publications include an “Arable Farming Strategy of German Agriculture” by the Executive Committee of the German Agricultural Industry (*Zentralausschuss der Deutschen Landwirtschaft – ZDL*) in 2018; a study entitled “Diversity into the field!” (*Vielfalt auf den Acker!*) by the World Wide Fund for Nature (WWF) in 2019 and a paper entitled “Sustainably securing the future of German Agriculture” by the Boston Consulting Group in 2019. Prior to this the German Agricultural Society (*Deutsche Landwirtschaftsgesellschaft – DLG*) published ten theories entitled “Agriculture 2030” in 2017.

The circle of experts

The foundations of this Arable Farming Strategy have been developed by a **working group of scientists** from the field of expertise in the Federal Ministry of Food and Agriculture (BMEL) and a number of federal states (Länder), who submitted a final report with recommendations for a German arable farming strategy. Based on this report, this proposal for an Arable Farming Strategy was then further developed and adopted by the Federal Ministry of Food and Agriculture. A panel of experts monitored the work on the Arable Farming Strategy.

Structure of the Strategy

The Arable Farming Strategy consists of

- **six guidelines** and
- **twelve areas of action** with **goals** and **measures**.

In this context, the **guidelines** serve as a framework for the orientation of arable farming which is fit for the future.

The **areas of action** encompass both specialist areas of action – that directly affect production and set out the scope for the actions of farmers – and overarching areas of action with an indirect link to production. The **initial situation, issues, conflicting goals** and goals are listed for each area of action, as well as measures for the **implementation** of these goals. Furthermore, a short assessment of **economic profitability** and **indicators** for the assessment of progress are given in each area of action.

3. Arable farming in 2019

Around half of the territory of Germany is used for agriculture. Out of a total of 16.7 million hectares of arable land, around 11.8 million hectares (**more than 70 percent**) are used as arable land and 4.7 million hectares are used as grassland. Perennial crops such as **fruit cultivation** and **wine-growing** account for 0.2 million hectares, i.e. just a small proportion of the total agricultural land in Germany.

Agriculture **differs to a very major degree** from region to region in Germany. Some regions focus on animal husbandry while others are primarily arable. Frequently, this is connected to the soil and climate conditions.

In Germany and on the global scene arable farming produces by far the largest share of staple foods and feed. Consequently, arable production systems are a **cornerstone of food security**. Against the backdrop of a continuously **growing world population** and, at the same time, the limited availability of arable land, climate change, the need to maintain species-rich natural habitats that merit protection (for instance, permanent grassland), the necessary contributions to environmental protection, climate change mitigation, resource conservation and the economic framework, arable farming must – in Germany, too – become even more **efficient, resource efficient** and **sustainable**. This will enable us to build on improvements already made to environmental protection, nature conservation and

climate change mitigation in agricultural practice in recent years.

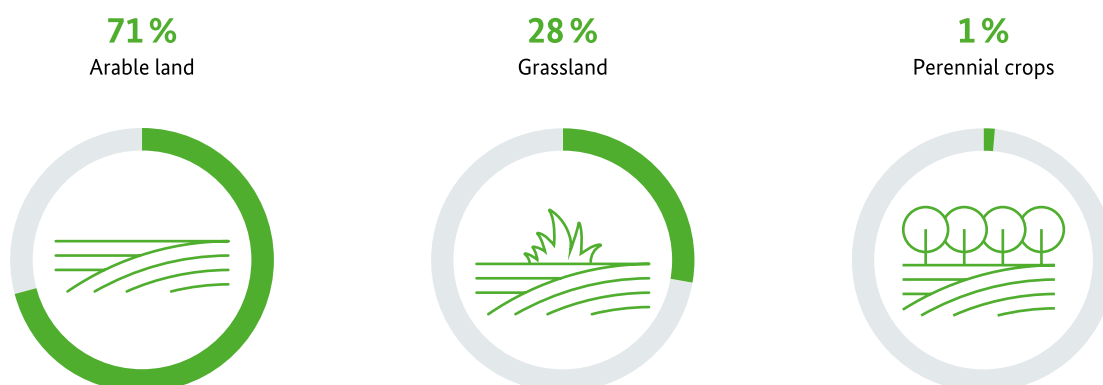
In Germany 11.8 million hectares are used as arable land, i.e. 70 percent of agricultural land. Arable farming is a cornerstone of food security.

Some sections of the population and the media frequently see agriculture and, by extension, arable land as separate from the global food supply. Germany is both a major importer and a net exporter of agricultural products. In this way agriculture makes a **contribution to the global food supply**. FAO estimates show that the global agricultural industry could feed the world population at the present time but that the necessary distribution of foods will, however, constitute a problem for the foreseeable future.

German agriculture makes a major contribution to feeding the growing global population. This must be done overall and globally in an environmentally sound, nature-conserving, climate-friendly and economic manner.

In this context consideration is to be given to the globalisation of agriculture and agricultural markets as well. In recent decades agriculture has continued its steady development. **Globalisation** and the greater market orientation of the CAP have led to heightened **specialisation in agriculture**. Coupled with steadily

Agricultural land by type of use in Germany



Source: bmel-statistik.de; total area by type of use (2017)

increasing international trade, they constitute a precondition for the efficient use of the scarce resource, soil, to supply the growing global population. Given the **global increase in the consumption of food, feed and renewable resources**, the **renunciation of productive arable farming in Germany** would be to the detriment of the **environment, nature and raw materials if arable farming were to be undertaken elsewhere in the world less efficiently** and sustainably than in Germany.

4. Agricultural policy framework – Common Agricultural Policy of the European Union

The CAP sets out the main framework for European and German arable farming. Amongst other things, it aims to safeguard production and promote sustainability and, in some cases, pay for **services provided by agriculture to society that are not remunerated from market earnings**.

Already during the current funding period (2014–2020) the CAP has been far more oriented towards the remuneration of environmental protection and nature conservation services. In conjunction with the basic requirements for agricultural production, there are standards to maintain Good Agricultural Environmental Conditions (GAEC) for agricultural land and the statutory management requirements. In addition, concrete services undertaken by agriculture for climate change mitigation, biodiversity, diverse crop landscapes and sustainable production are financed through the greening measures in the first pillar. **Land can be used and, at the same time, added-value generated for the environment.**

Other important instruments of the CAP are what are known as **agri-environment-climate measures** of the second pillar. Via the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), they remunerate, amongst other things, cultivation with diverse crop rotations, the creation of blossoming areas/strips, buffer strips/areas, extensive grassland management and, since 2014, the tending and maintenance of hedgerows, rows of trees and field shrubbery.

Furthermore, the federal states offer a number of region-specific support measures that aim to preserve old plant varieties and animal breeds.

In Germany measures to protect the environment and biodiversity are currently being implemented on approximately 4.4 million hectares, i.e. roughly one quarter of agricultural land. Around 110,000 farms are participating in the agri-environment measures and, in this way, are contributing to environmentally compatible and climate-friendly management.

As part of the further development of the CAP for the period after 2020, the BMEL is pushing for greater remuneration by the CAP of services provided by agriculture for the protection of the environment, biodiversity, the climate, animal welfare and natural resources. This is necessary in order to support the **sustainability** of agricultural production and **to improve the remuneration** of services of public interest. In this way the important function of direct payments to stabilise farmers' incomes and enable them to take precautionary measures in the event of risks, can be supplemented by additional payments.

5. Challenges

Economy

Today, mainly for economic reasons most arable production systems consist of **just a few cultivated crops**. The majority of fields are sown primarily with cereals followed by maize, barley and rapeseed. Many farm owners feel that their options of working in an economically viable manner are being increasingly constrained by comprehensive and, what they see as complicated legal regulations.

Farms must meet stiffer economic and social requirements.

Environment and climate

Arable farming is under fire, too, because of its **impact on the environment** such as the pollution of soil, water and air, for instance, by fertilisers and plant protection products. One of the reasons for the reduction in biodiversity in agricultural landscapes is intensive farming. Currently, 28 percent of groundwater measurement points positioned beneath agricultural land record nitrate in excess of the limit value. This is caused by run-off from nitrogen use in agriculture.

Today, arable farming is already being directly affected by **climate change**. In future, active climate change mitigation in arable farming must take on greater importance.

Criticism is being levied at crop production methods because of their impact on the environment. Their effects on soil, water, air, species diversity and climate change necessitate new approaches.

Society

The **societal expectations** of agriculture and the food industry are different today from those in earlier decades. The current common practice of conventional agriculture is now being challenged by sections of society, in particular on the grounds of environmental protection, climate change mitigation and animal welfare. Agriculture (like other economic sectors, including energy and transport) faces many societal expectations and demands, some of which are seen as creating an excessive burden – particularly because consumers are often not prepared to actually pay more for sustainably produced foods when they do their shopping.

The social esteem in which agriculture or arable farming is held today is being challenged. Consumers want an agricultural sector which functions in a more environmentally compatible and animal welfare-oriented manner without this having a sufficient impact on consumer willingness to pay more for sustainably produced foods.

Development of the structure of farms (> 5 hectares)



Source: bmel-statistik.de; farms by size category (2017)

Structural change

Major attention is to be paid to **structural change in agriculture**. The main drivers of structural change are **technical progress** and the stiff economic competition on the global markets for food and agricultural raw materials. The consequence today is that **fewer and fewer farms are each managing larger and larger areas**. According to the latest Agriculture Report of the Federal Government, structural change in the period 2012–2016, with a drop in farm numbers by 1.4 percent, was far lower than the average in the previous reporting periods. There is evidence of structural change but not of structural collapse.

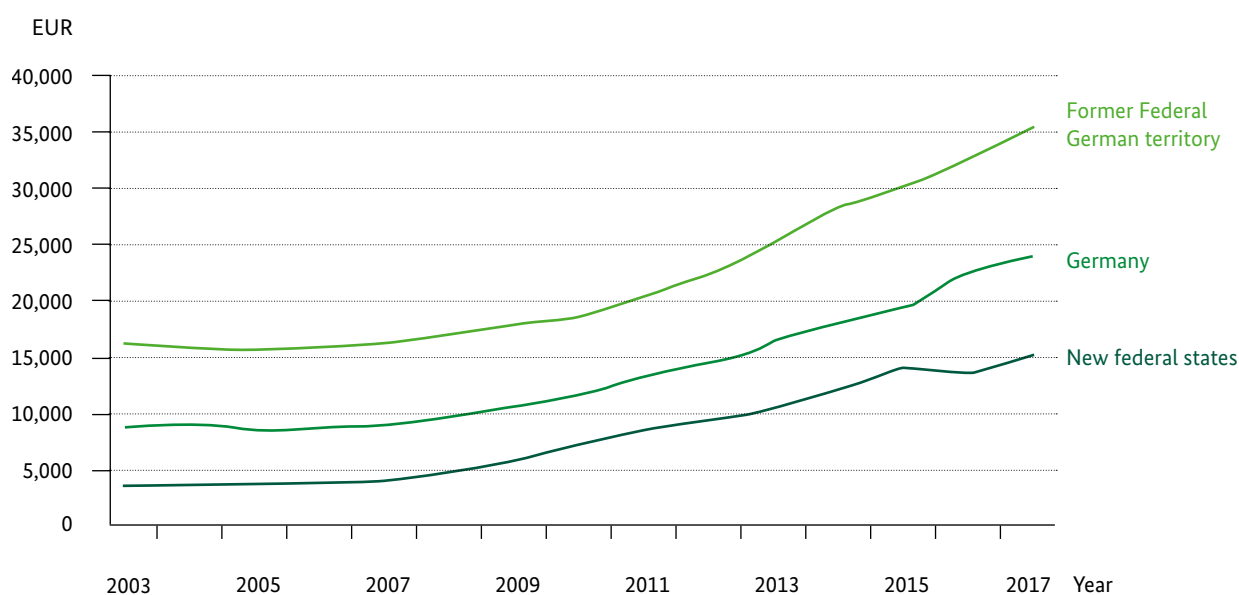
High technical and specialist requirements for environmentally compatible and, in part, digitalised production frequently necessitate **highly specialised** farms and staff with the corresponding training. For small farms this development – necessitating investment in state-of-the-art and often expensive technologies – is normally only economically feasible in the long term. Their strength, also in terms of their future prospects, lies in specialising in certain high-priced market niches. No matter what size they are, farms will continue to be an important economic factor in many rural areas in future, too.

Fewer and fewer farms each manage larger and larger areas. Digitalisation can open up new prospects of a reduced burden, increased efficiency and acceptance for small and large farms.

Land prices

Access to agricultural land by means of leasing and land purchase is of key importance for the development of farms. The competition for scarce land is fierce within the agricultural industry and is also heightened by **non-agricultural investors** – particularly when interest rates are low. Responsibility for this clearly lies with the federal states. They are called on to improve the legal framework in this regard to protect agriculture. In addition, there is the non-agricultural demand for agricultural land for construction, infrastructure and environmental measures. As a consequence, **land prices** have skyrocketed in recent decades.

Average purchase price for one hectare of land sold for agricultural use



Source: Destatis; purchase prices for agricultural land 2017

In recent years the prices for arable land have risen fourfold. This increases the general pressure to intensify farming to generate returns.

The consequence is that farms lose land they have held under tenancy for many years or they cannot purchase the plots of land on offer. At the same time, land taken for settlements and roads, and the related creation of compensation areas, is mostly to the detriment of agricultural land.

Rising purchase prices for agricultural land are an indication of **scarcity**. From the point of view of agricultural use, this calls for optimum and increasingly efficient use of the remaining land. This goes hand in hand with pressure to intensify farming.

Conflicting goals

In addition to the many challenges, there are **conflicting goals** in many areas. For instance, the cultivation of renewable resources is in competition with the production of food and feed in the same areas.

Furthermore, it is difficult to reconcile a high degree of species diversity in a field with high-yield crop production on the same area. In a **market economy prices are an important instrument** for balancing the different claims of usage. As part of this Strategy, conflicting goals are identified and possible solutions advanced.

B. Guidelines

The aim here is to further develop the model of productive arable farming in Germany into arable farming that is aligned with the diverse requirements of society and offers agriculture prospects for the future.

The following **six guidelines** have been developed to define the framework for sustainable, i.e. economically viable, environmentally sound and socially acceptable arable farming.

1. Supply

Food security still takes utmost priority in arable farming – in the global context, too. Furthermore, the supply of animal feed must be ensured as animal production is an integral part of food security. Increasingly, raw materials are being produced for energy and industry. Given the shift towards greater use of biogenic raw materials, this is an important task for the future.

2. Safeguarding income

Even under changing framework conditions, arable farming must be able to compete internationally and safeguard **farmers' incomes**. Changes in arable farming – for instance, greater diversity in crop rotations and adjustments in plant protection – usually mean additional costs for producers. Changes in crop ratio may also impact the prices of agricultural products. They must be identified as part of the Strategy and the risk and opportunities for the farms involved must be outlined as far as possible.

3. Environmental protection and resource conservation

In future, arable farming will have to be geared even more towards resource efficiency and sustainability. This includes **protecting the natural resources** of soil, water and air, reducing the negative impact on the environment and climate, and strengthening positive environmental effects. Reducing land take is part of this, too.

4. Biodiversity

Greater consideration must be given to the **biodiversity of the agricultural landscape**. The promotion of biodiversity supports integrated cultivation with beneficial organisms in plant protection, soil fertility and pollination. Plant genetic resources are part of biodiversity and they form the basis for plant breeding and, by extension, for the development of resistant and climate-smart crops. The decline of typical species in agricultural landscapes must be countered by, amongst other things, preserving and promoting suitable habitats.

5. Climate change mitigation and adaptation

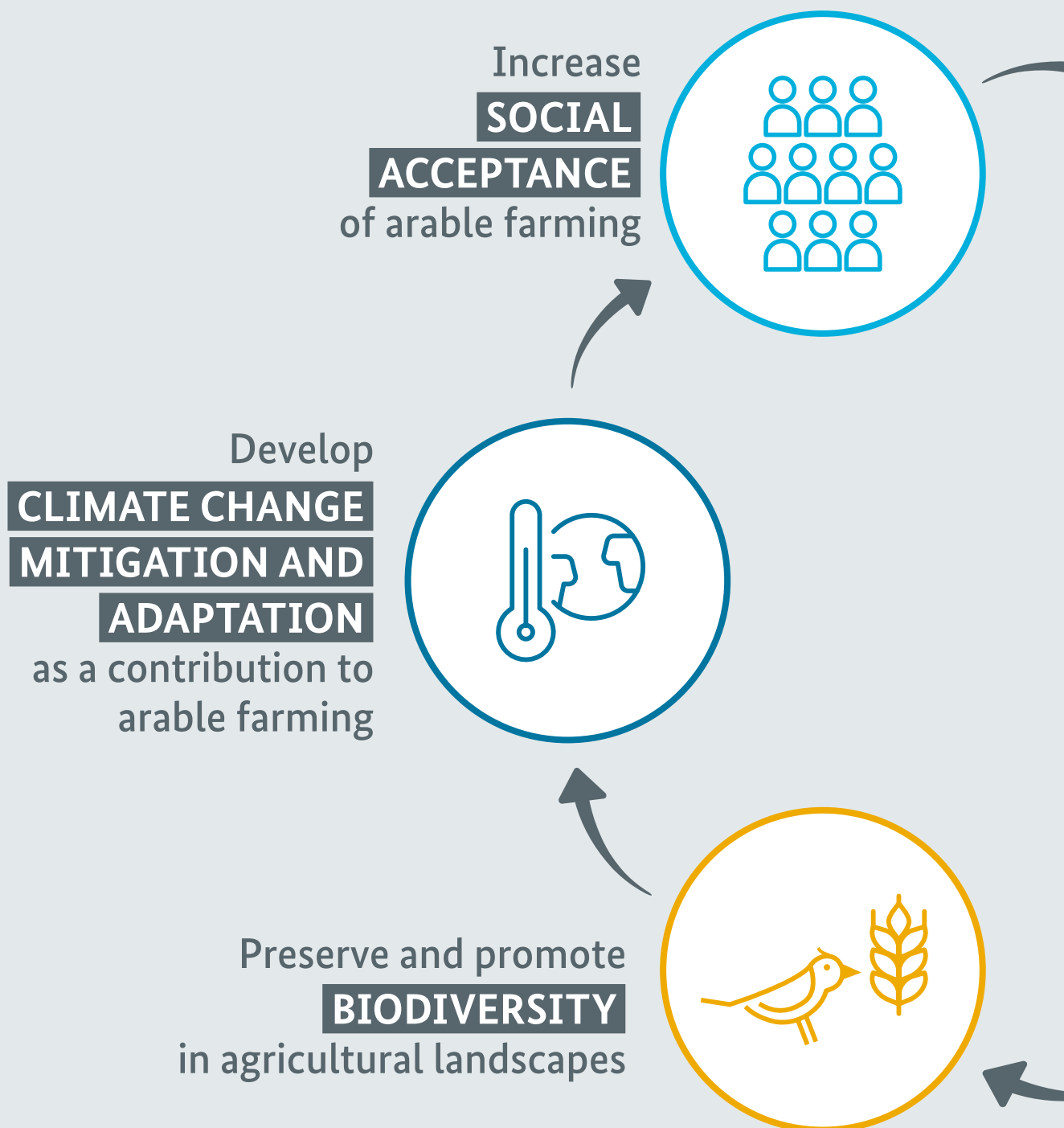
Climate change mitigation must be given higher priority in agriculture, too, as this sector is not only directly affected by it but also contributes to it. For example, emissions of climate change gases must be reduced to a greater degree in agriculture. Moreover, arable farming can sequester climate change gases by

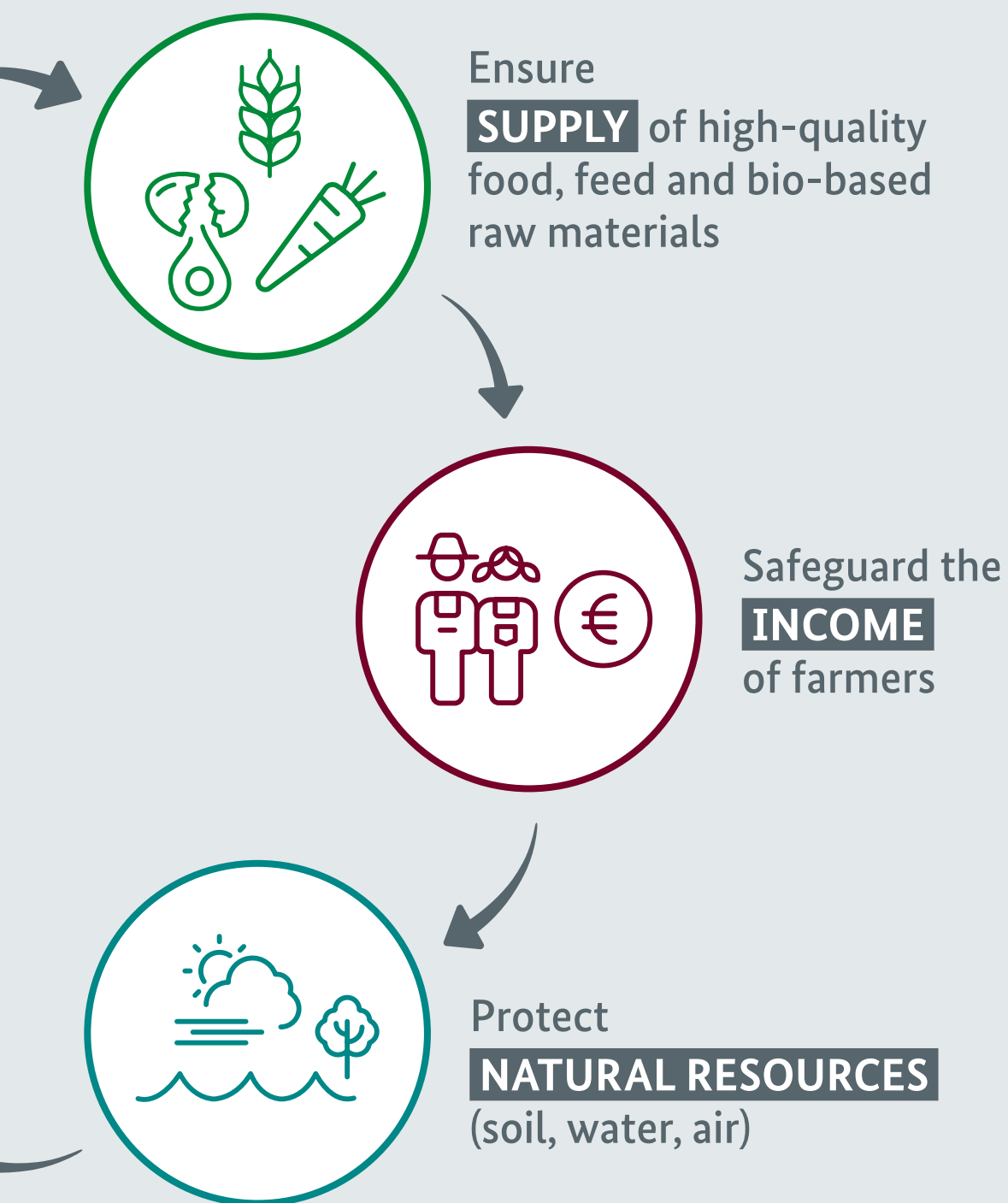
storing carbon through the formation of humus. In this context, arable farming is directly affected by the impact of climate change. New approaches to **climate-smart arable farming** are therefore needed. Ultimately, supply must be guaranteed even under changing climatic conditions.

6. Social acceptance

Acceptance of conventional arable farming by the population at large will have to be markedly improved in order to anchor conventional arable farming in the heart of society once again. This necessitates, firstly, changes to some areas of arable farming practice and, secondly, giving the general public a realistic picture of the challenges and opportunities of arable farming. Procedures in modern, sustainable farms must be presented in a plausible and transparent manner. This is the only way to boost confidence in domestic production methods. To implement this, it is important to promote sustainable production methods in practice and to disseminate information about them on an ongoing basis to people in the agricultural sector, production and consumers.

2035 Arable Farming Strategy Guidelines





C. Areas of action

Specialist and production-related areas of action

1 SOIL

INITIAL SITUATION

- Our soil is the production base for agriculture, the location for the production of healthy food and, at the same time, the largest terrestrial carbon sink (2.5 billion tonnes of **organic carbon**) in Germany. More than 90 percent of global food products are directly dependent on soil. This illustrates its major importance for food security. Central Europe is a **prime location**, some areas particularly in Germany boast very fertile soil. Furthermore, the prevailing climatic conditions here are especially conducive to the generation of high-quality, high-volume and secure yields.

ISSUE

- Soil is a non-renewable resource that is becoming more and more scarce. Soil in Germany is increasingly threatened by wind and water erosion. This is due to ever **larger acreage structures**, a **lack of erosion protection** and a rise in **extreme weather events** such as prolonged dry periods or heavy rainfall. Furthermore, **soil compaction** caused by inappropriate management and **undesirable inputs** of substances such as plant protection products or heavy metals can impair soil function and reduce its fertility and productivity. The competition for agricultural land is fierce and prices for arable land have risen sharply in recent years.

CONFLICTING GOALS

- **Reduced soil tillage** goes hand in hand with a number of positive effects such as, for instance, an increase in humus content in topsoil, greater erosion protection in particularly endangered locations and faster absorption of water ("infiltration capacity"). However, at the present time effective weed control is frequently only possible with the use of **broad spectrum herbicides**.

Humus formation

Humus is the term used to describe all dead organic matter in the soil. Humus plays an important role in a variety of soil functions and is, therefore, a decisive factor in **soil fertility**. For example, balanced and varied crop rotation, the growing of catch crops, the input of organic residues and organic fertilisation all contribute to humus formation. Active soil life and an optimum pH value in soil are important, too.



GOALS

Further strengthen soil protection and increase soil fertility

1. **Soil fertility**, including humus content and functional and structural **soil biodiversity**, have to be further **strengthened** and, if possible, improved. Here, consideration is also to be given to the fertilisation impact of the increased input of organic matter into the soil.
2. To **maintain the production and habitat function** of soil, harmful influences on it caused by erosion (loss of fertile soil), **soil-damaging compaction** and undesired pollutant entry must be **reduced**.
3. A **stable humus content** is to be preserved and safeguarded through the admixture and incorporation of organic residual substances. The goal is humus balance in all arable land by 2030.
4. **Land take** in Germany by non-agricultural usage such as settlements, roads, industry, infrastructure and nature conservation must be **reduced**.
5. Priority for **food security** must be ensured and valuable **natural areas** preserved. Land take is to be reduced to under 30 hectares a day by 2030 and the net-zero target (land recycling management) is to be achieved by 2050.
6. Soil is a resource and not an investment. The goals on the **soil market** are to promote a broad spread of land ownership and **to give farmers priority** when it comes to land acquisition.



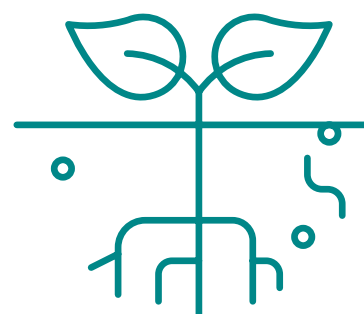
INDICATORS

1. Results of the agricultural **soil inventory** (humus stocks in agricultural soil).
2. Nationwide **erosion register** (erosion events).
3. Increase in settlement and road areas (**land take**).
4. **Soil protection indicator** (change in soil quality including loss of valuable arable land through land take).



MEASURES

1. Develop site-specific recommendations for actions to increase soil fertility, in particular **humus formation**.
2. Try out and introduce new alternative production methods in arable farming within the framework of **integrated crop production**. Main foci:
 - a. soil tillage
 - b. extended crop rotations
 - c. optimised fertilisation
 - d. reduced chemical plant protection
 - e. increased mechanical and organic plant protection
 - f. necessary structural share for beneficial organisms
3. Try out **mulch/direct sowing** methods in changed plant protection situation (e.g. discontinuation of glyphosate from 2023).
4. Promote **year-round soil cover**, e.g. through
 - a. perennial crops
 - b. catch cropping
 - c. undersowing
 - d. incorporation of crop and catch residues
5. Support protective mechanisms against soil compaction by means of **adapted vehicle parameters**: e.g. tyre pressure adjustment technology.
6. Gear **land consolidation methods** more towards soil protection and erosion reduction.
7. Amend land law in favour of a broad spread of land ownership and **priority for farmers in land acquisition** to minimise land purchase by non-agricultural investors.





PROFITABILITY ANALYSIS

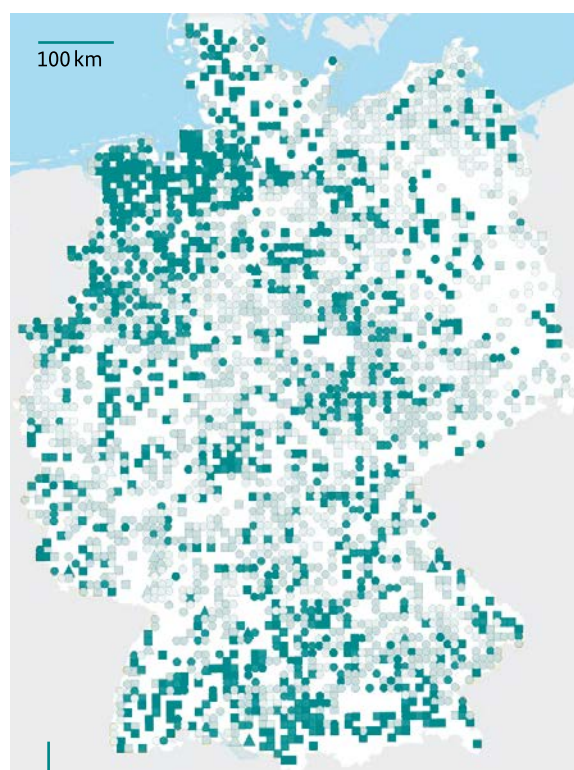
- The first effects of measures to improve soil protection and humus formation will only become clear **in the medium to long-term**. These measures are initially associated with additional expenses for agricultural enterprises. These costs should be covered, particularly in the first years of the changeover. In the long term the investments are likely to be amortised because of **higher soil fertility** and lower susceptibility to erosion.

FLAGSHIP PROJECT SOIL INVENTORY

(BMEL-funded and published in 2018)

The Thünen Institute of Climate Smart Agriculture (Thünen-Institut für Agrarklimaschutz) is undertaking the **agricultural soil inventory** (BZE-LW) and completed its first campaign in December 2018. This marked the laying of the foundation stone for the representative and systematic recording and assessment of the contents and stocks of organic carbon in agricultural land in Germany. In the course of the BZE-LW, samples down to a depth of 1 metre were taken from a total of 3,104 soils used for arable farming, grassland and special crops. The main test parameter was the stock of **organic carbon in the soil**. This is not just the main component of the soil fertility indicator, humus. It also plays an important role as a carbon sink in climate protection.

The second BZE-LW campaign will retest the sampling points at intervals of at least ten years in order to identify changes and possible factors that are impacting the stock of organic carbon. This is how science, agriculture and policymakers can identify changes and optimise **soil management** accordingly. Furthermore, the data are an important basis for national reporting on greenhouse gas emissions in Germany.



The stock of organic carbon in the upper 30 cm of agricultural land varies considerably in Germany (data from the agricultural soil inventory 2019).
t ha⁻¹

- < 30 ● 30–50 ● 50–70 ● 70–90 ● > 90
- Arable land ■ Permanent grassland ▲ Special crop

CROP DIVERSITY AND CROP ROTATION

2

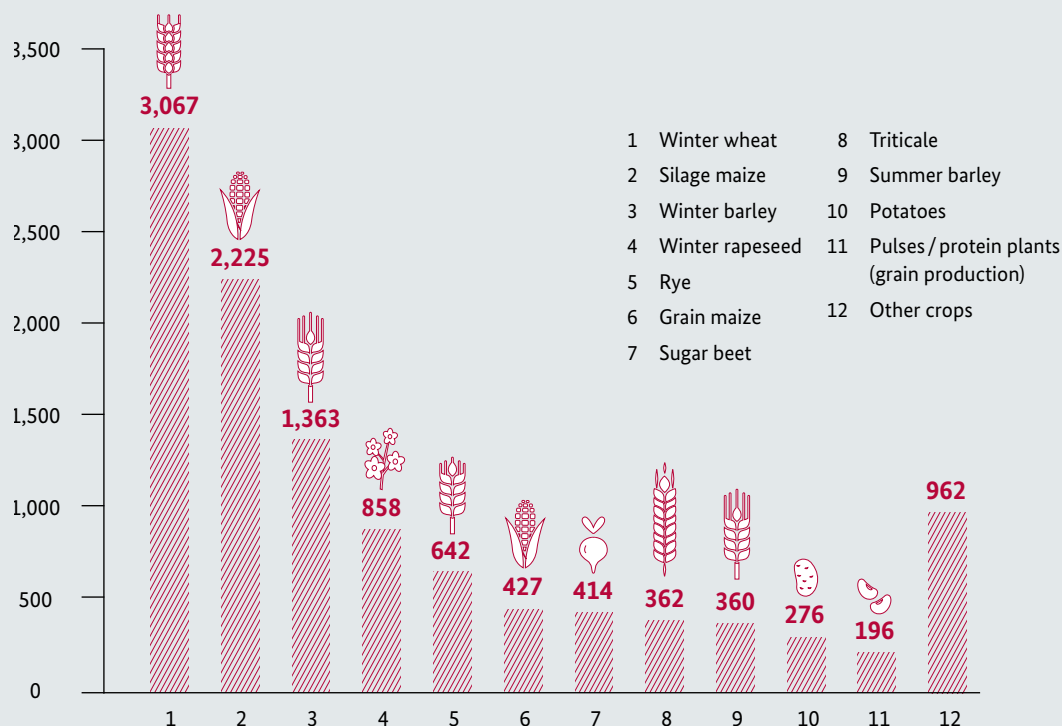
INITIAL SITUATION

→ In recent decades the range of crops has been severely limited because of the economic framework conditions and breeding progress

in individual plant species and is **currently concentrated in just a few crops**. The four most important crops – winter wheat, maize, winter barley and winter rapeseed – are grown on almost 70 percent of arable land.

Cultivated areas of the crop species that cover the most land in 2019 (share in total area of cultivated arable land*)

Cultivated areas of the crop species that cover the most land in 2019 (in 1,000 hectares)



Cultivated areas of the crop species that cover the most land in 2019 (in 1,000 hectares)

*not including permanent grassland or special crops

Source: Federal Ministry of Food and Agriculture (2019)

ISSUE

- The narrowing of the **range of crops grown** leads to increasing problems in practice. As a result, certain weeds and harmful organisms have become more widespread and must now be controlled more intensively. Furthermore, the reduction in the range of crops grown encourages the development and spread of **resistances to the active ingredients in plant protection products**. One example is the increased occurrence of black grass which is resistant to the active ingredients in herbicides. The impact becomes greater as the number of plant protection products with different actions decreases.
- This problem has increased in recent years as it has become more difficult to obtain approval for plant protection products because of strict requirements regarding their safety for human and animal health and for the natural environment. It becomes all the more important, therefore, to take a scientific approach to the effects of plant protection products. What are known as **quarantine pests** of plants that are generally very difficult to control may also occur to a greater degree in narrow crop rotations. Examples of quarantine pests are insects, mites, nematodes, bacteria or fungi which can be very harmful in areas in which they had not previously occurred. One example is potato wart disease or potato cysts which are currently becoming more virulent and are threatening to reduce potato yields.
- There is currently no chemical product to control either black grass or potato wart disease.

CONFLICTING GOALS

- A lack of **sales and marketing opportunities** and the high capital needs for investment in the necessary sowing and harvesting technology for alternative crops are obstacles to extending the range of crops and existing crop rotations. The non-availability of plant protection products can lead to a narrowing of crop rotations.

GOALS

Increase crop diversity and extend crop rotations

1. Any extensions to crop rotations must envisage a **balanced proportion of leaf and grain crops** and the observation of crop-free periods in order to strengthen the stability of crop-growing systems, maintain soil fertility and achieve resilient plant stocks. **Diverse crop rotations** also offer solutions to many environmental, climate policy and production technology challenges. Extended crop rotations help to maintain and promote biodiversity in agricultural landscapes. Changes to crop rotations that suit the farm and the location can, therefore, lead to agronomic, economic and ecological advantages. The precondition for this is that the **crop species grown are economically viable**.
2. To extend the range of crops, agronomically and economically suitable crops must be identified and integrated into crop rotations. Some examples are triticale, spelt, emmer, soya, peas and beans. The **goal is to increase the range of crops to at least five different crops for each arable farm by 2030**. This includes catch crops, undersowing and mixed cultivation. Current practice varies markedly from farm to farm. Some farms only grow two or three crops while others are already growing several.
3. Renewable resources for recycling or energy recovery such as *Silphium perfoliatum* as an alternative to maize, could be particularly suitable when it comes to extending the range of crops. A gradual extension by means of the introduction of new, perennial crops mainly characterised by high yields and relatively low resource usage ("low input plants") is needed – also from the perspective of a developing **bio-economy**, i.e. the use of renewable resources for material and energy recovery.
4. Other species will only become established in crop growing if they generate sufficient and stable yields and the products are in demand on the market. Consequently, the **breeding** of these crop species has to be **improved** and suitable growing methods have to be developed. If not already available, markets with a steady demand should be opened up at the same time. This is

first and foremost a task for the economic actors – the state can at best offer help in tapping into new markets. This is already being done, for instance, within the framework of the Protein Plant Strategy by promoting collaborative projects on lupines, broad beans, peas and soya beans.

INDICATORS

1. Cultivated areas with different crops.
2. Range of crops in the individual farms.

Crop rotation

Crop rotation means the temporal succession of different crop species (in a field). It also impacts a farm's range of crops/crop species ratio.



PROFITABILITY ANALYSIS

- To ensure sustainable crop diversity and broader crop rotations, **sales markets** for new and, up to now, little-used crops must be better exploited by the producers in interaction with commodity dealers and policymakers. Here, too, there is a need for comprehensive support particularly for the conversion of farms. If corresponding sales markets and marketing opportunities are available, a wider range of crop species may be possible even without further funding.



MEASURES

1. Support crop growing tests with a view to **extending the range of crops** in crop rotations.
2. Develop **decision-making aids** for farmers for the site-appropriate growing of crops.
3. Support pilot and demonstration projects on **regional bio-energy or bio-economy concepts**, with due consideration of progressive, multi-annual renewable resources, too.
4. Based on the model of the Protein Plant Strategy, tap into **sales markets for (new) crops** in future within the framework of projects along the entire value chain – namely from breeder via the farmer to the market and consumer.
5. Extend the spectrum of **renewable resources** for material and energy recovery as an alternative to maize and rapeseed. Also give support, for example, as an agri-environment-climate measure.



FLAGSHIP PROJECT

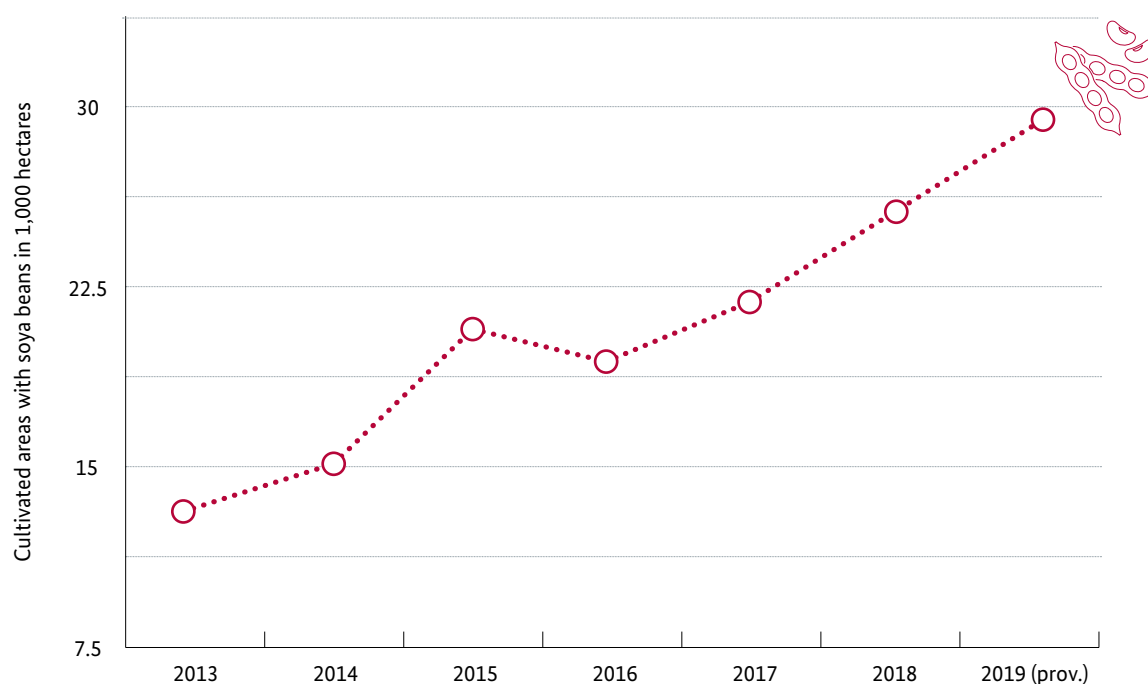
MODEL DEMONSTRATION NETWORK FOR THE EXTENSION AND IMPROVEMENT OF THE GROWING AND EXPLOITATION OF SOYA BEANS IN GERMANY (BMEL-funded from 2013 to 2018)

The goal of this project was to extend and improve the growing and processing of **soya beans** in Germany. To this end, a nationwide network with around 120 organic and conventional demonstration farms was established on which the latest research findings were translated into practice and demonstration facilities were set up to examine various technical production questions. The data generated on the farms were evaluated from the economic angle.

A key element in the network was the **transfer of knowledge** between research, advisory bodies and practice. Consequently, for the entire duration of the project, measures such as field days, seminars and lecture series on the growing and exploitation of soya beans were held for agricultural enterprises, advisory bodies and farms. Furthermore, the project website (www.sojafoerderring.de) was an important tool in knowledge transfer.

In December 2018 the soya network came to an end. After a five-year term the **results** were deemed to be positive. The work of the network was instrumental in achieving a more than **threefold** increase in the cultivated area of soya between 2013 and 2018 and a substantial rise in the number of **processing facilities**. Furthermore, three model value chains were established for the area of food and feed, and teaching material was developed for general, vocational and specialist schools. The project was funded within the framework of the BMEL Protein Plant Strategy and coordinated by the Bavarian State Research Centre for Agriculture (*Bayerische Landesanstalt für Landwirtschaft – LfL*) with project partners from eleven federal states.

Development of the cultivated area of soya beans in Germany between 2013 and 2019



Source: Federal Statistical Office (from 2016), prior to this, the German Soya Promotion Group (*Deutscher Sojafördering*)



Soya plant with pods

3

FERTILISATION

INITIAL SITUATION

→ **Need-based and precise fertilisation** is an important precondition for exploiting the yield potential of crops, preserving soil fertility, avoiding greenhouse gas emissions and achieving the product quality demanded by the market. The key to efficient fertilisation is that the nutrients are in a **balanced relationship** to each other. This is relatively easy to achieve in the case of mineral fertilisers but far more complicated in the case of farm manure and other organic fertilisers as they vary considerably in terms of their nutrient composition and availability. Following the ruling by the European Court of Justice in 2018, the Federal Government is currently revising the Fertiliser Application Ordinance (*Düngeverordnung* – DüV) of 2017 in order to reduce the nitrate pollution of groundwater.

ISSUE

→ Currently, 28 percent of the values recorded by the groundwater measurement points beneath agricultural land and notified by the federal states exceed the limit value of 50 mg nitrate/l. Farmland management contributes to this through **non-need-based fertilisation** resulting from intensive animal husbandry, the regional concentration of biogas plants and areas with a high level of vegetable growing. Furthermore, there are also non-agricultural causes such as low groundwater recharge rates in drylands. The high volume of

organic fertilisers, which is concentrated in some regions, is mainly the result of farm and spatial specialisation in animal husbandry. This constitutes a special problem. Because of its low nutrient concentrations, the transport of liquid farm manure over longer distances is not really economically viable and this can lead to excessive application in the direct vicinity of production.

→ Moreover, **ammonia emissions** in the air which lead, amongst other things, to the formation of fine dust or unwanted nutrient inputs in the soil are to be reduced. In order to meet the minimisation requirements set out in the new National Emissions Ceilings Directive (*Richtlinie über nationale Emissionshöchstmenge für bestimmte Luftschadstoffe* – NEC-RL) that require the reduction of ammonia emissions by 29 percent compared with the base year of 2005, ammonia emissions must be **reduced by approximately 200 kilotonnes of ammonia by 2030** according to the latest data. Around 95 percent of ammonia emissions come from agriculture, mainly from animal husbandry. Nonetheless, nitrogen-containing mineral fertilisers, in particular urea fertilisers, are a contributory factor, too.



CONFLICTING GOALS

→ The lack of a sufficient and need-based **supply of plants with nutrients** can be an obstacle to the effective **reduction of nutrient discharge** into soil, water and air.



GOALS

Increase fertiliser efficiency and reduce nutrient surpluses

1. The goal is to supply crops with nutrients **in line with their needs** and **to increase nutrient efficiency**. In this context, nutrient surpluses and the related discharge into non-agricultural ecosystems, water bodies and air are to be reduced. **Nitrate pollution in groundwater** must be reduced to under 50 gm nitrate/l in accordance with the Nitrates Directive.
2. What is specifically needed is an **increase in the efficient use of organic fertilisers**. This also necessitates the development or improvement of innovative and low-emission usage and **application technologies**. One example is the use of near infrared spectroscopy (NIRS) to estimate nutrient contents in organic fertilisers. The protection of biodiversity in water bodies and sensitive biotopes adjacent to arable land can be improved through buffer strips.
3. In addition, in vegetable growing the intensive **development and testing of nutrient-efficient vegetable varieties** and new fertilisation strategies should be encouraged.

- e. Slurry acidification with sulphuric acid during application.
 - f. NIRS (near infrared spectroscopy) method for nutrient analysis.
 - g. Application of fertilisers to specific sub-areas (support for exact top dressers).
 - h. Establishment of a quality assurance system for slurry.
2. **Strengthen research into the nitrogen cycle.**
 3. Establish a **nationwide early-detection system for the input of nitrates** into groundwater.

Based on the Federal Government's pilot and demonstration project "Indicators for the early detection of nitrate loads in arable farming" that is up and running in a few federal states, a nationwide harmonised **nitrate monitoring concept** is to be tested. Here the aim is to record, if possible in a harmonised manner, the changes in the nitrate loads at test sites of the federal states on the basis of proven scientific measurement and survey methods. The actual annual situation recorded in this way will form the basis for depicting trends and modelling developments in the future.



INDICATORS

1. Nitrogen surplus (area-related plan).
2. Nutrient-flow balance.
3. Nitrate level in groundwater.



MEASURES

1. Draw up a **Federal Nutrient Management Programme** and implement it by means of concrete support programmes. The current proposed measures for this are:
 - a. Construction of slurry containers to increase storage capacity to 10 months.
 - b. Covering of storage containers.
 - c. Improvement of the surface spreading of slurry with low nitrogen loss (trailing hose, shallow injection, trailing shoe technology).
 - d. Separation techniques to increase nutrient efficiency and transport worthiness of slurry.





PROFITABILITY ANALYSIS

- More efficient fertilisation is required to reduce the emission of greenhouse gases. The prerequisite for this is improved application technology. **Investments** in new technology and innovative application strategies will be needed. They can

help to save on fertilisers and reduce externalised costs such as drinking water treatment when groundwater contamination is reduced. **Precise fertiliser application** also leads to **diminishing costs** in arable farming.

FLAGSHIP PROJECT PUDAMA – HIGH-PRECISION FERTILISER APPLICATION DURING MAIZE SOWING (BMEL-funded from 2017 to 2019)

Scientists at the Institute of Construction Machinery and Agricultural Engineering (IBL) of TH Cologne have developed a novel method, in cooperation with the Kverneland Group Soest, that leads to savings of more than **25 percent of mineral fertiliser during the side-dressing of maize**. The project results are now available. In maize growing in Germany, side-dressing has become an established procedure during sowing. A continuous fertiliser band is placed under the grains of maize. Side-dressing aims to supply the maize plants in the youthful phase with nutrients such as phosphorus and nitrogen and thus encourage rapid youthful growth. An innovative method has been developed that involves the high-precision application of mineral side-dressing instead of the continuous fertiliser band commonly used in practice. This novel portioning unit is suitable for use in a conventional precision seed drill. A small portion of fertiliser is delivered to each grain when it is sown.

The agronomic study was conducted over a period of three years. It has concluded that the amount of **fertiliser used in side-dressing** can be reduced by at least 25 percent without any drop in yield. The tests showed a steady yield level even with a 50 percent reduction in fertiliser. Based on the combination fertiliser diammonium phosphate (DAP), which consists of 18 percent ammonia nitrogen and 46 percent phosphorus, savings of 13,500 tonnes of nitrogen and 34,500 tonnes of phosphorus could be made annually. At the current price of DAP at around EUR 400 per tonne, German farmers could chalk up savings of approximately EUR 30 million per year. The technology can be used for crops such as maize, soya beans, sunflowers, broad beans and sugar beet.

→ https://www.th-koeln.de/hochschule/weniger-duenger-bei-gleichem-ertrag_69848.php



The team at TH Cologne has developed a novel portioning unit for use in a conventional precision seed drill that is designed for all types of granulated fertiliser.

4

PLANT PROTECTION

INITIAL SITUATION

- Healthy and high-performance plants are the basic prerequisite for sustainable arable farming. Protecting them from harmful organisms is essential in order to **safeguard** the volume and quality of **yields**. Plant protection products, most of them efficient, are available for this.

ISSUE

- Many of the plant protection products used are biologically active substances. This means they have **also have adverse effects on the environment** and are co-responsible for decreases in biodiversity. Residues of plant protection products in harvested products and the detection of them and their relevant metabolites in groundwater, surface water and soil are further adverse effects.
- These side effects are also the subject of public criticism. Given the current approval situation in plant protection, a further **decline** in the available plant protection products is foreseeable. This will be particularly marked in the case of insecticides and fungicides. In addition, more **resistances** are to be expected to the few remaining active ingredients. These resistances will probably affect all areas of agricultural production.

CONFLICTING GOALS

- The use of efficient chemical plant protection products to safeguard yield and quality and to protect the climate and soil, combined with reduced soil tillage, goes against the wish of consumers for a reduction in the use of chemical plant protection products.

GOALS

Strengthen integrated plant protection and reduce adverse environmental effects

1. The goal is to markedly reduce **the use of plant protection products** which are not classified as “low risk products” as defined by the EU plant protection law by **2030**.
2. The goal is also to phase out the use of **glyphosate-containing plant protection products** by the end of 2023.
3. In future, even in conventional farming, plant protection is to be seen as part of the **overall system** of arable farming. To this end, aspects including the following are to be reviewed and optimised:
 - a. soil tillage
 - b. choice of varieties
 - c. crop diversity and crop rotation
 - d. fertilisation
 - e. direct plant protection measures

4. The development or **the updating of decision-making aids and suitable forecasting models for the application of plant protection products** is more urgently needed than ever before in order to ensure more effective compliance with the required scale of their application (see box “Flagship project Vali Prog”).
5. The new opportunities opened up by **digitalisation** and other state-of-the-art technologies are to be systematically researched in order to develop suitable systems in a timely manner for practice.
6. **Resistance breeding research** is to be carried out more intensively in order to prevent early on harmful organisms from forming resistance-breaking properties. The efficacy and reliability of non-chemical plant protection methods must be improved through more extensive research in order to put in place the preconditions for plant protection without any chemicals.
7. **Economic measures to cover the yield risks in crop production** resulting from the reduced use of chemical plant protection products are to be improved. The risk instruments of the Common Agricultural Policy, the direct payments and national measures are the basis for this.
5. Develop alternative and reliably efficacious plant protection methods for minimum, **erosion-reducing soil tillage** and ensure they are available.
6. Develop or revise **forecast and damage threshold models for the use of low risk products** in plant protection.



PROFITABILITY ASSESSMENT

- The fundamental prerequisite for the further development of plant protection is a **systemic shift in arable farming towards a resilient system with more robust crops**. Nonetheless, the use of resistant varieties and non-chemical plant protection products or methods will mean additional expenditure and investment in new technology. Synergies are to be expected in the farms in the medium term.



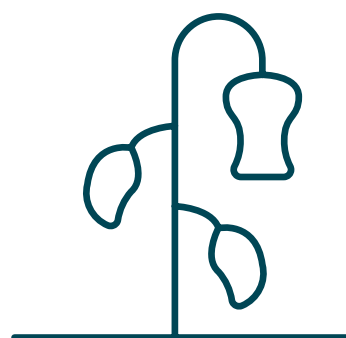
INDICATORS

- Sales of plant protection products and the “low risk proportion” contained therein.



MEASURES

1. Promote more intensively the development of biological and other **non-chemical means** and methods in plant protection. This could entail, for example, the **introduction of beneficial organisms and the creation of their habitats, thermal weed control or mechanical methods**.
2. Update and fine tune **computer-aided forecasts** and decision-making aids in plant protection.
3. Develop **specific damage thresholds** for varieties, pathogens and **groups of active substances**.
4. Set up pilot and demonstration projects on integrated plant protection plus (“**IPsplus**”) that build on the pilot and demonstration projects of integrated plant protection.



FLAGSHIP PROJECT

VALIPROG – COMPUTER-AIDED FORECASTING AND DECISION-MAKING AIDS IN PLANT PROTECTION (BMEL-funded from 2020)

Plant protection products are only to be utilised if their use is really necessary. Knowledge about the health status of the plant stocks is, therefore, essential in order to control harmful organisms. Based on this knowledge, and with the help of **damage thresholds**, farmers can take decisions about whether a plant protection product is to be sprayed or not. Inspection and assessment of plant stocks for infestation with diseases and pests and the presence of weeds is complicated. But farmers have less and less time for comprehensive infestation surveys. State-of-the-art aids are, therefore, urgently needed which support the agricultural enterprises.

In the future innovative technologies and computer-aided forecasts and decision-making aids will make an important contribution. With their backing, the time needed for **infestation surveys** could be considerably reduced. The precondition for this is the availability and practicality of these technologies. Sensors, models and other innovative tools have been available up to now only for selected diseases and harmful insects. Furthermore, the available values are mostly outdated. This means they no longer reflect the situation today, in particular the climate conditions.

This is exactly where the project ValiProg – Computer-aided forecasts and decision-making aids in plant protection initiated by BMEL – comes in. The project is run by the Central Institution for Decision Support Systems in Crop Protection (*Zentralstelle der Länder für EDV-gestützte Entscheidungshilfen und Programme im Pflanzenschutz – ZEPP*) of the federal states, the **plant protection services** of the federal states (PSD), the Julius Kühn Institute (JKI) and other partners. In the project that starts in 2020, the available forecasting and decision-support systems will be updated and made fit for practice. Based on the new data on the epidemiology and population dynamics of harmful organisms, the models are to be improved and linked to weather algorithms. This will increase the accuracy of the forecasts for infestation of crops with harmful organisms and reduce the use of plant protection products. In particular, models are to be developed for diseases and pests for which the potential saving of plant protection products is high.



PLANT BREEDING 5

INITIAL SITUATION

- Plant breeding is particularly important when it comes to tackling future challenges. In recent decades, breeding has been very successful. Today, varieties of many types of crops with markedly improved resistance and tolerance properties are available on the market. A **further development of established breeding techniques and the new molecular-genetic breeding methods** would certainly cater for the demand for new varieties.

ISSUE

- Changing environmental conditions mean there is a need for ongoing breeding adaptation for crops used in agriculture, particularly in terms of **resistance and tolerance properties** and improved **resource efficiency**. At the present time, breeding is concentrated on just a few crops. Widening the range of crops grown would necessitate work on breeding new, neglected or so far little-used crop species.

CONFLICTING GOALS

- The “New Plant-Breeding Techniques (NBTs)” offer the possibility of securing breeding success more rapidly. In the ruling of the European Court of Justice (ECJ), the new plant-breeding techniques such as CRISPR/Cas are, however, classed as genetic engineering and treated restrictively in

accordance with EU genetic engineering law. Consequently, these methods could not be used in breeding practice up to now in Germany and Europe.

GOALS

Develop and use resistant and site-adapted species and varieties.

1. The goal is to improve the breeding of crops, particularly in terms of resource efficiency and resistance and tolerance properties. This is an important measure to promote integrated crop growing. In this context, breeding activities in conjunction with new, neglected or so far little-used plant species is another important goal and should continue to enjoy support from public research funding. This creates opportunities to **extend the range of crops** when economic prospects present themselves for new products.
2. To speed up the required progress in breeding activities, **innovative breeding and selection methods** are to be developed further and used. It will then be possible to adapt crops rapidly to changes in both growing conditions and the range of harmful organisms.

3. The Federal Ministry of Food and Agriculture is engaged in a societal discussion process on the regulatory handling of “**New Plant-Breeding Techniques (NBTs)**” – both on the national and the European level. When it comes to handling NBTs what we need are legally secure research, application and transparency rules whereby consideration must also be given to ecological and social aspects.

ECJ ruling on “New Plant-Breeding techniques”

On 25 July 2018 the European Court of Justice (ECJ) ruled that plants bred with the “New Plant-Breeding Techniques (NBTs)”, such as for instance CRISPR/Cas, are genetically modified organisms (GMOs) according to EU genetic engineering law. Consequently, they are governed by approval and labelling provisions. In contrast, organisms produced using classical mutagenesis may be exempt by applying what is known as the “mutagenesis exemption provision”.

4. In addition, efforts will also continue to achieve progress in breeding by using **established breeding methods** that do not come under current EU genetic engineering law.

5. When it comes to selecting varieties, the main factors for farmers are still yield performance and quality materials and ingredients. **More comprehensive advice about crop growing** must be provided in terms of the region-specific factors (resistances, winter hardiness, drought tolerance) that positively influence the overall performance and thus safeguard the yield. The value for cultivation and use (VCU) testing systems in **state variety testing**, which at the same time deliver results for neutral advice on varieties for agriculture, must be sufficiently flexible to allow appropriate consideration of new variety properties.

INDICATORS

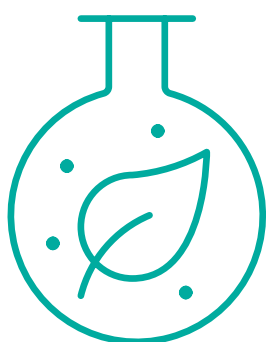
- Number of new approved varieties which meet the target criteria.

MEASURES

1. Develop new policy-making options for the **New Plant-Breeding Techniques**.
2. Promote improvements to crop breeding in terms of **tolerance, resistance and efficiency properties**.
3. Support the breeding of new and **less-used crops** such as, for instance, *leguminosae*, emmer, spelt, amaranth or buckwheat.
4. Examine the inclusion of new descriptive variety properties (for instance, tolerance of biotic and abiotic causes of damage, nutrient efficiency, in particular nitrogen efficiency) in **variety testing** and the respective weighting in the assessment of value-determining properties.

PROFITABILITY ANALYSIS

- This will only entail minor costs for agriculture but the farms will benefit from cost savings thanks to the new species and varieties because they will be more resistant and offer **greater yield stability**.



FLAGSHIP PROJECT

BREEDING TERTIUS: GENOME-BASED STRATEGIES FOR USING THE TERTIARY GENE POOL TO BREED CLIMATE-SMART WHEAT

(planned BMEL funding from 2020)

Today, ongoing climate change, including increased and longer periods of drought in the spring and summer months, is already confronting agriculture in Germany with major challenges. A key adaptation measure will entail the cultivation of drought stress tolerant varieties which have not been available up to now on the necessary scale. The overarching goal of TERTIUS is to develop wheat prototypes with improved water use efficiency and optimised root performance that demonstrate **stable, high grain yield performance even when exposed to drought stress**. TERTIUS therefore aims to increase genetic variation for the root system in winter wheat by using wheat-rye translocations. To this end, the TERTIUS project is systematically searching through the gene pool of wheat for valuable gene variants and is improving drought stress tolerance through its precision-breeding approaches.

The results obtained in TERTIUS will accelerate the development of drought-tolerant varieties and this will enable farmers to benefit from varieties offering high and stable yield. These varieties will help to increase the efficiency of water use which means that production will be shaped more sustainably and it will be possible to cover the growing demand of consumers for sufficient and healthy food in a sustainable way. The Julius Kühn Institute, the Bavarian State Research Centre for Agriculture and three private German breeding companies are involved in this project.



Wheat-breeding site

6

DIGITALISATION

INITIAL SITUATION

- Today, sensors and digital assistants are already helping to simplify work, increase efficiency and protect resources and the environment in arable farming. Digitalisation is likewise linked to **more extensive expectations in the areas of fertilisation, plant, environmental (soil, water and air), climate and biodiversity protection, sustainability, quality assurance and traceability** of the product to the arable farm it came from.

ISSUE

- Agricultural machinery, with corresponding digital features, is only slowly gaining a foothold in practice. The high investment costs, incompatible interfaces and, in some cases, farmers' lack of knowledge are obstacles to its speedier introduction. There is a need for improvements: **handling** must be further simplified, the costs of digital technologies lowered and access to data eased (for instance, diverse official data like geodata, remote sensing data, GPS correction signals). Improvements must be made to mobile phone coverage in rural areas, the protection of farm data, training, advice and also to various legal conditions, for instance, in the use of autonomous systems.

CONFLICTING GOALS

- The protection and security of farm data are frequently obstacles to the provision of data required for the introduction of new digital techniques.
- The costs for the procurement of new digital technology are frequently beyond the means of small farms.

GOALS

Make optimum use of arable farming potential through digitalisation

- Existing digital methods that contribute to **increasing sustainability** should be introduced and used on a wide basis, and new methods for improving resource efficiency should be developed. For this, the necessary preconditions must be created. These include nationwide **mobile phone coverage** and uninterrupted cover for real-time kinematic GPS methods to measure or stake out points with the help of satellite-based navigation systems. Furthermore, data sovereignty and protection must be clarified. Not every technical innovation in the field of digitalisation produces practical benefits. Consequently, new developments must be evaluated independently and the results made available to agriculture.

INDICATORS

1. Mobile phone coverage for agriculture.
2. Market penetration in arable farming for digital support systems.

MEASURES

1. There are major quality differences in digital applications for agriculture. **An independent “quality control body”** to test them could be beneficial for farmers.
2. **Develop innovative and digital technology** for possible methods and work procedures for use in arable farming, particularly for soil tillage, fertilisation and, in the case of plant protection, to improve both soil health and general efficiency in these sectors.
3. Promote digital technology for **small and medium-sized** farms, too, and multi-farm use.
4. Create the **statutory framework conditions** for the use of digitalisation (for driverless vehicles, etc.).

5. Introduce nationwide **coverage** for RTK-GPS and ensure farmers have access to public data.
6. Establish **digital test sites** on farms throughout Germany and thus provide information across the country about sustainable digital technologies.
7. Check the preconditions for how data produced in agriculture can be subject to control (“data sovereignty”) by the farmer and are sufficiently protected from unauthorised access.



PROFITABILITY ANALYSIS

- Digital technology is currently associated with what are, in some cases, **high procurement costs**. The acquisition of digital technology must, therefore, be funded in order to drive its rapid spread. The application and utilisation of digital technologies and methods are expected to lead to cost savings in the arable crop production process.



FLAGSHIP PROJECT CROPWATCH – AN INTEGRATIVE DATA MANAGEMENT AND INFORMATION SYSTEM FOR PROCESS CONTROL AND ANALYSIS IN CROP PRODUCTION (BMEL-funded from 2017 to 2019)

Modern agriculture produces increasingly large volumes of data. Tractors drive with GPS support, combine harvesters operate with NIR support, crop and soil sensors and cameras on drones promise to provide a precise assessment of plant and soil conditions, and weather stations detect periods of drought. The aim of CropWatch is the orderly recording and targeted, joint evaluation of the data in order to obtain crucial new information for the crop production process. The system can manage all kinds of data that occur in the arable crop production process. By means of **geocoordinates**, time stamps and semantic classification, **information on soil, weather conditions, arable crop management, plant condition and yields** are combined.

All spatially referenced data, for instance from drone flights, are automatically attributed to field structures. The data are available to users as tables, charts or maps on a daily basis to help with their decision-making. CropWatch enables users from research, plant breeding and agricultural practice to incorporate digital technologies into their farms and thus to apply nutrients and plant protection products with great precision.

→ For detailed information please visit the project homepage:
<https://www.plantbreeding.uni-bonn.-de/CropWatch>



Octocopter used in the CropWatch project

BIODIVERSITY 7

INITIAL SITUATION

- Biodiversity has a high intrinsic value as part of nature and fulfils a variety of functions, for instance, in terms of soil fertility, pest regulation, pollination of our crops and all other plants in nature. There has been a **major decline in species diversity** or biodiversity as demonstrated, for example, by the sustainability indicator – species diversity – on agricultural land. Although initial findings are available for a few areas, there has not, as yet, been sufficient analysis of the overall area of agriculture or arable farming and its impact on biodiversity.

ISSUE

- The reasons for the decline in biodiversity in agricultural landscapes are diverse and differ from region to region. Comprehensive national monitoring – not only of insects but also of biodiversity in agricultural landscapes overall – is currently being put in place.
- The main reasons given for this decline are:
 1. Intensive agricultural use.
 2. **Fragmentation** and **urban sprawl of the landscape**.
 3. **Development of transport routes**.
 4. **Elimination** of small-scale structural elements.
 5. **Sealing** of surfaces.
 6. **Light pollution**.
 7. Large-scale **discharges of pollutants**.

CONFLICTING GOALS

- In principle, the growing of crops on agricultural land pursues the goal of promoting their development and enabling them to assert themselves against their competitors and harmful organisms. Measures to increase and promote biodiversity in agricultural landscapes run counter to this goal.

GOALS

Enhancing biodiversity in agricultural landscapes

1. The decline in the number of species in agricultural landscapes must be halted and species diversity once again increased. Ecosystem and structural diversity contribute to this. This potential must be systematically used. **Interlinked** habitats for fauna and flora can be established, for example, by adding strips with **insect-friendly plants at the edge of fields** and throughout the land parcels.
2. The following six measures are needed to promote biodiversity in agricultural landscapes:
 - a. Multi-annual structural elements, e.g. **field hedges or flowering strips**.
 - b. Smaller land parcel sizes.
 - c. Elevated presence of **ecotones** in the transition from one crop to another.
 - d. **Multiple crop rotation**.
 - e. Reduced **production intensities** on the areas envisaged for this.
 - f. If possible, year-round soil cover and the presence of various crop species and varieties.

3. **Regional goals** should be defined for the effective planning of measures and evaluated through suitable **monitoring**. This includes identifying and overcoming obstacles which reduce the acceptance of biodiversity measures.
4. Changes in use to promote biodiversity in agricultural landscapes are to be **evaluated economically** and set against possible synergy effects. Changes in use must be legally secured to ensure they are reversible. The permanent conversion in the use of certain areas and the fixing of a different type of use for these areas should not be accepted and would damage legitimate expectations.

INDICATORS

1. Systematic, nationwide **monitoring** in agricultural landscapes (collaborative monitoring project of the BMEL (MonViA)).
2. **Sustainability indicator** for species diversity in agricultural land.
3. **Agri-environmental support** (funded area).
4. Development of biodiversity in **target areas** by way of example.

MEASURES

1. Undertake systematic nationwide monitoring of biodiversity in agricultural landscapes (**collaborative monitoring project** of the BMEL MonViA).
2. Specify regional **biodiversity goals** and improve networking of biodiversity-promoting measures beyond farm boundaries.
3. Build up regional **stakeholder alliances** consisting of representatives from agriculture, the environment and local authorities to plan and implement regionally agreed biodiversity-promoting biotope alliance systems – based on the “**Dutch model**”.
4. Introduce the “**biodiversity**” **crop rotation element**, for instance, by promoting it as an agri-environment-climate measure (AECM).
5. Dismantle **administrative** hurdles, minimise red tape for participation in biodiversity-promoting measures.
6. Create **structural elements to divide up large land parcels**.

PROFITABILITY ANALYSIS

- Measures to promote biodiversity in agricultural landscapes are frequently associated with constraints on use. But synergies can also develop with arable farming, for instance through pollination, pest control, etc.
- Measures and actions carried out in agricultural enterprises must be correspondingly remunerated.



FLAGSHIP PROJECT

MONVIA – NATIONAL MONITORING OF BIODIVERSITY IN AGRICULTURAL LANDSCAPES

(BMEL-funded from 2019 to 2024)

Existing monitoring programmes only permit limited scientifically grounded conclusions about the underlying cause-effect relationships. Furthermore, assessments of the impact of agri-environmental measures to promote biodiversity are only possible to a limited degree. This is why there is a need for a **representative nationwide database**.

In the collaborative MonViA project, scientists are seeking to provide sound answers to the following questions: How does biodiversity develop in open agricultural landscapes under the influence of agricultural production, land use and structural change in agriculture? How do changes in biodiversity impact the performance and the stability of agricultural production systems? How do agricultural and environmental measures affect biodiversity? MonViA is supplementing specialist nature conservation monitoring approaches and is launching a five-year pilot phase in which standardised recording methods and innovative indicator systems for three sub-areas will be developed: nationwide trend monitoring, more in-depth monitoring of issues

to do with agricultural areas and citizen science-based monitoring. The latter entails the involvement in particular of farmers in **monitoring activities**. MonViA is looking at various groups of organisms in addition to the diversity of habitats. One focus is on functional groups (pollinators, pests, beneficial organisms, soil fauna) which are of special importance for the performance of agricultural production systems.

A total of 12 specialist institutes of the Thünen Institute, the Julius Kühn Institute and the Federal Office for Agriculture and Food (BLE) are involved in the design of MonViA. The Thünen Institute for Biodiversity is responsible for its overall coordination.

→ <https://www.agrarmonitoring-monvia.de/>



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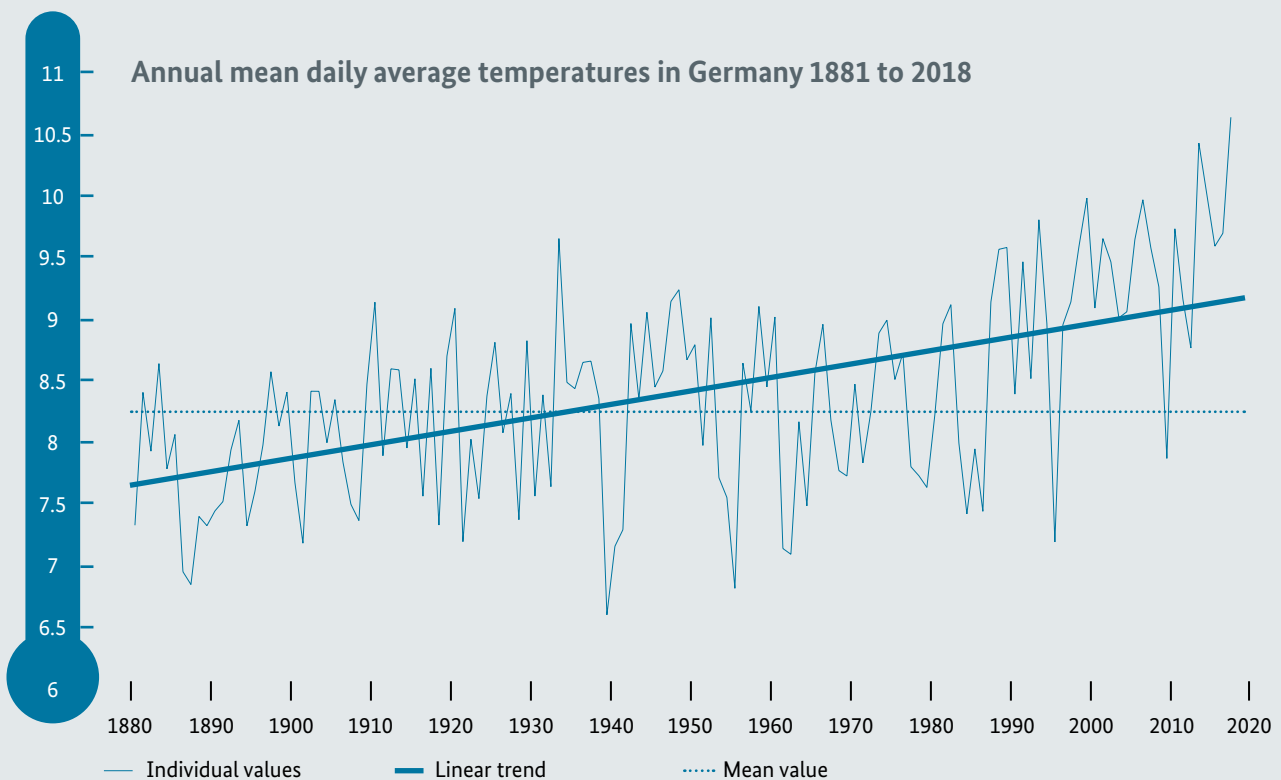
CLIMATE CHANGE ADAPTATION

INITIAL SITUATION

- Climate change will confront arable farming in particular with major challenges as it will be directly affected by the predicted changes such as **higher temperatures**, different **precipitation patterns**, higher **CO₂ concentrations** in the air and more frequent and more intensive **extreme weather conditions** and events.

ISSUE

- In future, arable farming will have to prepare itself even more for the expected **climatic changes**. These include longer vegetation periods, shorter courses of development, higher risks of late frost, more frequent heavy rain, longer drought and heat periods, greater risks of humus depletion and increased occurrence of new harmful organisms.



Source: German weather services (DWD), notification dated 12 June 2019

- **Future climate changes** will – like the changes observed already – **differ in intensity from season to season and from region to region**. Consequently, the degree to which regions are affected will vary.



CONFLICTING GOALS

- The extension of spray irrigation/watering capacities can be limited by the water supply available locally.



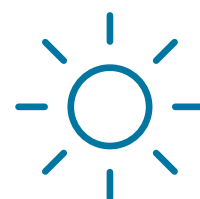
GOALS

Develop climate-smart crop growing concepts

1. In order to secure the supply of food, feed and biobased raw materials in future, the degree to which regions are affected must be ascertained. On this basis **crop growing systems and adaptation options** must be developed, for instance, in terms of plant species and selection of varieties, management methods and irrigation potential that are productive and sustainable under changing climate conditions. Regional **optimisation concepts** ranging from growing to processing are required. Targeted, long-term experiments and precision tests should be conducted on **regional-trial sites** in order to individually test new methods and systems.
2. In the context of increased drought during the main growth periods, **irrigation capacities must also be urgently planned and extended for arable farming**. To this end, mandatory land consolidation methods and other structural measures are to be implemented in such a way that they do not impede the establishment of a suitable irrigation infrastructure. In typical irrigation regions, the irrigation infrastructure is to be directly established within ongoing **land consolidation** procedures. This also applies to planned water withdrawals which are to be organised in a manner that preserves ground-water and surface water. Extensive expertise is the prerequisite for the conduct of need-based irrigation. Consequently, agricultural extension services and accompanying research are to be established in potential irrigation regions.

The finite resource, water, will have to be handled efficiently and sparingly.

3. **Monitoring programmes** must be developed which identify and depict the threat to various regions and the corresponding adaptation strategies. Numerous adaptation options can be envisaged such as:
 - a. **Diversification of crop rotation.**
 - b. **New crops that are tolerant of heat and drought stress.**
 - c. **Integration of soil structure-improving crops** into the crop rotation.
 - d. Targeted selection of **site-adapted** varieties.
 - e. Changed **stock management**.
 - f. Growing of **catch crops** and **perennial** crops
 - g. **Two-crop growing** subject to the availability of sufficient water.
 - h. **Mulch and direct sowing.**
 - i. **Soil protection-friendly** land consolidation to protect against erosion.
 - j. Adaptation of **fertilising timepoints**.
 - k. Adjustment of the incorporation and removal of **organic** substances.
 - l. Adaptation of **soil tillage methods**.
 - m. Advice is needed for the translation of adaptation strategies into practice.



INDICATORS

- Effects of changing climate conditions on quantities and qualities in agricultural production.

MEASURES

1. Evaluate degree to which regions are affected and make region-specific **recommendations for arable farming adapted to climate change** (crop species, varieties and crop rotations, management methods, soil tillage, erosion protection).
2. Test and integrate measures for **climate change adaptation** in crop production.

3. Establish and extend **additional irrigation capacities** bearing in mind nationwide principles, for example, on water withdrawal.
4. Develop training in and **advice** on climate-smart arable farming (see also: area of action, education and advice).

PROFITABILITY ANALYSIS

- Adaptation to changing climatic conditions sometimes involves **high-cost** measures. In the long term, these adaptations will have a positive impact on farm results as their crop growing systems will be more resilient and boast higher yield stability.

FLAGSHIP PROJECT AGRICULTURE-RELEVANT EXTREME WEATHER CONDITIONS AND RISK MANAGEMENT OPTIONS (BMEL-funded from 2013 to 2015)

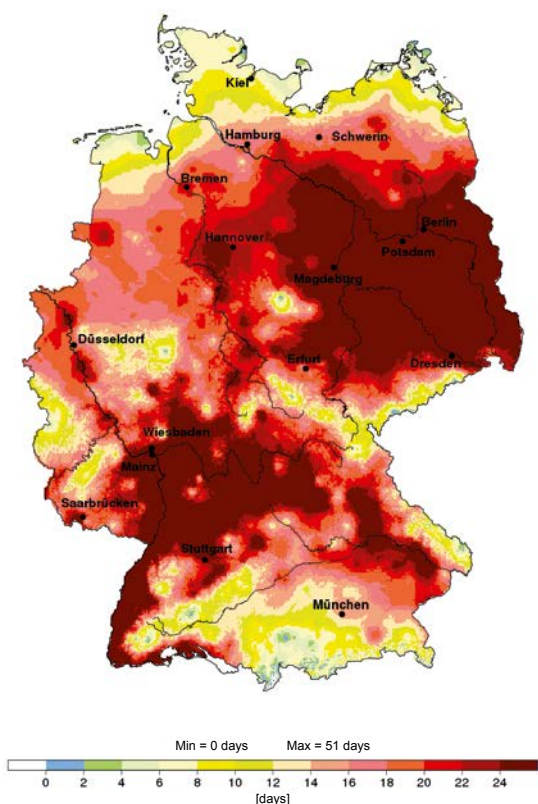
Extreme weather conditions such as heat, drought, storm, flooding, hail and frost can cause major damage to German agriculture and forestry. In the context of climate change, many climate research experts are afraid that these extreme weather events will occur more often.

According to experience gained so far, it can be assumed that the intensity of these damaging events will vary considerably from one small area to another and may not be foreseeable in individual cases. Up to now, no robust scientific findings were available on the effects and possible adaptation strategies.

An improved understanding of the interrelationships is, however, of major value for individual farm

planning and for private and public risk management. The collaborative research project examines (1) regionally differentiated changes in extreme weather conditions of relevance for agriculture in Germany, (2) their impact on agriculture including special crops and forestry and (3) possible adaptation measures. The results of the collaborative project offer a wealth of information and concrete recommendations for action. With this study the BMEL has created an important foundation for timely adjustments to the expected changes and reflection on suitable adaptation measures.

→ Find out more:
<https://www.agrarrelevante-extremwetterlagen.de>



Number of hot days, 2018



Number of hot days, 1881–2018

Overarching areas of action

9

CLIMATE PROTECTION

INITIAL SITUATION

- In arable farming, the most important **greenhouse gas emissions** are nitrogen emissions (mainly in the form of laughing gas) particularly from fertilisation, the incorporation of harvest residues and organic fertilisers, and the mineralisation of moor soils. In addition, there are carbon dioxide emissions from drained moor locations used for agriculture and from direct energy consumption. Whilst direct energy consumption causes relatively low CO₂ emissions, the adapted use of moor locations offers far greater climate protection potential.

ISSUE

- In 2017 German agriculture was responsible for the emission of around 66 million tonnes of carbon dioxide equivalents, i.e. **7.3 percent of total German greenhouse gas emissions**. In comparison the energy sector emits 34 percent, industry 23 percent and transport 19 percent. Agriculture in Germany was the **main source of ammonia emissions** amounting to 640,000 tonnes.

CONFLICTING GOALS

- Effective climate protection in arable farming is dependent on long-term and sustainable solutions. These may, however, **run counter to** high production levels and trigger **production relocation effects**. The increased use of mechanical methods in plant protection resulting from the phasing out of chemical plant protection products will lead to higher CO₂ emissions.

GOALS

Extend climate protection in arable farming and use synergies

- The environment and climate-relevant emissions produced in arable farming must be minimised. Here, the preservation and the sequestering of carbon in agricultural land plays an important role. As **humus is one of the biggest terrestrial sinks for organic carbon**, the humus content in organic and mineral soils must be preserved and, where appropriate and possible, further extended. For organic soils, management concepts are needed which lead to a reduction

in environment and climate-relevant emissions, for example through humus depletion. The energy efficiency of management practices in arable farming must also be improved, for instance, by reducing the number of times soil is tilled. Higher **efficiency in nitrogen application** to reduce N emissions is also needed. Furthermore, arable farming should make a contribution to achieving the energy, environment and climate goals, and increase the proportion of renewable energies.

INDICATORS

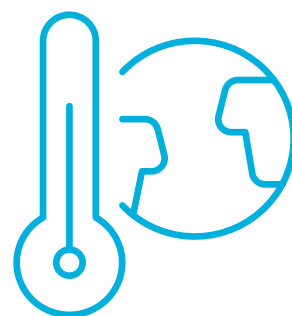
- Greenhouse gas reporting Agriculture

MEASURES

1. Support projects to **measure** and **reduce** greenhouse gas emissions in arable farming.
2. Develop **management concepts** for organic and mineral soils from the perspective of climate protection.
3. Support agricultural enterprises in **measures for carbon storage in soil** (see: area of action, soil).

PROFITABILITY ANALYSIS

- Increased climate protection in arable farming may, in some cases, mean high costs for agricultural enterprises. In such cases, support for **investments** in the relevant technology will particularly be required.



FLAGSHIP PROJECT FEDERAL NUTRIENT MANAGEMENT PROGRAMME (planned BMEL funding from 2020)

The primary goal of the Federal **Nutrient Management** Programme is to reduce nutrient leaching from farm manure into the environment. In particular, high nitrogen and phosphorus leaching, in the form of nitrates and phosphates, pollute **groundwater and surface water**. In addition, the release of gaseous ammonia from liquid organic fertilisers (for example slurry, fermentation residues) impairs **air quality**.

In recent decades, animal husbandry that is highly concentrated in certain geographical regions has developed in Germany with a correspondingly high accumulation of farm manure. As farm manure is only worth transporting to a limited degree because of its high water content, optimised **slurry and fermentation residue** application and treatment is all the more important in order to avoid area-related surpluses and undesirable leaching into the environment.

Measures that can be funded within the framework of the Federal Programme on Nutrient Management as pilot and demonstration projects should, therefore, identify the respective potential for improving nutrient use in agriculture and for optimising **nutrient efficiency** whilst, at the same time, minimising unwanted nutrient leaching into the environment. The following aspects should be examined in more detail:

- Opportunities and limits of online **real-time nutrient quantification** in farm manure and fermentation residues during application (for instance, using NIRS technology) as the precondition for need-based fertilisation.
- The **preparation** of farm manure in a transportable form, for instance, by means of separation and other methods and in products. This should help to achieve a need-based and low-emission application with higher nutrient availability.
- The reduction of ammonia emissions from slurry and fermentation residues with a view to improving air quality and reducing gaseous nutrient losses. **Acidification** has the potential to reduce ammonia losses in animal sheds and during the application of farm manure. Losses during storage can be reduced by placing covers on storage containers. Furthermore, the application technology, in particular, offers opportunities for low-loss, surface application where nitrogen is rendered useful to a greater degree for plant nutrition.



Slurry disc injector to spread slurry between the rows

EDUCATION AND ADVICE

10

INITIAL SITUATION

- Robust **special knowledge** about resource-saving production technologies in agricultural practice is the precondition for sustainable arable farming. Innovative advice and continuing training concepts that focus more on aspects of sustainability, environmental protection and resource conservation, are therefore an important component.

ISSUE

- In many federal states, no agricultural extension services are currently provided.

CONFLICTING GOALS

- Education, including vocational training, and advice are sovereign tasks of the federal states. The Federal Government and the federal states must come up with a **consensus-based solution** in which agricultural training and advisory bodies develop new paths for cooperation without infringing the competences of the federal states.

GOALS

Strengthen education and advice

1. Qualified initial and continuing training of farmers and the strengthening of the **knowledge exchange system** (networking) between the key stakeholders from agriculture, science, advisory bodies, companies and training, and the stepping up of agricultural extension services are to be seen as key environmental measures. Advice, coupled with support or investment programmes, can contribute to environmentally sound production technologies being established more rapidly in agricultural enterprises. Research findings must be passed on more speedily to practice. The implementation of research findings should be guaranteed in the long term.
2. **Agricultural vocational training and continuing training should reflect the diversity of the goals described in the Arable Farming Strategy.** This applies in particular to aspects of relevance for biodiversity and climate. To this end, innovative advice and continuing training concepts must be developed that focus more on aspects of sustainability and resource protection. For the purposes of demonstration, suitable pilot sites are to be put in place which can be used for the intensive transfer of knowledge to farmers.

INDICATORS

1. Demand for **seminars** and acceptance of the proposed seminars in the Arable Farming Strategy.
2. Inclusion of the prepared **information material** and its contents in the actual initial, further and continuing training courses and in advice.

MEASURES

1. Develop and offer seminars for **advisory bodies** and educators with regard to measures/options in the Arable Farming Strategy.
2. Prepare **information material** on measures/options to be offered through the Arable Farming Strategy.
3. Demonstrate individual measures as part of the **lead farms for crop growing**.
4. Intensify the **prompt transfer of research findings** to practice/advisory bodies, ensure long-term implementation.
5. Supporting measures from the Federal Government to strengthen agricultural extension services offered by the federal states.



PROFITABILITY ANALYSIS

- Agricultural enterprises will benefit from improved education and advice. The **development options** identified in this strategy for arable farming in the future must be introduced rapidly and reliably into agricultural training. This will make the measures set out in the Arable Farming Strategy more plausible for farmers and should considerably increase their acceptance. By means of **optimised processes**, savings can be made on operating resources. More sustainable management will lower externalised costs, too.



AGRICULTURE AND SOCIETY

11

INITIAL SITUATION

- In recent decades, agriculture, like other economic sectors, has undergone major changes as a result of rapidly advancing automation and the pressures of competition. The proportion of the population who live in cities has been on the rise for decades. Fewer and fewer people have any personal experience of modern agriculture. **A lack of respect and appreciation** in society for the work undertaken in livestock sheds and in the fields is the criticism levied by the farming community. This was also the basis for an agriculture summit at the Federal Chancellery in December 2019.

ISSUE

- Modern production methods in arable farming are sometimes viewed critically by society. Glyphosate, slurry or “monocrops” have virtually become **emotive terms**. In an affluent country like Germany, the central importance of arable farming when it comes to contributing to ensuring food security at home and around the world, is underestimated. This is because any bottlenecks in domestic production can be easily compensated by imports from the world market.

- However, **the negative impact of intensive arable farming, the finer points of which cannot yet be determined**, such as nitrate pollution of groundwater and the decline in biodiversity in agriculture, are indeed the main reasons for the lack of social acceptance of arable farming.

CONFLICTING GOALS

- A growing number of consumers are calling for farming that uses alternative plant protection methods and takes due account of species diversity and other ecologically sound methods. However, **agricultural enterprises have to cover their costs** and often have little leeway to cater for the demands of society. There is a need here to mediate, provide information and create a balance between these positions.

GOALS

Greater appreciation of farmers

- To achieve **greater acceptance of agriculture** in society, its negative effects must be reduced, for instance, by a significant drop in the exceeding of limit values for nitrates in groundwater, and a measurable increase in biodiversity in agricultural landscapes. This could serve as the basis for improved communication. The procedures in modern farms must be communicated to the public at large in a plausible and transparent

manner, for instance, at demonstration farms (lead farms for crop production). The task in hand here is to raise awareness amongst consumers **that their behaviour when purchasing food is directly linked to the shaping of production systems** and that an agriculture sector with arable farming and diverse livestock husbandry on one farm is no longer competitive in the context of globalisation. Indirectly, society will derive major benefits from the avoidance of environmental damage, the conservation of resources (water, climate) and the securing of the future of agriculture.

INDICATORS

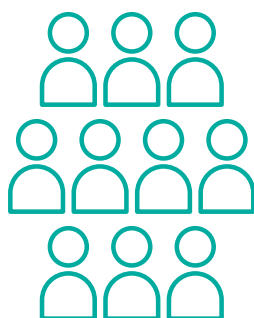
1. Ongoing **market analyses/opinion polls** on the perception of arable farming by society.
2. Market shares of **certified production forms**.

MEASURES

1. Establish a permanent network of arable farms (**“lead farms for crop production”**) that demonstrates the current status quo of innovative arable farming in a way that generates high publicity. These farms are already using many of the measures and techniques proposed in the Arable Farming Strategy. They may also serve as the point of contact for interested colleagues.
2. Create transparency for consumers on the market (**labels/certification of sustainable/biodiversity-compatible production in arable farming**). This would enable consumers to see at a glance in supermarkets whether cereals or other field crops come from arable farming that is particularly supportive of species diversity.
3. Develop and provide **teaching and information material** for all target groups and age groups in order to increase mutual understanding and appreciation. This includes, amongst other things, taking this topic to the Standing Conference of the Ministers of Education and Cultural Affairs of the federal states in Germany.
4. The subject of arable farming should also be intensively discussed in the nationwide **dialogue process** with society on agriculture that begins in January 2020. The lead farms for crop production can also play an important role in public relations work.

PROFITABILITY ANALYSIS

- A major contribution to rendering agricultural activities in modern arable farms understandable and tangible is to be made by a **nationwide network of “lead farms for crop production”**. The expenses incurred through public relations work and pilot projects on their land will be reimbursed to the participating farms. Additional financial resources are needed for this. The costs of individual measures are to be evaluated.



FLAGSHIP PROJECT

LEAD FARMS FOR CROP PRODUCTION (planned, BMEL-funded project)

In consultation with the federal states, a **network** of agricultural enterprises, the lead farms for crop production, will be set up to monitor and implement the Arable Farming Strategy. In these farms, the use of new measures of practical relevance, which are listed as measures in the Arable Farming Strategy, will be demonstrated during actual farm work and access given to the public at large, practitioners and different groups in society.

The purpose of the lead farms is **to pass on knowledge about sustainable crop production** (plant protection, fertilisation, soil fertility via content and increased levels of humus, crop diversity, biodiversity-compatible and insect-friendly special areas and many other measures). The conducted measures will be explained in the farms and rated in terms of their ecological relevance.

In the farms, knowledge about **farm services will be transferred** to society by holding field and farm days at relevant times. In this context, modern crop production systems with biodiversity-compatible and climate-friendly crop production will be presented in an authentic and credibly transparent manner.

As part of their **public relations work**, all these lead farms will have information material at their disposal for all types of visitors, from kindergarten children up to graduates from universities of the applied sciences. The Federal Information Centre for Agriculture (*Bundesinformationszentrum Landwirtschaft* – BZL) already has a large stock available.

The services of the lead farms will be evaluated and **remunerated within the framework of the network**.



12

MONITORING OF IMPLEMENTATION

INITIAL SITUATION

- Due to economic pressure, arable farming concentrates today on a few, economically attractive crops. Wheat, silage maize, winter barley and winter rapeseed account for two-thirds of crops grown in Germany. Arable farms here have **less and less scope for costly changes** when it comes to enlarging their range of crops and meeting other new requirements because of their seriously fluctuating and, generally speaking, declining incomes and strong competition from the world market.

ISSUE

- The consistent implementation of the models and goals of this Strategy will necessitate changes in arable farming. Corresponding changes, for instance, in the use of fertilisers and plant protection products, further crop rotations, greater consideration of biodiversity concerns and environmental requirements mean **additional costs**. But there will also be cost savings from the application of the principle of integrated farming and the avoidance of costs externalised up to now and incurred through environmental damage (nitrate pollution in drinking water, water pollution, loss of biodiversity). **Cost burdens and synergy effects must be weighed up against each other** and accompanied by corresponding programmes.

CONFLICTING GOALS

- Consumer demands for arable farming to deliver services of public interest are in conflict with the desire for low food prices.

GOALS

Political and financial monitoring of the implementation of the Arable Farming Strategy

1. In order to achieve the goals of the Arable Farming Strategy, **targeted support programmes** will be needed, particularly in the start-up and transition phases in order to support and facilitate the expenditure and investment required for this. Targeted support is possible, for instance, within the framework of the Joint Task for the Improvement of Agricultural Structures and Coastal Protection (GAK), and of other support programmes of the Federal Government.
2. Basically, **society as a whole must contribute to the changes it demands of arable farming**. Many of the services required of agriculture go beyond the statutory standards (for instance, in the field of environmental and climate protection) and are not remunerated by the market by means of corresponding product prices. The demands made of arable farming that go beyond statutory embedded services and serve the public interest must be evaluated in monetary terms. Increasing ecological and climate policy requirements and competitive crop production must not, however,

be mutually exclusive and the desired securing of income must be given equal consideration.

3. As arable farming in Germany is integrated into the European market, **uniform requirements** must also be devised in future for the further development of arable farming on the **European level**, and flanked by measures. The goal is to disseminate the Arable Farming Strategy on an international level in order to create largely uniform conditions of competition.

INDICATORS

1. Ongoing market analyses/opinion polls on the perception of arable farming in society.
2. Market shares of certified forms of production.

MEASURES

1. Draw up proposals for the restructuring of agricultural support, including the **adjusted remuneration for services of general interest** that arable farming provides.
2. Undertake an ongoing **economic assessment** of the individual measures in this Strategy.
3. Carry out an **impact assessment** of the economic and environmental effects of the Strategy, monitor and assess ecosystem services, the expected synergy effects and possible cost decrease effects (in terms of soil, crop rotation effects, biodiversity, climate, etc.).

4. Set up a “**Standing Monitoring Committee on the Arable Farming Strategy**”.
5. **Evaluate** the Arable Farming Strategy at five-yearly intervals.

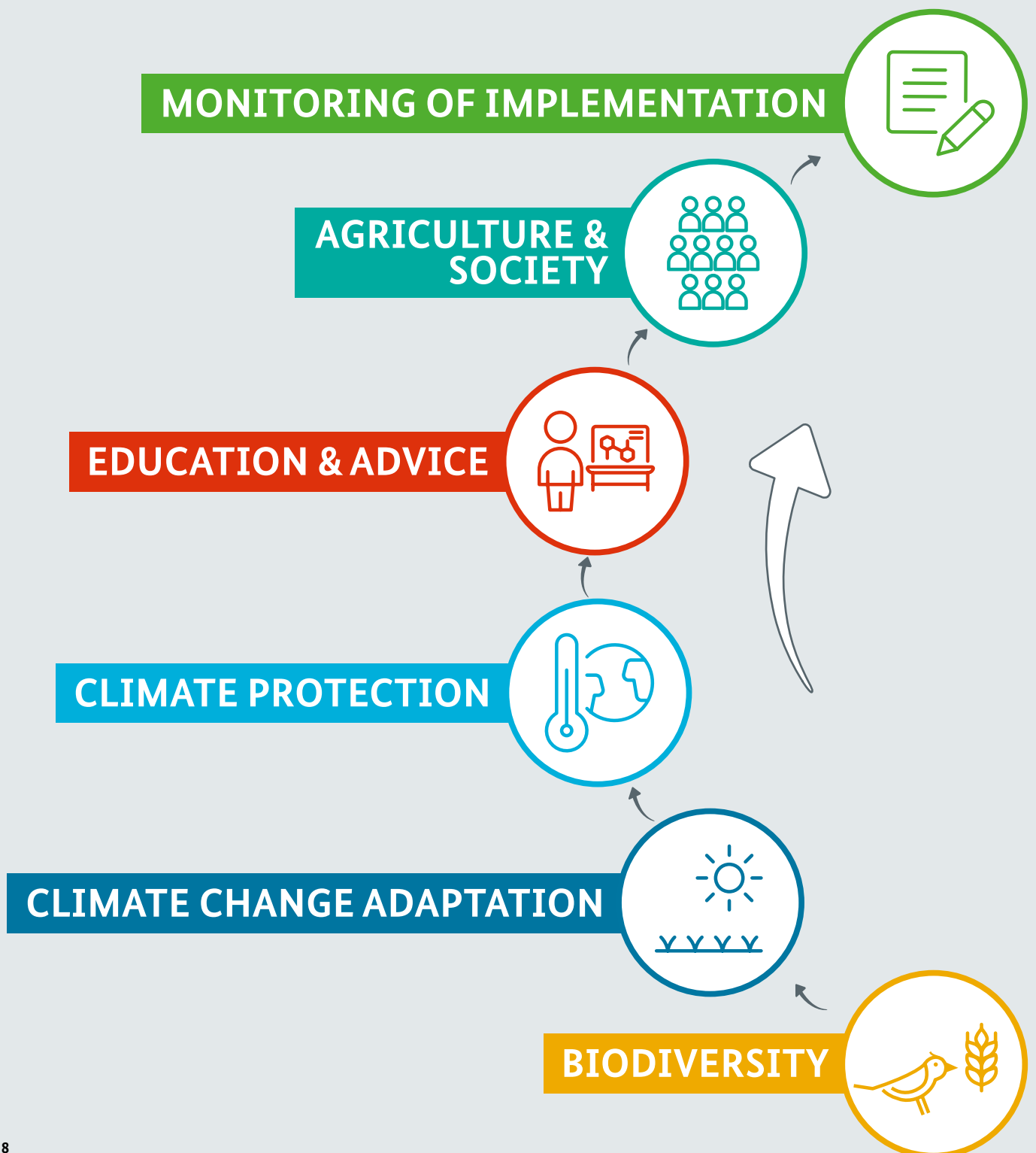


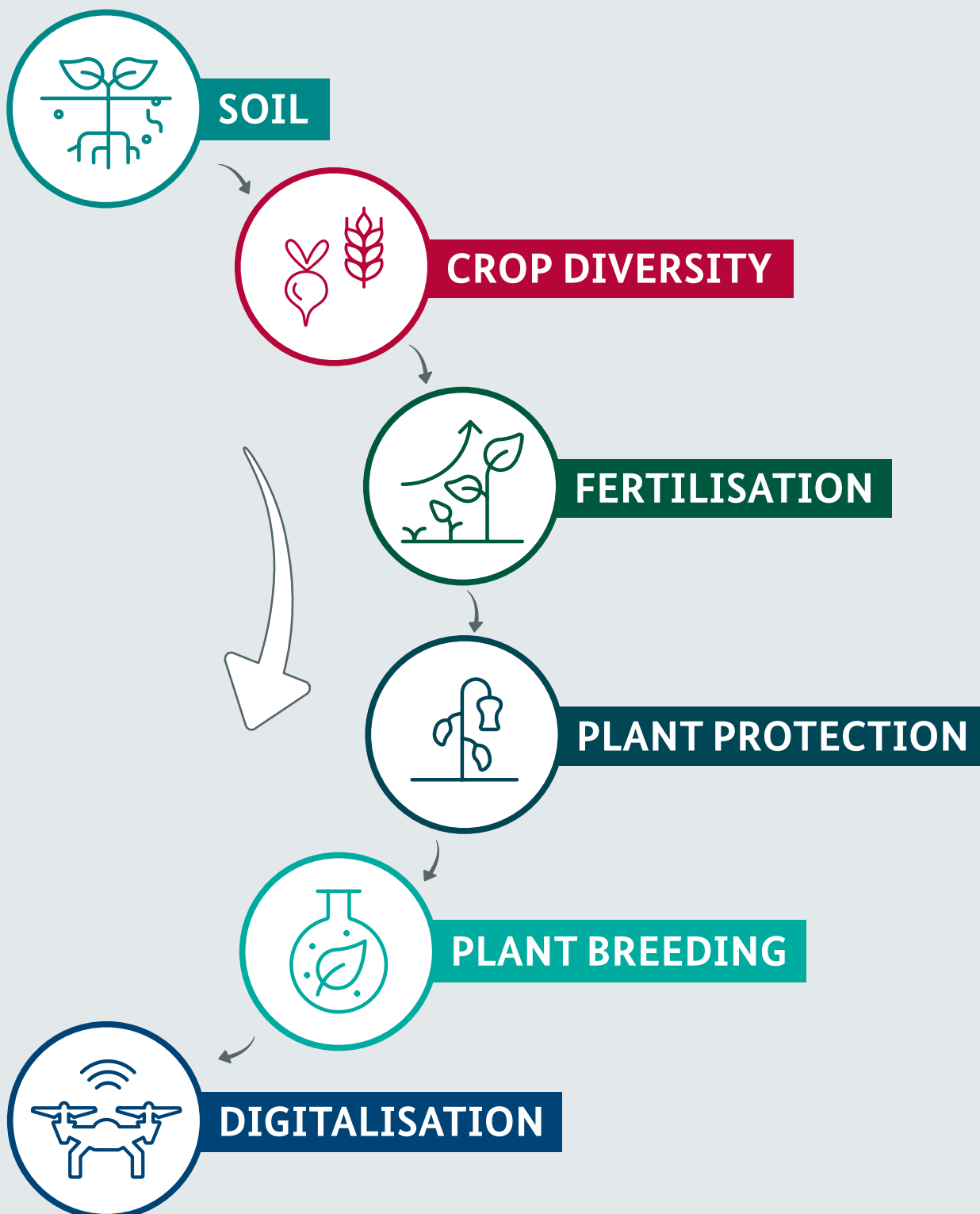
PROFITABILITY ANALYSIS

- In parallel to the implementation of the Arable Farming Strategy, the costs of the respective individual measures are to be determined and **synergy** effects assessed. Furthermore, a monitoring body will analyse the **economic impact** of the Arable Farming Strategy and suggest necessary improvements to the BMEL.



Action Areas of the 2035 Arable Farming Strategy





OVERVIEW

In Germany, arable farming provides the largest share of staple foods and feed and is, therefore, the **bedrock of our diet**. In recent decades, enormous improvements in performance have been achieved. This makes it possible to supply safe, high-quality foods. The high level of productivity in arable farming does, however, throw up **challenges** in terms of environmental protection, nature conservation, the economy and social acceptance. Furthermore, potential solutions must be found for existing **conflicting goals**.

The basics of the Arable Farming Strategy adopted in the **coalition agreement** of the 19th legislative term have been further developed by a **working group** containing scientists from the relevant field of expertise in the Federal Ministry of Food and Agriculture and a number of federal states. This Arable Farming Strategy has been drawn up on the basis of this preliminary work. An **expert group** has continuously monitored the work. With this Strategy, the Federal Ministry of Food and Agriculture has created the **foundations for further discussion** about the ongoing development of arable farming in Germany.

This Arable Farming Strategy is a **medium to long-term strategy**. It is not intended to be a **manual**. With this Arable Farming Strategy, the Federal Ministry of Food and Agriculture wishes to delineate the parameters for arable farming in Germany that is fit for the future, **to identify prospects and to actively support the agricultural sector in its implementation**.

Structure of the Arable Farming Strategy

The Arable Farming Strategy comprises **six guidelines and twelve areas of action**. The guidelines serve as the framework for the viable direction that arable farming can take.

Guidelines

1. Ensure the **supply** of food, feed and biogenic raw materials.
2. Safeguard the **income** of farmers.
3. Strengthen **environmental protection and resource conservation**.
4. Preserve biodiversity in agricultural landscapes.
5. Extend the contribution to **climate protection** and adapt arable farming to **climate change**.
6. Increase **social acceptance** of arable farming.

Areas of action

Issues and conflicting goals are described for each area of action in the Strategy. Goals and measures have been designed to provide solutions. The following **12 points** outline the underlying principles for the areas of action:

1. Further strengthen **soil protection** and increase soil fertility.
2. Increase **crop diversity** and extend crop rotations.
3. Increase **fertiliser efficiency** and reduce nutrient surpluses.
4. Strengthen **integrated plant protection** and reduce adverse environmental effects.
5. Develop resistant and site-adapted **species and varieties**.
6. Optimise the potential of arable farming with the help of **digitalisation**.
7. Strengthen **biodiversity** in agriculture.
8. Develop **climate-adapted** production methods.
9. Further develop **climate protection** in arable farming and use synergies.
10. Strengthen **education and advice**.
11. Increase **appreciation** of farmers.
12. Provide political and financial backing for the **implementation** of the Arable Farming Strategy.

Implementation of the Arable Farming Strategy/measures

Arable farming is a **complex system**; simple approaches to problem-solving are not expedient. For this reason, a number of individual measures have been described in this Arable Farming Strategy which can contribute to successfully tackling the challenges. A few of these **measures** are described here by way of example.

Many of the measures are directly intended for farmers and should thus support the further development of arable farming: for instance, the drawing up of **recommendations for action on humus formation** and carbon sequestration in agricultural soil and the **promotion of sales markets** for new and little-used species and varieties to widen the range of crops. Nutrient surpluses from agricultural fertilisation are to be reduced through the **Federal Nutrient Efficiency Programme**. The increased **development of organic and non-chemical plant protection methods** will strengthen sustainable crop production.

Measures such as the establishment and development of irrigation capacities and other measures in numerous areas are intended to **foster adaptation to climate change**.

In conjunction with the use of digitalisation, the Federal Ministry of Food and Agriculture is supporting the creation of the **statutory framework** and promoting the **development of innovative and digital technology**.

To accelerate breeding progress, the Federal Ministry of Food and Agriculture is supporting the **adjustment of the European provisions on New Plant-Breeding Techniques** in order to facilitate the use of these technologies in Germany in a legally certain context. With regard to biodiversity in agriculture, the Federal Ministry of Food and Agriculture is, for the first time, promoting the **nationwide monitoring of biodiversity in agricultural landscapes** in order to obtain representative data. Furthermore, there are plans to support the establishment of **regional stakeholder alliances** from agriculture, the environment and public authorities in order to plan and implement regionally coordinated biodiversity-promoting measures.

A greater appreciation of farmers will be encouraged by the establishment of **lead farms for crop production**, i.e. a nationwide network of agricultural enterprises. The lead farms will act as the contact point for interested members of the public and farming colleagues in order to demonstrate the current status quo in terms of innovative arable farming.

The next steps

This Strategy is the basis for a broad public discussion with all relevant stakeholders.

Annex: Assessment matrix

The assessment matrix below lists the measures in the Arable Farming Strategy for each of the fundamental goals and assesses their impact. The practicability of the measures (in the short, medium and long-term) is also

assessed. The assessment is based on the unpublished final report of the working team. This table does not contain an economic assessment of the measures.

- ++ very positive impact
- + positive impact
- o no direct impact
- negative impact
- very negative impact

No.	Measure	Supply	Protection of natural resources	Promotion of biodiversity	Climate change adaptation	Climate protection	Social acceptance	Practicability
Soil								
1.1	Develop site-specific recommendations for actions to increase soil fertility, in particular humus formation.	+	+	+	+	++	o	short
1.2	Try out and introduce new alternative production methods in arable farming within the framework of integrated crop production.	+	+	o	+	+	o	medium
1.3	Try out new concepts for the further development of minimum soil tillage or methods for mulch drilling/direct sowing in a different plant protection situation (e.g. no use of glyphosate from 2023).	o	o	o	+	+	+	short
1.4	Promote year-round soil cover, for instance, with perennial crops, catch cropping, undersowing, incorporation of harvest and catch-crop residues.	+	++	++	+	+	+	medium
1.5	Support protective mechanisms against soil compaction by means of adapted vehicle parameters: for instance, tyre pressure adjustment technology.	+	++	+	+	+	+	short
1.6	Gear land consolidation procedures more towards soil protection and erosion reduction.	+	++	o	+	+	+	medium
1.7	Amend land law in favour of a broad spread of land ownership and give priority to farmers in land acquisition to minimise land purchase by non-agricultural investors.	+	+	o	o	o	o	medium-long
Crop diversity and crop rotation								
2.1	Support crop growing tests to extend the range of crops in crop rotation.	+	o	+	+	+	+	short-medium

No.	Measure	Supply	Protection of natural resources	Promotion of biodiversity	Climate change adaptation	Climate protection	Social acceptance	Practicability
2.2	Develop decision-making aids for farmers on the site-appropriate growing of crops.	+	+	+	++	o	+	short
2.3	Support pilot and demonstration projects on regional bio-energy and bio-economy concepts, with due consideration also given to progressive, multi-annual renewable resources.	+	+	+	+	+	o	medium
2.4	Based on the Protein Plant Strategy model, support sales markets for (new) crops in future with projects along the entire value chain – from the breeder via the farmer to the market and consumers.	+	+	+	+	o	+	medium-long
2.5	Extend the spectrum of renewable resources for material and energy recovery as an alternative to maize and rapeseed; also support this, for example, as an agri-environment-climate measure.	o	o	+	+	o	+	medium
Fertilisation								
3.1	Draw up and implement a Federal Nutrient Management Programme.	+	++	o	o	+	o	short-long
3.2	Step up research on the nitrogen cycle.	+	+	o	o	+	o	short-medium
3.3	Set up a nationwide early detection system for nitrate loads that builds on the “nitrate loads” pilot and demonstration project.	o	o	o	o	o	o	medium-long
Plant protection								
4.1	Promote more intensively the development of biological and other non-chemical means and methods in plant protection.	+	+	+	+	o	++	short-long
4.2	Update and fine tune computer-aided forecasts and decision-making aids in plant protection.	+	+	+	o	+	o	medium
4.3	Establish specific damage thresholds for varieties, pathogens and groups of active ingredients.	+	+	+	o	+	+	short-medium
4.4	Set up pilot and demonstration projects on integrated plant protection plus (IPSplus) that build on the pilot and demonstration projects of integrated plant protection.	o	o	o	o	o	o	medium
4.5	Develop and ensure the availability of alternative and reliably effective plant protection methods for minimum, erosion-reducing soil tillage.	+	+	o	o	o	+	medium
4.6	Develop or review forecasting and damage threshold models for the use of low-risk products in plant protection.	+	+	+	o	+	+	short-medium

No.	Measure	Supply	Protection of natural resources	Promotion of biodiversity	Climate change adaptation	Climate protection	Social acceptance	Practicability
Plant breeding								
5.1	Develop new policy-making options for the New Plant-Breeding Techniques.	Not yet assessable						medium-long
5.2	Promote improvements to crop breeding in terms of tolerance, resistance and efficiency properties.	+	o	+	++	o	+	medium-long
5.3	Support the breeding of new and less used crops.	+	o	+	++	+	+	medium
5.4	Examine the inclusion of new descriptive variety properties (for instance, tolerance of biotic and abiotic causes of damage, nutrient efficiency, in particular nitrogen efficiency) in variety testing and the respective weighting in the assessment of value-determining properties.	+	o	o	++	+	o	short/medium
Digitalisation								
6.1	Set up an independent “quality control body” for assessment purposes as there are major quality differences in digital applications for agriculture.	o	o	o	o	o	o	medium
6.2	Develop innovative and digital technology for possible methods and work procedures for use in arable farming, particularly for soil tillage, fertilisation and, in the case of plant protection, to improve soil health and general efficiency in these sectors.	+	++	+	+	+	o	medium-long
6.3	Promote digital technology for small and medium-sized farms, too, and for multi-farm use.	+	+	+	+	+	o	short/medium
6.4	Create the statutory framework conditions for the use of digitalisation.	o	o	o	o	o	o	medium
6.5	Introduce nationwide coverage for RTK-GPS and ensure farmers have access to public data.	+	+	o	o	o	+	medium
6.6	Establish digital test sites on farms throughout Germany and thus provide nationwide information about sustainable technologies.	+	+	+	+	+	+	short-medium
6.7	Check the preconditions for how data produced in agriculture can be subject to control (“data sovereignty”) by the farmer, and are sufficiently protected from unauthorised access.	o	o	o	o	o	o	short-medium
Biodiversity								
7.1	Undertake systematic nationwide monitoring of biodiversity in agricultural landscapes (collaborative monitoring project of the BMEL (Mon-ViA)).	o	o	+	o	o	+	medium
7.2	Specify regional biodiversity goals and improve networking of biodiversity-promoting measures beyond farm boundaries.	o	o	+	o	o	+	medium
7.3	Build up regional stakeholder alliances consisting of agriculture, environment and local authorities to plan and implement regionally agreed biodiversity-promoting measures, and biotope alliance systems – based on the “Dutch model”.	o	o	++	o	o	+	medium
7.4	Introduce the “biodiversity” crop rotation element, for instance, as promotion of agri-environment-climate measures (AECMs).	–	o	++	o	o	++	short-medium
7.5	Dismantle administrative hurdles, minimise red tape for participation in biodiversity-promoting measures.	o	o	+	o	o	o	short-medium
7.6	Create structural elements to divide up large areas.	–	+	++	+	o	++	medium

No.	Measure	Supply	Protection of natural resources	Promotion of biodiversity	Climate change adaptation	Climate protection	Social acceptance	Practicability
Climate change adaptation								
8.1	Evaluate degree to which regions are affected and make region-specific recommendations for arable farming adapted to climate change (crop species, varieties and crop rotations, management methods, soil tillage, erosion protection).	+	+	o	++	o	o	medium-long
8.2	Test and integrate measures for climate change adaptation in crop production.	+	o	o	+	o	o	medium-long
8.3	Establish and extend additional irrigation capacities bearing in mind nationwide principles, for instance, on water withdrawal.	+	o	o	++	o	o	medium-long
8.4	Develop training in and advice on climate-smart arable farming (see also: area of action, education and advice).	+	+	o	++	o	o	medium
Climate protection								
9.1	Support projects to measure and reduce greenhouse gas emissions in arable farming.	o	o	o	o	+	+	short-medium
9.2	Develop management concepts for organic and mineral soils from the perspective of climate protection.	–	+	+	o	++	o	short-medium
9.3	Support agricultural enterprises in measures for carbon sequestration in soil (see: area of action, soil).	o	+	o	+	++	o	short-medium
Education and advice								
10.1	Develop and run seminars for advisory bodies and educators with regard to measures/options in the Arable Farming Strategy.	No direct impact				short		
10.2	Prepare information material on measures/options to be offered through the Arable Farming Strategy.	No direct impact				short		
10.3	Demonstrate individual measures as part of the lead farms for crop growing.	No direct impact				short-medium		
10.4	Intensify the prompt transfer of research findings to practice/ advisory bodies and ensure long-term implementation.	No direct impact				short		
10.5	Supporting measures from the Federal Government to strengthen the agricultural extension services of the federal states.	No direct impact				medium		
Agriculture and society								
11.1	Establish a permanent network of “lead farms for crop production” that demonstrates the current status quo regarding innovative arable farming in a way that generates high publicity.	No direct impact				++		short
11.2	Create transparency for consumers on the market (labels/ certification of sustainable/biodiversity-compatible production in arable farming).	No direct impact				++		medium-long
11.3	Develop and make available teaching and information material for all target groups and age groups.	No direct impact				+		short
11.4	The subject of arable farming will also be intensively discussed in the national dialogue forum on agriculture that begins in January 2020.	No direct impact				+		short
Monitoring of implementation								
12.1	Draw up proposals for the restructuring of agricultural support, including the adjusted remuneration for services of public interest that arable farming provides.	No direct impact				medium		
12.2	Undertake an ongoing economic assessment of individual measures in this Strategy.	No direct impact				short		

No.	Measure	Supply	Protection of natural resources	Promotion of biodiversity	Climate change adaptation	Climate protection	Social acceptance	Practicability
12.3	Carry out an impact assessment of the economic and environmental effects of the Strategy, monitor and assess ecosystem services, the expected synergy effects and possible cost decrease effects (in terms of soil, crop rotation effects, biodiversity, climate, etc.).	No direct impact						short-medium
12.4	Set up a “Standing Monitoring Committee for the Arable Farming Strategy”.	No direct impact						short
12.5	Evaluate the Arable Farming Strategy every five years.	No direct impact						medium-long

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