English

The JKI

Federal Research Centre
for Cultivated Plants

JKI Research Strategy

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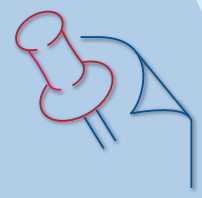


Development of resource-conserving, economically viable and socially acceptable crop production systems against the background of climate change

The JKI research strategy - in a nutshell

Against the background of current challenges and taking into account the latest scientific findings as well as the use of future-oriented innovations and technologies the research and development agenda of the Julius Kühn Institute, JKI in short, aims to improve the resilience and performance of crop production systems, to minimise the negative impacts of agricultural production on biodiversity and the environment and to avoid adverse effects on human and animal health. In view of the expected impacts of climate change crop production systems are to be developed, which are resource conserving, economically viable and accepted by society.

In this context, JKI is addressing the following **questions concerning the future**:

- a) What do resource-conserving, high-performance and economically viable crop production systems of the future look like? How can these be adapted to climate change and how can negative external effects be avoided in the future?
- b) How can the broadest possible crop diversity with well-supplied healthy plants be ensured in these crop production systems?
- c) How can such crop production systems be dynamically adapted to the changing societal conditions (e.g. shift in dietary patterns) and a future bio-based economy?

The following **research focal points** are derived from these questions:

- Crop diversity, genetic resources, biodiversity
- Plant plant raw materials
- Healthy crop plant
- Climate adaptation strategies
- Resource-conserving crop production systems

In order to be able to work on these fields comprehensively and transdisciplinary, JKI uses innovative methods and **tools**, such as omics technologies, digitilisation, bioinformatics, and more. The results are the basis for the development of holistic concepts for plant production.

I. Preamble

The agriculture of the future faces the challenge of ensuring food for a growing world population while having to protect the natural resources society uses at the same time. Achieving both goals equally is becoming increasingly difficult.

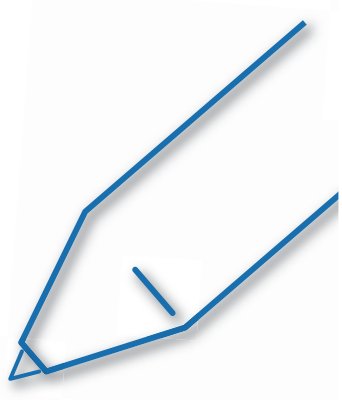
The specialisation of farms for economic reasons and the associated spatial concentration of animal, plant, energy and raw material production have led to the well-known negative consequences, such as large-scale farming units, accordingly dimensioned agricultural machinery, narrow crop rotations and transregional nutrient cycles. In addition, the liberalisation of the markets aggravated the economic situation of the farms.

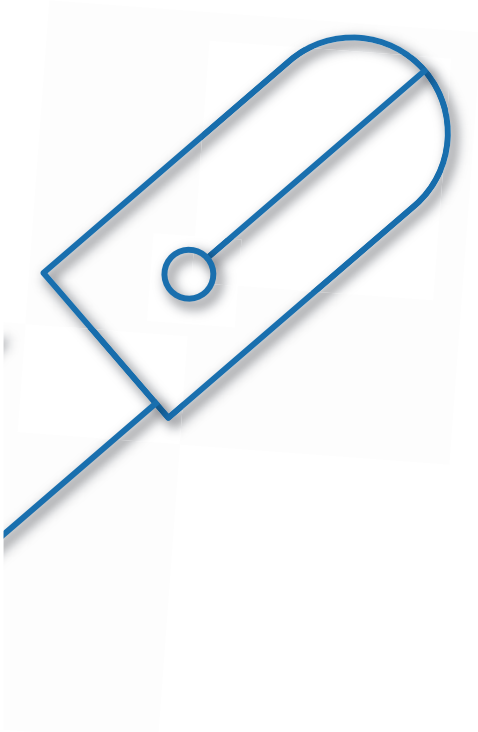
The consequence of this development shapes the landscape to a large extend and impacts the environment, the climate, the biodiversity and thus mankind.

Crop production in particular is caught in a conflict between economic constraints and ecological requirements, leading to increased discussions in society and politics. It is therefore necessary to explore the causes and effects of this conflict in more detail in order to develop future crop production systems that will be well accepted by society. The growing challenges posed by climate change, biodiversity loss and finite land resources must be taken into account while maintaining the efficiency of food production and bioeconomy.

Agriculture must serve more than before as a resilient, resource-conserving agricultural ecosystem with minimal negative effects on the environment. Material cycles in agricultural production must be re-established, strengthened and, if necessary, closed.

Securing tomorrow‘s resources





The natural resources such as soil, air, water, fossil energy and biodiversity must be preserved or promoted. This requires an optimal use of the means of production preferring environmentally friendly processes: it may thus be necessary to forego maximum yields on one hand and food at low prices on the other. Climate protection must also be a priority in agriculture, and appropriate production methods have to be used to minimise the effects of climate change.

All areas of crop production ought to be critically examined and assessed for their future viability. A holistic approach is necessary for this, starting with the avoidance of the introduction of non-native pests, through plant breeding, plant protection and plant cultivation all the way up to post-harvest procedures and stockpiling. In addition, greater consideration must be given to regional soil, climate and other ecosystem specifics. The development of high-performance, climate-adapted varieties and strategies to increase resource efficiency (e.g. nutrients, water, energy) are becoming increasingly important.

II. The JKI

As the Federal Research Centre for Cultivated Plants, the Julius Kühn Institute (JKI) covers all sectors of crop production, i.e. agriculture, forestry, horticulture and specialty crops.

JKI pursues the goal to ensure the future development of sustainable and climate-adapted production of healthy, high-quality crops by means of research and scientific policy advice, to develop the transformative processes required for this and accompanying their implementation. In doing so JKI contributes to the European Green Deal and the Farm-to-Fork strategy of the European Union (EU).

Digitalisation is becoming increasingly important in this context: in all its research fields, JKI uses the diverse potential of precision farming, geographical information systems, remote sensing, drones, sensors and autonomous agricultural machinery.

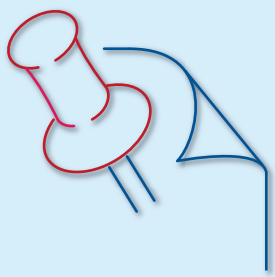
The research work targeting sustainable improvement of plants, their cultivation conditions and their usability must be economically viable, internationally competitive and socially acceptable. To this end, research must lay the scientific foundations for breeding adapted crops and combine knowledge from monitorings with studies on the effects of agriculturally relevant substances and the influence of production methods on different agricultural ecosystems.

The results of this interdisciplinary approach, which the JKI covers due to its broad expert knowledge, serve as a base to develop cultivation systems with smaller structures.

The economic as well as ecological evaluation of single measures and their effects on the protection of natural resources, biodiversity and the crops themselves is essential for the holistic observation of crop production and impact assessment.

III. Current challenges - contributions of JKI

Against the background of current and expected challenges, the aim of JKI's research and development work is to improve the resilience and performance of crop production methods, to minimise the negative impacts of agricultural production on biodiversity and the environment, and to avoid adverse effects on human and animal health, taking into account the latest findings and the use of future-oriented innovations and technologies.



Mission

Development of resource-conserving, economically viable and socially acceptable crop production systems against the background of climate change.

In this context, JKI is addressing the following **questions concerning the future**:

↳ a) What do resource-conserving, high-performance and economically viable crop production systems of the future look like? How can these be adapted to climate change and how can negative external effects be avoided in the future?

↳ b) How can the broadest possible crop diversity with well-supplied healthy plants be ensured in these crop production systems?

↳ c) How can such crop production systems be dynamically adapted to the changing societal conditions (e.g. shift in dietary patterns) and a future bio-based economy?

IV. Research focal points

- Crop diversity, genetic resources, biodiversity
- Plant raw materials
- Healthy crop plant
- Climate adaptation strategies
- Resource-conserving crop production systems

Research focus 1: Crop diversity, genetic resources, biodiversity

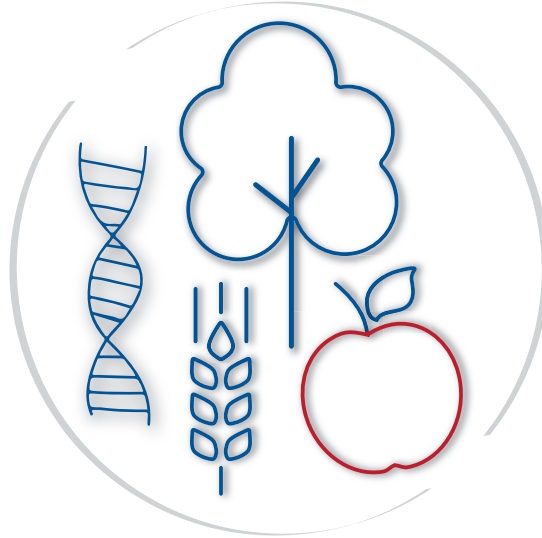
Crop diversity plays a central role in the land use systems of the future. Many problems of today's agriculture result from the limited diversity of our crop plants. JKI therefore aims to increase crop diversity and improve the biodiversity and ecosystem services of agricultural production systems.

A key role in increasing crop diversity and improving varieties in terms of their suitability for resilient production systems is played by plant genetic resources.

JKI makes important contributions to safeguarding plant genetic resources for food and agriculture within the framework of its participation in the strategies of the Federal Ministry of Food and Agriculture (BMEL) (Agrobiodiversity Strategy, National Technical Programme ‚Plant Genetic Resources') and its collaboration in national and international committees. JKI develops strategies for the conservation of breeding-relevant wild species in their natural habitats (*in situ*) and of cultivated species in the context of agricultural use (*on farm*).
Of particular importance with regard to the adaptation of our crop species to changing production conditions is the evaluation and characterisation of genetic resources at physiological, metabolic and molecular level using so-called omics technologies and their utilisation through breeding research and pre-breeding. The collection and conservation of fruit and vine genetic resources in gene banks (ex situ) and their evaluation, including the documentation of data in public databases, are further important fields of action.

Agriculture is now held responsible as one of many causes for the current decline in biodiversity in Germany. JKI is playing a key role in setting up long-term monitoring to record the state of biodiversity in agriculture using reliable data. In addition, JKI is looking for the causes of the decline in biodiversity and for ways to promote biodiversity in the agricultural landscape. For example, optimised cultivation systems are being developed that contribute to the protection and promotion of endangered animal and plant species.

This also includes expanding the diversity of crop species by integrating neglected and new crop species. In addition, work is being done on optimising plant protection and cultivation methods in order to protect beneficial organisms, pollinators and other non-target organisms and to open up development potential for them.



Research focus 2: Plant raw materials

Cultivated plants are the basis of nutrition for humans and animals. It is important to produce these in sufficient quantity and quality under changed production conditions and changing demand.

One challenge is the transition from a fossil-based economy to a bioeconomy in which fossil raw materials are successively substituted by biobased raw materials. These include specific carbohydrates, e.g. from cereals and sugar beet, special fatty acids from oil plants such as rapeseed, sunflower and linseed, but also fibres from linseed or nettle as well as active ingredients from medicinal and spice plants. Their uses are diverse and include biopolymers, construction and insulation materials, fibre composites, growing media (e.g. as peat substitutes) and valuable raw materials for human and animal health.

The aim of JKI's research is the sustainable production and efficient, cycle-oriented use of biogenic raw materials while preserving soil fertility, protecting the environment (especially water and air quality) and maintaining or increasing biodiversity.

The crops are analysed with regard to the type and content of quality-determining ingredients, active ingredient yield, energy content, their ability to be integrated into sustainable cultivation systems and the possibilities of environmentally sound plant protection.

This is particularly true for species that are not cultivated or only cultivated to a small extent and their integration into existing crop rotations. Cascade utilisation or new utilisation options for residual materials or co-products are also being examined.

Research focus 3: Healthy crop plants

Our crops are exposed to a wide range of pests, which are increasingly introduced species or species spreading due to climate change, which affect the performance, i.e. the yield and quality of the crops.

The plant protection methods used to combat these harmful organisms have so far been based primarily on synthetic chemical agents. Society and politics are increasingly demanding a timely reduction of chemical methods (Farm-to-Fork Strategy, National Action Plan for the Sustainable Use of Plant Protection Products).

With a focus on the development of non-chemical agents and methods as well as preventive phytosanitary measures, JKI investigates the biology of weeds, pathogens (bacteria, fungi, viruses, etc.) and pests (insects, mites, nematodes, vertebrates, etc.) as well as the ability of crop plants to protect themselves against them.

Investigations of the interactions between crop plants, biotic pests and their natural counterparts are an integral part of the research.

Another focus of work is the recording of the genetic basis of resistance properties and their utilisation and improvement up to breeding new varieties in fruit and vines. This serves the holistic approach and the development of sustainable strategies for the reduction of biotic stress factors and the promotion of healthy crops. In designing such strategies, JKI responds to the demands from society and government to use more non-chemical means and methods to protect crops. The aim is also to introduce these strategies into practice and integrate them into cultivation systems in a timely manner.

Research focus 4: Climate adaptation strategies

Climate change has a significant impact on crop production conditions. Extreme weather events, such as drought, heat, high solar radiation, heavy rain and hail, are among the abiotic stress factors that cause the greatest yield losses and quality reductions in crops.

Climate adaptation strategies aim to reduce both climate-relevant emissions and harmful effects of climate change on production systems, or to exploit positive effects, e.g. by increasing CO2 levels and lengthening the growing season.

Crop production must be adapted to climate change, associated with higher temperatures, changes in precipitation distribution, more frequent and more severe extreme weather events or changes in the occurrence of pests, in order to ensure food supply in the future and at the same time conserve resources such as soil and water.

JKI's specialised institutes in the fields of breeding research, plant protection and crop production are working on integrated strategies to strengthen the resistance of our crops to abiotic stress in order to be able to meet these requirements in the future.

Regional differences in both the affectedness and the adaptation options are of central importance in this context. The knowledge gained is used to forecast and model scenarios in order to be able to use suitable climate adaptation strategies in the cultivation of our crops.

JKI's research therefore aims to develop new crop production strategies that include suitable crops, varieties and locations and climate-adapted cultivation methods.

The general objective is to support and ensure the cultivation of our crops under changing climatic conditions.

Research focus 5: Resource-conserving crop production systems

For the sustainable and environmentally friendly use of the resources necessary for crop production, it is important to optimally use the means of production, to regulate or limit their use if necessary, and to develop alternative environmentally friendly, economically viable processes.

Comprehensive resource protection includes recording and assessing the status quo in the cultivated land. This is to be done through appropriate measures, such as monitoring and recording potential impacts of crop production on the environment and climate.

Through assessment of the possibilities to minimise any negative impacts, recommendations for the use of production inputs can be derived and sustainable production processes can be designed. Important sub-aspects here are the examination and evaluation of the effects of the use of production methods and the selected production processes on the protection of the resources like water, air, soil, climate, but also animals, plants, micro-organisms and their biocoenoses.

In addition to the respective evaluation of individual measures, a consideration of the entire cultivation system including the evaluation of ecotoxicological effects and subsequent risk-benefit assessment is required. The general aim of the work in this research focus is therefore to develop suitable measures and procedures that sustainably conserve production areas as well as the natural resources of soil, water and air, strengthen the health, resilience and resistance of crops and protect beneficial organisms including honey bees and other pollinators.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