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CORDIS Results Pack on

agroecology

A thematic collection of innovative EU-funded research results

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Growing a more sustainable farming and food system



Research and Innovation

NEW EDITION

Contents

3
Sharing knowledge between Europe's organic fruit farmers

5
Breeding climate-resilient crops for organic agriculture

7
New contracts to boost innovation in green public goods

9
Incentivising farmers to adopt greener agriculture

11
Cultivating transnational research in organic farming

13
Increasing the use of crop diversification across Europe

15
Giving momentum to legume breeding

17
A tool to help farmers control weeds without relying on herbicides

19
Phasing out contentious inputs from organic – and conventional – agriculture

21
New agroecological approaches to scale up organic farming

23
Living labs bring agroecology potential to life

24
A pan-European network to boost agroecology

25
Sowing organic agriculture's future with better seed stock

26
Sustainable systems and policies for future permanent grasslands

Editorial

Growing a more sustainable farming and food system

The EU has set ambitious targets for the agricultural sector. Not only do Europe's farmers need to ensure a reliable supply of high-quality food – fruit, vegetables, nuts, cereals and animal products – and non-food products at competitive prices, they must also deliver on the environmental commitments of the EU Green Deal and farm to fork strategy.

Over the last 70 years, the farming sector has achieved great success in the first goal, but this has often come at the cost of environmental degradation, land and water pollution, negative impacts on biodiversity, and a high carbon footprint.

Agroecology offers a way to couple the EU's food production needs with environmental stewardship and climate ambitions. It has been identified as an approach that can be supported through the eco-schemes under the first pillar of the revised common agricultural policy.

Horizon 2020 and its successor, Horizon Europe, are playing a key role in developing agroecology in Europe by supporting specific research and innovation projects. Through breeding programmes, field trials, novel technologies, living labs, stakeholder networks, policy recommendations and more, EU-funded research is increasing agroecology's knowledge base and methods, and is strengthening the EU's R&I system for agroecology.

The importance and potential of agroecology has been underscored by the food security crisis caused by the war in Ukraine, and the need for sustainable farming approaches that reduce the agricultural sector's reliance on inputs from outside of the EU.

The European Commission, EU Member States and countries associated with Horizon Europe, coordinated under a Strategic Working Group on Agroecology within the Standing Committee on Agricultural Research (SCAR), have co-created the foundation for a future Horizon Europe partnership on 'Accelerating farming systems transition: agroecology living labs and research infrastructures', to be tentatively launched in 2024.

The overarching goal of this partnership is to align EU and national research agendas in this promising research area to tap into the potential of agroecology to accelerate the transition towards resilient, sustainable, climate-, ecosystem- and social-friendly farming systems. The research and innovation activities will also support the objectives of the new organic action plan, in line with the Commission target to have at least 25 % of agricultural land under organic production by 2030.

This new Results Pack on Agroecology presents 14 EU-funded research projects that are helping to shape the future of farming. These projects are contributing to an increased understanding of the practical implementation of agroecological practices, along with their environmental, climate, economic and social benefits. By sharing these successes, we hope to inspire and mobilise stakeholders to work together to scale up this important research area.

Sharing knowledge between Europe's organic fruit farmers

Organic farming is growing in popularity, but specialist knowledge is often restricted within national borders. The EU-funded BIOFRUITNET project worked to overcome this bottleneck.

Organic farming is growing quickly in Europe. However, in 2020, only 9.1 % of the total agricultural land across the EU was dedicated to organic production. Under the EU Green Deal, the farm-to-fork strategy set the goal of having 25 % of the EU's agricultural land under organic farming by 2030.

Organic farming is challenging and technically demanding. Farmers are faced with a range of difficulties for which they cannot turn to conventional solutions, such as soil and fertilisation management, and crop protection. Many European organic farmers have developed their own agroecology strategies to improve plant health and optimise organic agriculture, yet much of this knowledge is not spread widely, in part due to linguistic and geographical barriers.

"There is already a culture of sharing information through formally or informally established knowledge exchange networks in Europe," says Sophie Egerer from Naturland, BIOFRUITNET (Boosting Innovation in Organic FRUIT production through strong knowledge NETworks) project coordinator. "However, these networks are mainly active at local level, and information on existing practical knowledge in particular is barely crossing regional or national borders."

The EU-funded BIOFRUITNET project aimed to overcome this communication problem, by creating a knowledge network – both online and physical – to collect and share local and scientific knowledge on organic fruit farming across the EU in local languages.



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"The contribution to making knowledge about organic farming much more accessible for farmers across Europe delivered by BIOFRUITNET is considered a strong effort in fostering the transition toward a greener EU," notes Egerer.

Identifying existing farming knowledge

The BIOFRUITNET team first surveyed farmers, advisers and their associations to map out existing knowledge exchange networks across the EU and neighbouring countries.

A second survey, which reached around 250 farmers and advisers across 12 EU countries, helped the BIOFRUITNET team identify and define which pests and diseases are of the greatest concern in organic orchards. This also revealed the adoption level of orchard management practices suitable for organic farming, particularly those related to variety choice, fertilisation, functional biodiversity and crop protection.

"We could obtain an up-to-date and accurate picture of the challenges faced by organic fruit farmers throughout Europe, and identify the topics where BIOFRUITNET could be most beneficial to them," adds Egerer.

The team then reviewed existing scientific and 'grey' literature to prepare a wide range of communication materials, to overcome the language-barrier bottleneck. Now available in 10 languages, these included 30 short technical videos, 100 practice abstracts, five podcasts and three e-learning courses – each comprising four to five modules of about half an hour each.

A growing European organic knowledge web

BIOFRUITNET's new knowledge materials provide a solid basis of training on organic fruit growing, while the communication networks will allow for increased direct sharing of knowledge between Europe's organic fruit farmers.

"The creation of a European web of knowledge networks has been conceived to maintain and further develop the transfer of know-how in the future," Egerer says.

The EU web of knowledge networks is also designed to ensure continuation of the project's work beyond its end.

Information on existing practical knowledge is barely crossing regional or national borders.

As the project went beyond EU borders, integrating knowledge networks from non-member countries in Europe and the Mediterranean, its impact would benefit a wider transition to a greener agriculture. "Among these are countries where organic fruit production is still in its infancy and thus there is a huge potential for the transition towards organic farming," concludes Egerer.

PROJECT
BIOFRUITNET – Boosting Innovation in Organic FRUIT production through strong knowledge NETworks

COORDINATED BY
Naturland in Germany

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/862850

PROJECT WEBSITE
biofruitnet.eu

Breeding climate-resilient crops for organic agriculture

To tackle the nutritional challenges for a growing world population in a context of changing climatic conditions, the EU-funded BRESOV project aimed to enhance the productivity of vegetable crops in organic farming.



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The global population is estimated to reach 9.8 billion by 2050. Coupled with changing climatic conditions, this presents a huge impending risk to food security in the 21st century.

Organic agriculture must both increase and evolve to face these challenges. Farmers will need crops that maintain nutritional value and are able to deal with multiple unprecedented stressors in the coming decades. Without new climate-resilient crops, many small farmers across the EU will go out of business as their plants stop producing seeds.

The BRESOV (Breeding for Resilient, Efficient and Sustainable Organic Vegetable production) project, which runs until April 2023, is working to discover and enhance the genetic resources of organic crop production for farmers throughout the EU and beyond. Through breeding programmes, BRESOV is exploring the genetic diversity of three economically significant crops: broccoli, green bean and tomato, improving the competitiveness of these crops for use in organic farming.

"The BRESOV consortium's overall aim is to increase the plants' tolerance to biotic and abiotic stresses and adapt these varieties to the specific requirements of organic and low-input production processes," explains Ferdinando Branca, associate professor of Horticulture and Floriculture at the University of Catania in Italy, and BRESOV project coordinator.

Finding the right genetic resources

Before any climate-resilient crops could be bred, the BRESOV team had to find the right genes. The consortium assembled a series of crop collections, including many different morphotypes from each crop.

The researchers then read and compiled the genetic data for each of these crops, in order to find those parts of the code related to specific characteristics. These traits include good taste, high nutritional value, and resistance not only to pathogens and pests, but also to a range of abiotic stresses like heatwaves and drought.

With this information, BRESOV could begin breeding organic crop cultivars to test their characteristics in real-life conditions.

Breeding for climate resilience

In a series of trials, members of the BRESOV consortium grew thousands of plants, including landraces (domesticated crops), inbred lines, commercial cultivars and their wild relatives.

Others were selected and introduced due to their qualitative traits – such as colour, size and structure – and nutritional value (quantity of antioxidants, polyphenols and glucosinolates).

Our selection showed precious sensorial, nutritive and nutraceutical traits for the three considered crops, and will help ensure food security in Europe and beyond.

The key results from the project include the development of new resilient cultivars and crops, with improved organoleptic and nutritional qualities, says Branca. BRESOV's work will also feed into organic agronomic practices, by increasing the production of high-quality organic seeds. Furthermore, the team developed advanced tools to control the sanitary quality of organic broccoli, snap bean and tomato seed lots.

"Our selection showed precious sensorial, nutritive and nutraceutical traits for the three considered crops, and will help ensure food security in Europe and beyond," says Branca.

Helping to secure the future of food

The BRESOV consortium consists of 22 partners from nine EU Member States, in addition to members in China, South Korea, Switzerland and Tunisia.

The results acquired by BRESOV activities, and the elite crop genotypes will be disseminated until the end of the project and during the final project conference, expected at the end of March 2023.

"We hope that our project outputs will contribute significantly towards developing context-specific climate-resilient organic production systems in the face of the imminent climate change scenarios," concludes Branca.

PROJECT
BRESOV – Breeding for Resilient, Efficient and Sustainable Organic Vegetable production

COORDINATED BY
University of Catania in Italy

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/774244

PROJECT WEBSITE
bresov.eu

New contracts to boost innovation in green public goods

Innovation is needed to promote the creation of environmentally friendly public goods. The EU-funded CONSOLE project developed a new contractual framework to support their development.

Forestry and agriculture form core parts of Europe's economy and society, creating millions of jobs for European citizens. Around 70 % of land across the EU is dedicated to forests or agriculture, providing a vast amount of natural capital.

Nevertheless, there is a need to innovate in the delivery of agri-environmental-climate public goods (AECPGs), such as clean water, and landscapes that harbour and boost biodiversity.

These are especially important in light of recent initiatives launched by the European Commission, including the European Green Deal, the farm to fork strategy, and the biodiversity strategy for 2030.

"Public goods are usually not provided enough through the market, so public policy intervention is needed," says Davide Viaggi, a professor in the Department of Agricultural and Food Sciences at the University of Bologna. "Innovative solutions are needed," he adds.



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Developing a community of practice

In the EU-funded CONSOLE (CONtract SOLutions for Effective and lasting delivery of agri-environmental-climate public goods by EU agriculture and forestry) project, Viaggi, the project coordinator, and his team aimed to develop innovative contracts to support the provision of AECPGs. The CONSOLE team built a 'community of practice' (CoP) – with multidisciplinary teams in 13 countries working to create a new contractual framework. This included agriculture organisations, research institutions, regional administrators, and forest and water management bodies.

Public goods are usually not provided enough through the market; innovative solutions are needed.

"A community of practice is a group of people who share a concern for something they do – in our case having a role in AECPG-related measures – and learn how to do it better through regular interaction," Viaggi explains. "It can help public administration, farmers and other actors to know each other and understand each other's viewpoint, as well as exchange ideas on innovative solutions and learn from each other's experiences."

Co-creation of new contracts

CONSOLE first researched existing contract solutions, creating a collection of over 60 case studies to be analysed and learned from. The team then surveyed around 2 700 land managers and 500 other stakeholders in 12 different countries. Finally, the CONSOLE team modelled a range of new contracts.

The project focused on four contract types: specific environment-related tenure contracts; results-based approaches such as payments based on environmental performance; collective implementation for groups of farmers or others to work together; and value chain and private-public solutions, where AECPGs can be valued on markets.

The framework is available online as a web application, which includes real-life case studies. The project team hopes that it will help in the design of new contracts for the provision of AECPGs.

"The idea is to have it growing over time to support decision makers in the different steps of designing new contracts, hence boosting the use of better solutions and finally a better delivery of AECPGs to meet broader EU objectives," adds Viaggi.

Boosting potential for agroecology

The project could increase the uptake of technologies related to agroecology, and the provision of public goods, Viaggi says: "There is a huge potential contribution of contracts studies, and in general socio-economic research, to agroecology. Unfortunately there is no standard recipe for these solutions. However, a consistent understanding of the different design and implementation options and of how they affect the desired outcome can greatly increase the diffusion of new technologies."

PROJECT
CONSOLE – CONtract SOLutions for Effective and lasting delivery of agri-environmental-climate public goods by EU agriculture and forestry

COORDINATED BY
University of Bologna in Italy

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/817949

PROJECT WEBSITE
console-project.eu

Incentivising farmers to adopt greener agriculture

Agriculture's benefits to the environment can be increased if current practices are transformed. The EU-funded Contracts2.0 developed a series of farming approaches that balance productivity with sustainability.



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An evolution in agriculture could help mitigate the impacts of two major ongoing crises: climate change and the decline of biodiversity.

Currently, farmers can participate in agroecology and climate schemes, and receive financial compensation for efforts to carry out conservation measures on their land. However, effective implementation and monitoring of these schemes can be complex, which is hampering their wide adoption by farmers across the EU.

"Current schemes are often inflexible and do not consider the reality of geographical differences," explains Bettina Matzdorf, social scientist at the Leibniz Centre for Agricultural Landscape Research, and project coordinator of Contracts2.0 (Co-design of novel contract models for innovative agri-environmental-climate measures and for valorisation of environmental public goods).

She adds: "Novel contracts that offer payments by results, that foster the collaboration of farmers, could better incentivise them to produce not only agricultural products but also biodiversity and other ecosystem services."

Landscape-scale solutions

The EU-funded Contracts2.0 project developed innovative approaches to make these schemes more effective and enticing to farmers.

The overall idea was to incentivise farmers to produce more environmental public goods: non-exclusive, non-expendable products such as attractive landscapes. The Contracts2.0 team wanted to find out which contract models enhance the provision of such environmental public goods, while at the same time enabling economically viable agricultural production.

"The solutions to many of our biodiversity, water and climate goals need to be delivered at the landscape scale," says Matzdorf.

To find which approaches might work best, the team examined a range of results-based and collective agri-environmental climate schemes. They also considered land tenure approaches, as well as looking further down the value chain at ideas such as private payment schemes based on certificates.

"We analysed existing examples around Europe, tested new contract designs within economic experiments, and co-developed solutions on the ground," Matzdorf notes. The team also researched the necessary policy framework conditions for implementing new schemes in nine different EU countries.

Creating innovation in the field and online

The Contracts2.0 project created 11 contract innovation labs across Europe, bringing together farmers, scientists and environmental experts to develop new, feasible solutions that could be placed into contracts. These were complemented by policy labs, which brought policymakers in particular to the table to develop appropriate policy frameworks.

Beginning in 2019, the team held a series of field trips, to encourage the exchange of knowledge, demonstrate best practice examples, and make the approaches and goals tangible. "Practitioners emphasised the importance of learning from each other. The trips facilitated the exchange between stakeholders from different labs, but we also participated as researchers," says Matzdorf.

During the pandemic the team had to replace in-person workshops with 'virtual' events on agro-eco themes. The online format, free access and invited experts facilitated the great success of the workshops.

The future of sustainable food

Matzdorf highlights that the collaboration between farming practice, policy and science in many European countries, meant that a vast variety of circumstances, farming types, landscapes and policy environments were considered. "I do think we have been able to move some pebbles in the river towards better contracts for agriculture and nature," she remarks.

The project also produced a catalogue of factors facilitating and hindering existing approaches, and a guideline for policy framework fostering contract-based approaches and the development of appropriate agri-environmental-climate policies.

Current schemes are often inflexible and do not consider the reality of geographical differences.

PROJECT
Contracts2.0 – Co-design of novel contract models for innovative agri-environmental-climate measures and for valorisation of environmental public goods

COORDINATED BY
Leibniz Centre for Agricultural Landscape Research in Germany

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/818190

PROJECT WEBSITE
project-contracts20.eu

Cultivating transnational research in organic farming

The EU-funded CORE Organic Cofund project is a network of European ministries and research councils dedicated to funding research in organic farming and farming systems.



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One of the best-defined paths towards sustainable agriculture and food production is organic farming. "Due to the lack of plant protection products and the use of a wider variety of crops, organic farming can improve soil health, decrease pollution and promote biodiversity, making it a sustainable alternative of choice in food production," explains Ivana Trkulja, a CORE Organic coordinator at the International Centre for Research in Organic Food Systems.

However, to truly reap the benefits of organic farming, it must be implemented at scale. "Together with individual organic farms, which is what we have, we need to build an ecosystem of organic agriculture," says Trkulja.

Helping to build such an ecosystem is the EU-funded project CORE Organic Cofund (Coordination of European Transnational Research in Organic Food and Farming Systems Cofund).

A proven track record

Established in 2004, CORE Organic is a network of European ministries and research councils dedicated to funding research in organic food and farming systems. "By joining forces across organisations and Member States, we are able to better support transnational research projects addressing some of the most important challenges along the organic value chain," adds Trkulja.

Over the past 18 years, the programme has held eight transnational calls and has provided EUR 61.9 million in funding to 62 research projects. These calls have involved researchers from all partner countries, including smaller countries and countries from eastern Europe. The calls have covered agroecology topics such as animal disease, cropping systems, mixed animal and plant production, animal feed, organic food processing, and circular and zero-waste food systems.

"CORE Organic has a proven track record of building capacity and competency in organic research," remarks Trkulja. "As a result of these funded projects, not only has Europe seen an increased interest in organic agriculture, it is also seen as a core enabler of a sustainable, climate-resilient and circular food system."

Due to the lack of plant protection products and the use of a wider variety of crops, organic farming can improve soil health, decrease pollution and promote biodiversity.

During the CORE Organic Cofund phase, the network launched three transnational research calls. Following an independent call in 2016, the network collaborated with the SUSFOOD2 Cofund to launch a 2019 call on sustainable and organic food systems. The integration of system thinking established by the 2019 call was further advanced by a 2021 call on organic farming systems for improved mixed plant and animal production.

In total, the cofund phase involved 29 funding organisations from 21 countries/regions that supported 29 projects.

Achieving the targets of the Green Deal

Even with more than a decade-and-a-half of success under their belt, Trkulja says that CORE Organic is just getting started. "There are still challenges that need to be addressed, especially with the ambitious European Green Deal target of making 25% the EU's farmland organic by 2030."

To achieve this goal, CORE Organic Pleiades, the programme's phase launched in September 2022 under the umbrella of the EU-funded OrganicTargets4EU project has its full focus on understanding the implications of the Green Deal's organic farming targets.

In the meantime, CORE Organic maintains its mission of coordinating the research investments needed to facilitate further innovation in the organic farming sector. "The CORE Organic network has provided a much-needed level of continuity," concludes Trkulja. "This ensures that funding has a lasting impact and that the organic research community is well-positioned to address current and emerging challenges."

PROJECT
CORE Organic Cofund – Coordination of European Transnational Research in Organic Food and Farming Systems Cofund

COORDINATED BY
Aarhus University in Denmark

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/727495

PROJECT WEBSITE
projects.au.dk/coreorganiccofund

Increasing the use of crop diversification across Europe

To succeed, cultivars must be selected to match local conditions. Researchers with the EU-funded DiverIMPACTS project worked with farmers to develop tailored diversification strategies.

Today's agriculture is often characterised by large fields growing a limited number of crops. While this model has helped increase the sector's economic efficiency, it has also made farming less resilient and increasingly reliant on the use of chemical fertilisers and pesticides.

The lack of crop diversity, in combination with the use of fertilisers and pesticides, has often led to high incidences of pests and diseases, soil erosion, loss of soil fertility and pollution, and a decrease in biodiversity.

"What was originally meant to support the agricultural sector now threatens its very existence," says Antoine Messéan, research manager at INRAE, the French National Research Institute for Agriculture, Food and Environment. "As such, modern agriculture has become unsustainable."

For researchers like Messéan, the solution to agriculture's sustainability problem lies in diversification. "Crop diversification has the potential to improve agrobiodiversity and support the ecological processes that are necessary for the sustainable production of agricultural products," he explains.

As coordinator of the project DiverIMPACTS (Diversification through Rotation, Intercropping, Multiple cropping, Promoted with Actors and value-Chains Towards Sustainability), Messéan is leading an effort to increase the use of crop diversification across Europe.



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Working together with farmers

As Messéan explains, crop diversification involves increasing crop diversity within a field, both in space and across time. "It means moving away from today's highly simplified cropping systems and towards diversified cropping systems characterised by longer rotations, the growing of multiple crops, intercropping, or a combination thereof," he says.

Crop diversification offers numerous benefits, including a reduced dependence on fertilisers and pesticides, a more efficient use of resources, and an increase in production and nutrition. "This practice can reduce risks and increase resilience to environmental changes by diversifying one's income streams, restoring biodiversity and soil quality, and protecting crops against the effects of climate change," adds Messéan.

While the transition to crop diversification may sound straightforward, according to Messéan, it's easier said than done. "The benefits of this diversification vary depending on local conditions, which means there is no one-size-fits-all solution," he explains.

Messéan says that there's also a series of technological, organisational and institutional barriers all along the value chains and within the sociotechnical system (policies, education, research, regulation). "Local farmers need to understand the process and be given the support they need to make the transition to crop diversification," he remarks.

This is where the DiverIMPACTS project comes into play. Working hand-in-hand with local farmers and agricultural stakeholders, researchers supported 25 multi-actor case studies and a number of agroecology field experiments. For example, a case study in Germany looked at how crop diversification can improve water quality stability, while in Romania researchers studied how farmers could diversify cereal-based rotations under adverse conditions.

"By codesigning solutions with local actors and assessing the sustainability of crop diversification at different levels, we were able to identify critical points to help develop diversification strategies tailored to local needs while also meeting agriculture's urgent sustainability needs," notes Messéan.

Helping farmers make the transition to crop diversification

With the insights gained during these case studies and experiments, the project has developed strategies for farmers and the agri-food sector. They also served as the basis for several policy briefs to help policymakers understand the importance of crop diversification and develop mechanisms to support farmers in making the transition.

What was originally meant to support the agricultural sector now threatens its very existence.

"The DiverIMPACTS project may be finished, but our work is just getting started," concludes Messéan. "Leveraging the momentum built during this project, we are now taking what we learned and applying it to other EU-funded projects and initiatives."

PROJECT
DiverIMPACTS – Diversification through Rotation, Intercropping, Multiple cropping, Promoted with Actors and value-Chains Towards Sustainability

COORDINATED BY
National Research Institute for Agriculture, Food and Environment in France

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/727482

PROJECT WEBSITE
diverimpacts.net

Giving momentum to legume breeding

An EU-funded project is helping Europe and China increase their level of protein autonomy.



© Bernadette Julier

Legumes are an important part of feed and food production and have a positive effect on the environment. Rich in protein, contributing to the entry of nitrogen in cropping systems, thus potentially reducing the need to use synthetic nitrogen fertilisers, they also offer a nutritious plant-based alternative to meat – a market that is growing, with many seeking new ways to harness the potential of plant-based protein production. As such, there are many reasons to grow more legumes.

In Europe and China, however, areas with appropriate agroecological conditions for growing plant proteins, there is a deficiency, with both continents heavily dependent on protein imports and great use of synthetic nitrogen fertilisers. Helping to reduce this dependency is the EU-funded EUCLEG (Breeding forage and grain legumes to increase EU's and China's protein self-sufficiency) project.

"We worked on legume crops, with the final aim being to improve varieties," notes Bernadette Julier, project coordinator and research director at INRAE – France's National Research Institute for Agriculture, Food and Environment. This involved genotyping, phenotyping and statistical work.

Improving genetic progress

EUCLEG focused on the five most cultivated legume species in Europe: two forages, alfalfa and red clover, and three grain legumes, pea, faba bean and soybean.

"Our objectives were to help breeders create more adapted, performant varieties. These legume varieties will be grown in geographic areas where legume crops are already cultivated and

provide higher yield, quality and stability than current varieties or will help to expand the area of cultivation in regions where not many legumes are grown," explains Julier. A higher yield and a higher cultivation area will contribute to producing more domestic proteins; new varieties will be more easily introduced into crop rotations (diversification).

The project's work has led to the release and/or adoption of genomewide genotyping tools for the five major legume species. "We have also achieved a new vision of genetic diversity available for breeding in each species. The huge number of markers obtained on a large set of accessions has clearly renewed the knowledge on alfalfa and soybean. New sources of phenotypic variation have also been identified," adds Julier.

We have achieved a new vision of genetic diversity available for breeding in each species. The huge number of markers obtained on a large set of accessions has clearly renewed the knowledge on alfalfa and soybean. New sources of phenotypic variation have also been identified.

With genome-wide genotyping, it was possible for the project to identify molecular markers associated with trait variation. These markers could be used in breeding programmes to speed genetic progress. "Additionally, prediction ability for major traits has been calculated, and the results suggest that genomic selection should also speed genetic progress of legume breeding, as in other major plant and animal species," says Julier.

Increasing ambition

Several public and private legume breeders contributed to the collection and analysis of data. "This partnership is favourable to the transfer of knowledge from research to industry," remarks Julier. Training sessions for breeders were also organised during the project. "They have seen the expected potentialities of molecular breeding in legumes. In the long term, I expect that legume breeding will make use of molecular tools to speed up genetic progress and to release varieties adapted to different constraints and uses," she adds.

As for the next steps, the project aims to demonstrate the progress that can be gained from molecular breeding in comparison to phenotypic breeding. "In parallel, it is crucial to decrease the genotyping costs by adapting the methods and the number of markers that are required in a breeding programme. Finally, the breeding schemes must be adapted to introduce molecular breeding into the variety creation process while updating prediction equations and markers to the genetic diversity under study," concludes Julier.

PROJECT
EUCLEG – Breeding forage and grain legumes to increase EU's and China's protein self-sufficiency

COORDINATED BY
National Research Institute for Agriculture, Food and Environment in France

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/727312

PROJECT WEBSITE
eucleg.eu

A tool to help farmers control weeds without relying on herbicides

Farmers recognise the need to move away from herbicides. However, non-chemical alternatives can be difficult to identify and implement. The EU-funded IWMPRAISE project trialled a range of integrated weed management strategies, and made these solutions available to stakeholders.

Weed management is a critically important element of farming. Unwanted plant growth can negatively impact crop yields, interfere with production practices and contaminate the harvested crop, impacting yields negatively.

While famers have traditionally applied herbicides to control weeds, over-reliance on herbicides has contributed to not only the pollution of soils and the environment, but also the development of herbicide-resistant weeds. This practice is no longer sustainable.

It is vital that new weeding practices are introduced. They must be sustainable, not only for environmental reasons but also to ensure the economic viability of farming in Europe. One such



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agroecological approach is integrated weed management (IWM), which has been supported and developed through the IWMPRAISE (Integrated Weed Management: PRActical Implementation and Solutions for Europe) project.

Identifying herbicide replacements

"The key to IWM is that it uses multiple control tactics," explains IWMPRAISE project coordinator Per Kudsk from Aarhus University in Denmark. "The idea is to implement a range of methods, in order to give producers the best chance of controlling troublesome weeds without resorting to herbicides."

Some of these strategies might be preventive, such as delayed sowing, field margin management, dead mulching and covering crops. Other strategies designed to reduce the impact of weeds on crops include competitive crops, mechanical weed control and focusing on nutrient placement.

A challenge however is that no single tool or strategy is as effective on its own as herbicides. The solution is to find ways of combining different approaches throughout the growing season, in order to deliver a comparable effect without the need for chemicals.

Testing viable weed strategies

The key objective of IWMPRAISE was to help agricultural communities identify practical IWM solutions suited to their specific contexts. To achieve this, the project team worked closely with farmers, their advisors, and SMEs to find solutions acceptable to them.

"We began by sitting down with farmers and advisors, to get a better idea of their way of thinking when it comes to IWM," says Kudsk. "We also looked at the economic viability of IWM, as well as the long-term impact on issues such as biodiversity."

While no single solution is 100 % effective, together these methods can significantly reduce weed infestation.

National clusters in each of the eight participating countries were formed, bringing farmers, suppliers and agricultural experts together to test various strategies over a 3-year period.

"We trialled strategies such as delaying the sowing of particular crops," notes Kudsk. "This reduced weed germination and made them easier to kill before sowing crop seeds."

In terms of weed control, mechanical methods were also tested as alternatives to herbicides. "All this means that while no single solution is 100 % effective, together they can significantly reduce weed infestation," he says.

Encouraging farmers to adopt IWM

Out of this work, the project team was able to develop a web-based IWM tool, now freely available for anyone to access. Users can log on, select which crop group they are growing, and find a visual representation of possible alternatives to herbicides.

"The tool provides an overview of alternatives for tackling weeds at different stages," explains Kudsk. "Different colours are used to indicate which stage in the life cycle you are addressing." Green for example indicates solutions to prevent the establishment of weeds; grey indicates solutions to reduce their impact on crops; while orange indicates ways of reducing weed seeding.

"Our hope is that this tool will encourage farmers to adopt IWM," says Kudsk. "This is really important, as spraying herbicides year after year increases the risk of herbicide resistance. What's more, there are no new herbicides coming to the market, and EU legislation means that many existing products will disappear. This is why new weed management strategies are needed."

The project has also developed websites for each partner country in the national language, in order to reach as many farmers as possible. Each website contains results on the field trials, inspiration sheets and inventories of non-chemical inputs.

PROJECT
IWMPRAISE – Integrated Weed Management: PRActical Implementation and Solutions for Europe

COORDINATED BY
Aarhus University in Denmark

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/727321

PROJECT WEBSITE
iwmpraise.eu

Phasing out contentious inputs from organic – and conventional – agriculture

Shifting to less harmful agrichemicals is critical to achieving sustainable agricultural production and improving consumer trust. The EU-funded Organic-PLUS project identified viable alternatives to problematic inputs, and provided farmers with roadmaps for their adoption.



© Organic-PLUS Schmutz

While the EU is committed to having 25% of agricultural land under organic farming by 2030, a number of challenges within the sector remain. A key priority for the organic sector is to replace certain contentious inputs – such as pesticides made from mineral oil or copper – with sustainable and cost-effective alternatives.

The Organic-PLUS (Pathways to phase-out contentious inputs from organic agriculture in Europe) project set out to provide farmers and policymakers with feasible pathways for contentious inputs to be removed or replaced.

"We applied ideas of agroecology and ecological economics to analyse various phase-out scenarios," explains Organic-PLUS project coordinator Ulrich Schmutz, a professor from Coventry University in the United Kingdom. "We wanted to be open about the challenges, and get everyone on board."

The project began by evaluating contentious inputs currently used in European agriculture. This was achieved through expert interviews with conventional and organic farmers, certification bodies, organic suppliers and manufacturers in Europe, with a special focus on Mediterranean countries.

The project team also wanted to know how consumers view the issues, and conducted a large-scale, representative consumer survey.

The legally agreed phase-out of peat as a growing media in horticulture in the United Kingdom is a good example of how our research can help.

Possible alternatives were assessed, and trials conducted to test possible alternatives. The project team then undertook environmental, social and economic assessments of all possible phase-out scenarios.

"In this respect, Organic-PLUS complemented other EU-funded projects, such as RELACS," notes Schmutz. "Using copper in crop protection is a big issue, and each crop is different. Each project was able to look at different crops, to provide a wider picture. The same goes for other contentious inputs."

Pathways to more sustainable agriculture

Out of this work, a number of phase-out pathways were identified. For example, the project suggests that copper as a fungicide could be reduced from 4 kg/ha per year to 2 kg/ha per year by 2027, with viable alternatives such as plant-based oil entering the market.

"This is an issue that has dogged the organic sector for over 30 years," says Schmutz. "I'm delighted to see that there is light at the end of the tunnel. However, we still need policy support for alternative treatments."

Mineral oils for plant protection, on the other hand, could be phased out immediately, as alternatives are readily available.

Another key finding is that fossil fuel-derived plastic mulch could be phased out by 2030. While alternative biodegradable bioplastics are available, they require further research in more applied innovation actions.

Peat was another contentious issue that the project tackled. Produced by the decomposition of bog plants, peatlands provide excellent carbon sinks. The drainage, transplantation and use of peat as an organic soil fertiliser was identified as being highly problematic.

"The legally agreed phase-out of peat as a growing media in horticulture in the United Kingdom is a good example of how our research can help with sustainable alternatives to contentious inputs," says Schmutz. "First movers in the phase-out will have a competitive edge in the bio-economy without mining peat and restoring peatlands."

Phasing out antibiotics used in animal production was recognised as a significant challenge, and only possible through a significant redesign of current intensive organic systems. "Without recreating a mixed grazing landscape with agroforestry, farms will have little chance of becoming organic without antibiotics until 2050," adds Schmutz.

High-quality food, low environmental impact

Schmutz notes that a further issue is that contentious inputs are highly diverse. "Our project was able to develop a model, involving aspects such as life cycle assessments, which could be used to assess other contentious issues in the future."

By phasing out all contentious inputs in organic farming, Schmutz and his team believe that the sector can maintain its leadership in sustainable practices, which might then spill over into conventional farming. There is also hope that the International Federation of Organic Agriculture Movements (IFOAM) will agree with EU standards in phasing out contentious inputs.

"We have been able to show how all contentious inputs can be phased out – the only question is when," he notes. "Our research will also benefit consumers, by being transparent about the costs involved in making our food production more sustainable. This is about creating trust, and consumers valuing the investments made in a phase-out."

PROJECT
Organic-PLUS – Pathways to phase-out contentious inputs from organic agriculture in Europe

COORDINATED BY
Coventry University in the United Kingdom

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/774340

PROJECT WEBSITE
organic-plus.net

New agroecological approaches to scale up organic farming

Scalable and cost-effective alternatives to several contentious inputs used in organic farming have been identified. These new approaches could help boost organic production in Europe, and create new opportunities in the green economy.

Organic farming is a system of farming very much aligned with the principles of agroecology. To have minimal environmental impact however, organic farming needs to be implemented at scale. A key sticking point to date has been achieving this scale without the use of certain contentious inputs, for example the use of copper pesticides, or antibiotics in livestock management.

Working with farmers

The goal of the EU-funded RELACS (Replacement of Contentious Inputs in organic farming Systems) project was to identify the most suitable technologies and methods for phasing out organic farming's dependency on these inputs. To achieve this, the project began by building up a network of farming associations, researchers and industry players from across Europe.

"We set out to address all input aspects upstream of the farm," explains RELACS project coordinator Lucius Tamm from the Research Institute of Organic Agriculture (FiBL) in Switzerland. "This meant taking into account crop protection strategies, fertilisers and conventional manure, and the health management of livestock."



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The project team also looked at the cost to farmers of any proposed replacement strategies, as well as receptiveness among both farmers and consumers. Possible solutions were then shared with farming communities through nationally organised workshops, ensuring their compatibility with specific regions.

Rethinking plant protection

This collaborative process enabled RELACS to make important discoveries, and to put forward possible solutions in a number of key areas. In plant protection, copper was found to be used to treat a wide range of plant pathogens. Not only that, but staggering amounts of copper were being used; more than 3 000 tonnes a year in the 12 countries studied alone.

"Replacing this at scale will be a challenge," remarks Tamm. "This is not going to come from a silver bullet, but rather from a range of solutions." Four candidate plant protection products were trialled in various climatic conditions, and were seen to perform well.

The project team also identified viable alternatives to mineral oil to manage crop pests. "One interesting non-pesticide-based solution we trialled was disruption by acoustics," says Tamm. "Overall, we're confident that we can achieve a reduction in mineral oil within a reasonable time frame."

Greening nutrient supply was identified as a major challenge. Fertiliser is bulky and cannot sustainably be transported across Europe, so locally adapted, optimised circular solutions must be prioritised. "There is a clear societal need to make better use of available raw materials, and to transform these into high-quality, recycled soil fertility products," adds Tamm.

Organic animal farming

The project team also looked at inputs into organic animal farming. A key area of focus was reducing the need for pharmaceutical products such as anti-worming medicine for cattle. One option identified was to feed livestock heather; another was to exploit a fungal-based biocontrol agent.

"This passes through the cattle and becomes active in the excrement, where the eggs of parasites are found," explains Tamm. "What you are doing in effect is decontaminating your pasture."

Farmers and vets were also brought together to share experiences and discuss best practices in terms of feeding regimes and breeding. This preventive approach was actually shown to be able to reduce antibiotic use by more than half.

Essential oil therapies, pioneered by farmers themselves, were also assessed in terms of efficacy and cost. Existing recommendations on vitamin intake for livestock were found to be exaggerated; the project team believes that supplements could be significantly reduced without compromising animal safety or well-being.

Boost for the green economy

"I think this project has made good progress in framing the input challenges in organic farming, and identifying potential alternatives in terms of scalability, cost and acceptance," notes Tamm. "A key success has been involving farmers from an early stage."

Tamm stresses however the need for policy intervention. Plant protection prototypes to replace copper are more expensive for farmers. The time needed to register new crop production products is also a market barrier that needs to be addressed.

A key success has been involving farmers from an early stage.

More positively, antibiotics dependency in the organic livestock sector was found to be far lower than in conventional farming. What's more, the possibilities identified by RELACS, across all sectors of organic farming, can now be built upon, helping Europe to meet ambitious sustainability targets contained in the farm to fork strategy.

"There are plenty of upstream opportunities for SMEs here," says Tamm. "Replacing these inputs represents a huge market opportunity for the green economy."

PROJECT
RELACS – Replacement of Contentious Inputs in organic farming Systems

COORDINATED BY
Research Institute of Organic Agriculture in Switzerland

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/773431

PROJECT WEBSITE
relacs-project.eu

Living labs bring agroecology potential to life

New farming, as well as research and innovation approaches, are needed to overcome the challenges posed by climate change, biodiversity loss and soil degradation. The EU-funded ALL-Ready project is demonstrating how agroecology practices can be adapted across a range of European climates and habitats.

A growing global population is putting ever-increasing pressure on our natural resources, and forcing us to rethink the way we farm. This has led to the emergence of agroecological farming, which fully takes into account all the complex ecological interactions occurring in agriculture. This means adopting food production systems – including organic farming – that offer high rates of nutrient recycling, reduced use of synthetic inputs and lower levels of greenhouse gas emissions.

One challenge of course is that agricultural ecosystems vary from region to region. Building on this recognition, the objective of the ALL-Ready (The European Agroecology Living Lab and Research Infrastructure Network: Preparation phase) project is to develop agroecological approaches that apply to site-specific contexts.

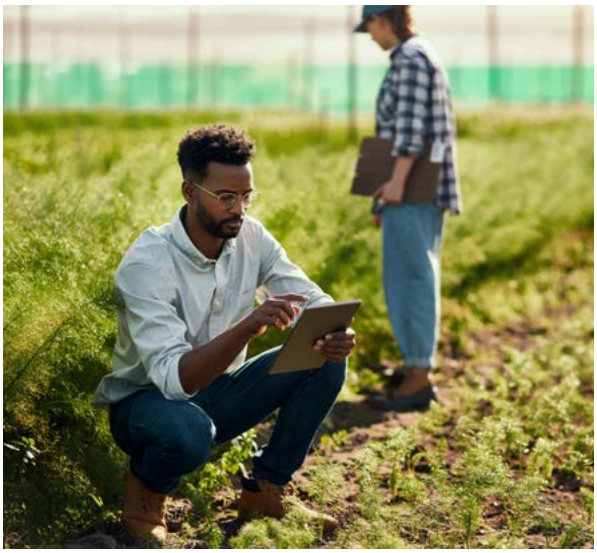
To achieve this, the project aims to establish a network of Living Labs and Research Infrastructures, to increase cooperation across Europe and bring about this much-needed transition. Living Labs are multi-actor, placed-based, open innovation arrangements that have user-centredness and testing in real-life conditions as their main principles. An important goal here is to achieve an even geographical distribution, and to take into account the various scales of users, maturity levels and scopes of activities found across Europe.

After a selection process conducted between June and August 2021, the ALL-Ready pilot network was launched at the end of 2021, with 15 pilot members across Europe and Canada.

One example is the ÖMKi On-Farm Living Lab in Hungary. Through co-developing and designing agroecological practices, products and technologies in partnership with organic farmers, a number of successes have been achieved. These include bringing to the Hungarian market an organic flour produced from locally grown landrace emmer and einkorn grains.

In a second phase, different prerequisites and activities for the future network will be prepared. Finally, the work will be communicated widely throughout Europe by a variety of mechanisms. A principal outcome of the project will be a pilot-tested plan for implementing the validated framework of AgroEcoLLNet.

In doing so, the ALL-Ready network is acting as a test bed for such agroecological experiments, and provides feedback on the tools and recommendations that have been developed through the project. The ultimate aim is to encourage ongoing cooperation between different agroecology-focused Living Labs and Research Infrastructures, and to drive the transition to sustainable agricultural practices forward.



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PROJECT
ALL-Ready – The European Agroecology Living Lab and Research Infrastructure Network: Preparation phase

COORDINATED BY
National Research Institute for Agriculture, Food and Environment in France

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/101000349

PROJECT WEBSITE
all-ready-project.eu

A pan-European network to boost agroecology

Agroecology projects are taking root across Europe. The EU-funded AE4EU project aims to spread best practices through improved networking and infrastructure.

There is an increasing need to make agricultural practices consider not only production quotas, but also every living and non-living component of the farmland ecosystem. Alternatives such as organic farming may be a step forward for consumers wanting food produced in more sustainable ways, but its capacity to single-handedly curb the sector's impact on ecosystems is limited. This is where the concept of agroecology comes into play. Research is key to advancing agroecology. Increasingly it is seen as the only viable path to sustainable food systems. Yet, despite all the potential, agroecology-relevant research projects have in the past remained limited and fragmented due to a lack of pan-European coordination.

The AE4EU (Agroecology for Europe) project consortium, comprising 12 partners from 10 European countries, asserts that scattered or isolated knowledge about agroecology in research, practice, education, training and policies should be brought together and made available to many stakeholders.

AE4EU has six main objectives. The first consists in increasing connections between relevant actors. Project partners will map all local initiatives, national and regional policies, cooperative research efforts as well as all actors involved, to create a European Agroecology Exchange Network.

The project team will set up three living labs in Italy, the Netherlands and the United Kingdom, seeking to identify mechanisms that can strengthen agroecological research and innovation ecosystems in Europe. These living labs will target farmers, as well as researchers, policymakers and citizens.

Project partners will then analyse and provide recommendations to funders in order to make their efforts more complementary. The project will combine top-down and bottom-up approaches to understand how funding is delivered, what works, and what doesn't.

The fourth objective is to use the European Agroecology Exchange Network to facilitate knowledge exchanges. Finally, they will provide recommendations for future policies, and develop a roadmap and framework for the future European R&I partnership in agroecology. The latter is key to the AE4EU approach, as it will "accelerate the transition towards sustainable farming and food systems practices by promoting networking, connectivity and place-based innovation in a co-creative environment," according to the project website.

Although the project is still in its infancy, early findings on the nature and effectiveness of existing agroecology funding have already been published. The team has delivered a full database of relevant projects, programmes and institutions, drafted policy briefs for the new common agricultural policy and the European Green Deal, and initiated the co-creation of what the project terms an "overarching network of agroecological networks in Europe."



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PROJECT
AE4EU – Agroecology for Europe

COORDINATED BY
ISARA in France

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/101000478

PROJECT WEBSITE
ae4eu.eu

Sowing organic agriculture's future with better seed stock

The EU-funded ECOBREED project brings together partners from Europe, Australia, China and the United States to build a better supply of organic seeds for wheat, potatoes, soy and buckwheat.

Organic farming requires organic seeds. While this sounds relatively straightforward, organic seeds are expensive, difficult to source, carry a higher risk of seed-borne diseases, and can be contaminated by their non-organic counterparts.

The ECOBREED (Increasing the efficiency and competitiveness of organic crop breeding) project's ambition is to prevent bottlenecks such as this hindering growth of the organic market. It aims to improve the availability of suitable seeds and varieties, identify traits with the highest potential, and increase breeding activities for organic and low-input crop production.

The project kicked off in May 2018, pursuing seven objectives: identifying suitable traits and variations; evaluating the potential of genetic variation to enhance nutrient acquisition; increasing weed competitiveness and control; developing better participatory breeding systems; pre-breeding 'elite' varieties; and organising training programmes.

Field trials and phenotyping

The initial phase of the project was dedicated to the identification, selection, evaluation and multiplication of genotypes to allow for further studies and field trials. The latter specifically focused on four crop species: wheat, potato, soybean and buckwheat. According to Vladimir Meglič, coordinator of the project and researcher at the Agricultural Institute of Slovenia, the ultimate objective is to ensure that the new varieties of organic crops have the same yield per hectare as conventional ones. The team identified promising crosses for specific traits such as drought tolerance, resistance to pathologies and nutritional value.

The field trials took place in several different countries. In Slovenia, the Agricultural Institute ran tests on organic potatoes, seeking to improve seed tuber quality and vigour through the use of cover crops. Phosphorus uptake efficiency trials focusing on buckwheat took place in Slovenia and the United States, while experiments in Serbia focused on the negative economic impact of the southern green shield bug on European soybean production.

Powering the organic transition

Project partners also ran three trials specific to durum wheat, with Tuscia University in Italy leading the charge. A total of 72 durum wheat lines were evaluated during the first year of the



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project, on Italian, Austrian and Bulgarian fields. The experiments resulted in cross-selections with higher productivity than already commercialised crops.

"Completely switching to organic production would be impossible because organic food is still a niche market, and because many organic farmers simply wouldn't survive without subsidies at this stage," Meglič told a Slovenian newspaper in 2018. "What we can do and are already doing with ECOBREED, however, is to try and find new approaches and technologies to reduce manual work, eliminate weed and provide disease-resistant varieties to organic farmers."

The project is expected to conclude in early 2024.

PROJECT
ECOBREED – Increasing the efficiency and competitiveness of organic crop breeding

COORDINATED BY
Agricultural Institute of Slovenia

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/771367

PROJECT WEBSITE
ecobreed.eu

Sustainable systems and policies for future permanent grasslands

Farmers, policymakers and researchers have joined forces under the EU-funded SUPER-G project to lay the groundwork for sustainable and profitable grassland systems across Europe.



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In agroecological terms, permanent grasslands are herbaceous plant covers of great variety. They provide high ecological balance, preserve soils and protect biodiversity. Farmers can use them for grazing, for renewable energy production, or simply to improve soil properties for a duration of at least five years. In practice, however, permanent grasslands are under threat from abandonment, heat, drought stress and conversion to temporary grassland.

The SUPER-G (Developing SUstainable PERmanent Grassland systems and policies) project was set up to tackle these issues with a multi-stakeholder approach involving farmers, landowners and managers, civil society, NGOs, researchers, policymakers and businesses. "We are trying to identify sustainable systems based on permanent grassland that can benefit society and then to get the policies in place to allow farmers to make a decent living while maintaining these grasslands," says Paul Newell-Price, principal research scientist at project partner RSK ADAS.

The project has four core objectives: better understanding grasslands across five European regions, benchmarking their performance, co-developing approaches for sustainable permanent grassland management, and co-developing tools and policy mechanisms.

Since SUPER-G was kicked off in 2018, the team has developed a European grassland typology and a conceptual model of farming systems. They claim to have reached a much better understanding of the functioning of permanent grasslands and started making an inventory of management approaches and emerging technologies.

Another key achievement so far is the data gathered from five biogeographic regions (Alpine, Atlantic, Continental, Mediterranean, and Pannonian). Some innovative practices were identified, such as multispecies swards, virtual fencing, and remote sensing technology to optimise ecosystem service delivery. Field experiments, trials and demonstrations have also been set up on commercial farms and experimental platforms. The consortium successfully established a total of 23 farm networks across 14 countries.

With a total of 32 scientific articles already available on the SUPER-G website, the project is already proving to be quite fruitful and wide-reaching. The project consortium has successfully provided, among other things, a systematic review of threats in European grasslands, proposals to improve the sustainability of European grasslands, and a systematic review of ecosystem services from permanent grasslands.

Further papers are dedicated to specific solutions developed by the project consortium, such as a farm-level decision support tool to help farmers better manage their permanent grasslands, while others cover specific questions, including whether citizen science can be used to estimate grassland vegetation based on smartphone pictures.

SUPER-G is due for completion in February 2024.

PROJECT
SUPER-G – Developing SUstainable PERmanent Grassland systems and policies

COORDINATED BY
Newcastle University in the United Kingdom

FUNDED UNDER
Horizon 2020

CORDIS FACTSHEET
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PROJECT WEBSITE
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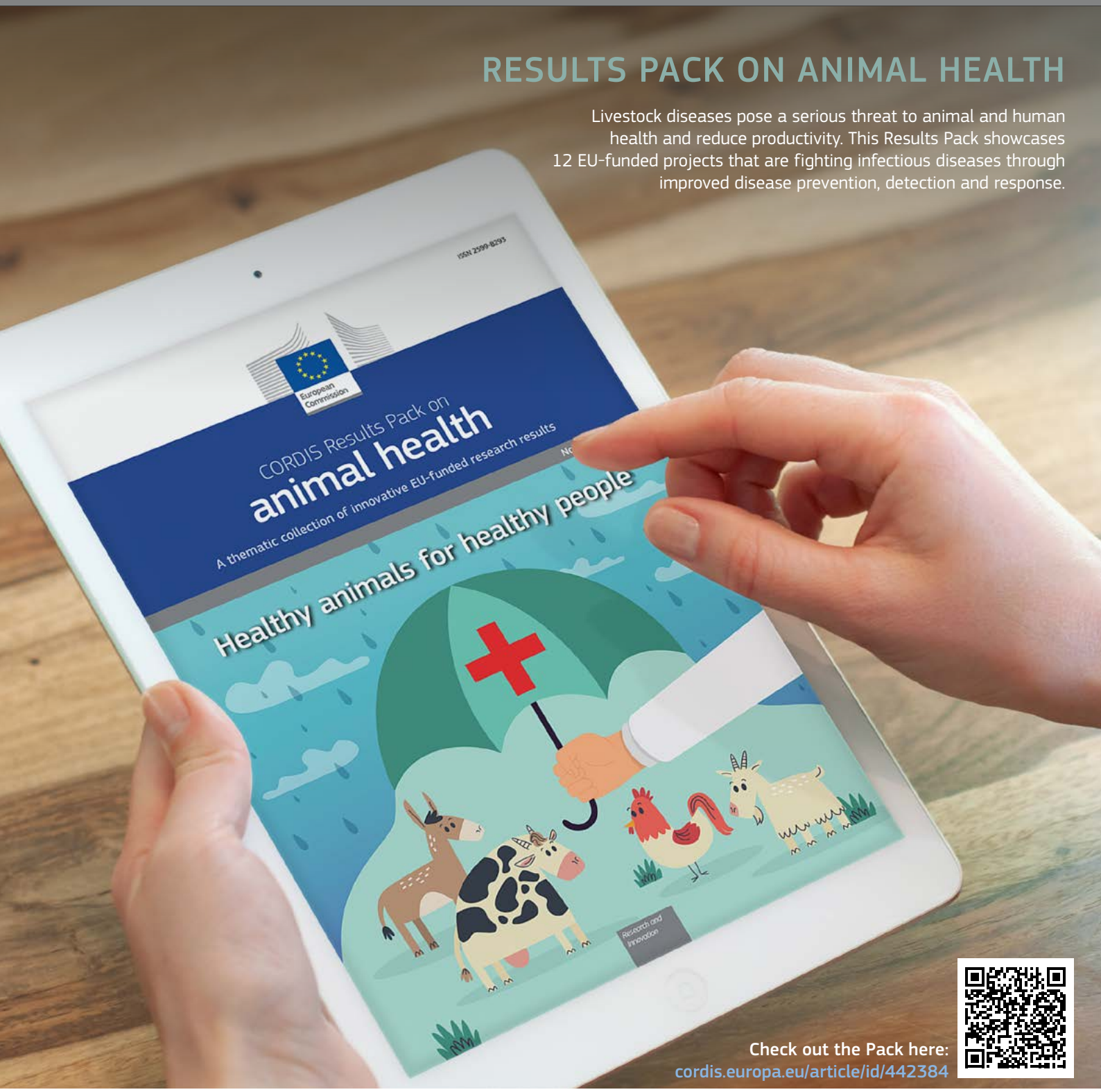
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RESULTS PACK ON ANIMAL HEALTH

Livestock diseases pose a serious threat to animal and human health and reduce productivity. This Results Pack showcases 12 EU-funded projects that are fighting infectious diseases through improved disease prevention, detection and response.



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