Coordinating research to overcome the challenges of agriculture, food security and climate change

Close collaboration between scientific researchers across Europe is central to addressing major societal challenges. We spoke to **Dr Hartmut Stalb**, **Dr Heather McKhann**, **Professor Michael Bruford** and **Dr Marta Pogrzeba**, about the work of FACCE-JPI in supporting transdisciplinary research into interconnected challenges around climate change, sustainable agriculture and food security

Joint Programming Initiatives (JPIs) are designed to enable coordinated action on major societal challenges, with countries sharing research expertise and resources to investigate key areas of societal concern through the alignment of national priorities and research programming. One such challenge is maintaining food security and agricultural productivity in the face of the impacts of climate change, a topic that lies at the core of FACCE-JPI, an initiative which coordinates research across these areas in 24 countries. FACCE-JPI is supported by a coordination and support action FACCE EVOLVE (see panel information). "We work with the commission to identify research priorities across this broad area of food, agriculture and the bio-economy," says Dr Heather McKhann, one of the coordinators of FACCE- JPI. The European Research Area (ERA) provides a framework for research cooperation between Member States on specific areas of research, and several ERA networks (ERA-NETs) have been proposed by FACCE, while JPIs are more about strategic planning. "FACCE is really about this intersection between agriculture, food security and climate change. So we are taking a system-based approach, not a topic-based approach," outlines Dr Hartmut Stalb, the Chair of FACCE-JPI.

This helps to ensure resources are allocated effectively and prevents duplication of research, while also putting in place the foundations for future collaboration. While there is of course a lot of ongoing research into different aspects of agriculture and food production, Dr McKhann says it's important to not view it in isolation, and consider the wider picture. "With FACCE, we've really tried to look around at initiatives working on different topics that touch on our remit. Then we can exchange information with them, and in many cases even work with them and put in place joint actions," she outlines. The research landscape evolves continuously, so Dr McKhann and her colleagues are also aware of the need to monitor emerging topics of interest. "We hold exploratory workshops and bring together experts to see if there is something which needs to be addressed by FACCE," she says. "FACCE has a portfolio of research actions including several ERA-NETs, and there are research projects within each of the actions that are running. We try to assess what's been covered up to that point, so we're always thinking about the future direction of research."

ClimGen project

One action is the FACCE ERA-NET Plus, which examines 'Climate Smart Agriculture' through 11 research projects. A major research priority is investigating the impact of climate change on agriculture, a topic that is central to the work of the ClimGen project. "Our project is about trying to understand the genomic architecture of different livestock breeds, and predicting how they could function and operate outside their climate comfort zone," says Professor Michael Bruford, the project's Principal Investigator. Researchers have been examining genome-scale data in four species, looking at breeds living in very different climatic environments. "We're looking at genome data from livestock species in tropical Africa and tropical south America, all the way through to breeds in Yakutia, which is one of the coldest parts of Russia, as well as some from northern Finland and Iceland," continues Professor Bruford. "From there we can ask; what does that tell us about how breeds adapt to climate differences?"

Photograph by Øyvind Antonsen

Yakutian cattle are raised in an environment where the temperature regularly **drops as low as -50°**, demonstrating that under some circumstances **livestock can adapt** to very extreme conditions

Yakutian cattle are raised in an environment where the temperature regularly drops as low as -50°, demonstrating that under some circumstances livestock can adapt to very extreme conditions. While many factors need to be considered in terms of a species' ability to adapt to environmental change, the primary focus in the project is on genetic and physiological adaptability, with Professor Bruford and his colleagues measuring changes in the animals through the genes they express. "For example, one part of our project involves looking at the red-legged partridge, which is being bred in southern Spain, an area where temperatures are really rising rapidly," he outlines. Researchers are looking at the transcriptomes of those animals. "We're interested in how the characteristics of their different transcripts change as a function of heat-related immune stress," continues Professor Bruford. "We're also looking at the epigenome, which is expressed differently in each tissue. The DNA is modified by a process called methylation – and expression patterns can rapidly change according to the environment."

The project's work has also involved investigating cattle from Colombia, descendants of Spanish bulls that were taken to the new world by Christopher Columbus. Over a relatively short time, these bulls have developed adaptations to the tropical Colombian environment. "Their genetic architecture and expression patterns have effectively been modified. We're looking at this process in cattle and pigs, at the effect of temperature on how the epigenome is organised. Our team is also comparing sheep and goat populations living in colder environments at high altitudes in the Atlas mountains with those living at low altitudes in much hotter, desert environments," says Professor Bruford. The wider goal in this research is to develop new breeding strategies and help future-proof livestock under various climate change scenarios. "The final aim is to take the data that we've generated – on how many genomic signatures of selection there are and how important they are in the traits of the animals – and incorporate that in breeding simulation models to see how we can accelerate climate adaptation in vulnerable livestock populations," outlines Professor Bruford.

Miscomar project

A number of other projects are also funded under another ERA-NET called FACCE SURPLUS on sustainable and resilient agriculture for food and non-food systems, which funded 14 research projects in a first call, including MISCOMAR, a project developing techniques for the production of biomass on marginal land. The soil on marginal lands is often unsuitable for food crop cultivation, so researchers are investigating possible alternative uses. "In our project, we are trying to convince farmers to use this land not for food production, but to produce bioenergy crops," says Dr Jacek Krzyzak, a key figure in the project. The project is investigating the potential of growing different novel hybrids of *Miscanthus*, a high-yielding energy crop, on marginal land, with researchers trialling it in three different locations. "We have a trial at a site in Poland, in heavy-metal contaminated soil. In Germany, we planted *Miscanthus* in high-clay content soil. The third site is in Lincolnshire in the UK," outlines Dr Marta Pogrzeba, the project's Principal Investigator. "The problem in Lincolnshire is that the soil was previously used quite intensively for agriculture, and now there is a very low concentration of nutrients. So the soil is very low-quality."

Researchers are also working to identify possible options for the eventual utilisation of this crop in terms of energy production. The crops have been divided into green biomass – collected in the Autumn – and brown biomass, which is collected during the Winter. "We use this Winter biomass for combustion for example, and we're also looking at anaerobic

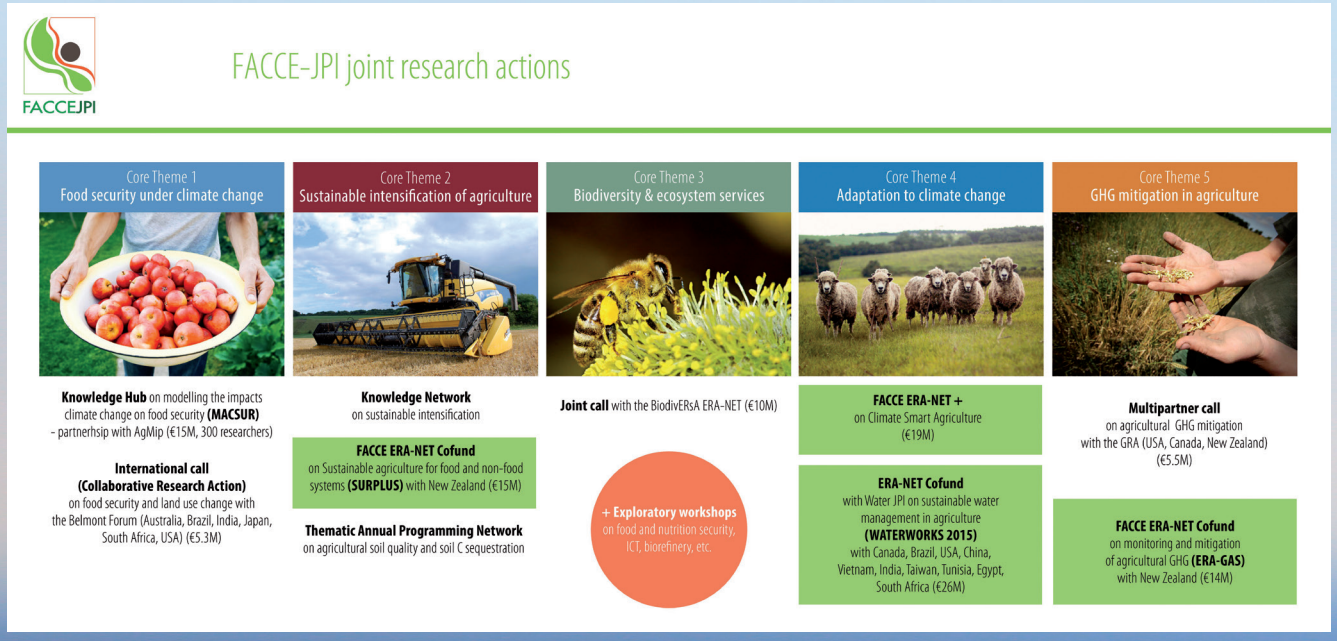

Figure 1: Main FACCE-JPI joint research actions


Photograph by Øyvind Antonsen

digestion," says Dr Pogrzeba. Currently, biofuels are often produced from agricultural land, leading to tensions with food producers; the project's research holds clear potential in these terms, opening up the possibility of producing biomass elsewhere, while also helping to strengthen the rural economy. "Biomass production is a possible way of helping local people gain a greater degree of independence in their energy supply, but that's more of a long-term goal," says Dr Krzyzak. "What's important for us at the moment is to improve the management of soil in contaminated areas, to try to find a solution for such soil, and to help farmers and land users in such areas build a sustainable source of income."

Funding the future

The funding through the ERA-NET is central to the future of the project, giving researchers a firm financial foundation on which to investigate questions of importance to wider society. The funding has allowed researchers to build on earlier investigations into biomass production in agricultural areas. "We previously focused on selecting crop species for use on land contaminated with heavy metals. With the MISCOMAR project, we can develop a more or less full value chain for the biomass from contaminated and marginal land – so it really helps us, both from the scientific point of view, and also from the stakeholder point of view," outlines Dr Krzyzak. FACCE-JPI will continue to support this kind of research in future, contributing to the goal of building a bio-based economy in Europe, while Dr Stalb says the initiative will also evolve in line with emerging challenges. "We will continue to develop our strategic research agenda, and we will update our implementation plan, according to the challenges that have been identified in the field of agriculture and climate change," he outlines. "We will also look to coordinate research more effectively with other JPIs in related areas, while we will also develop our international strategy."

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FACCE-JPI

Agriculture, Food Security and Climate Change

FACCE-JPI Objectives

The Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) was launched in 2010, bringing together 24 member countries.

Its aim is to build the European Research Area tackling the challenges at the intersection of agriculture, food security and climate change that cannot be addressed solely at the national level (Fig 1).

This is being realised through the alignment and integration of national and European research programmes, the funding of new research programmes, and through exploring innovative approaches for the member countries to work together to address the challenge of ensuring a secure food supply to an ever-increasing global population in the context of climate change.

FACCE-JPI VISION: An integrated European Research Area addressing the challenges of Agriculture, Food Security and Climate Change to achieve sustainable growth in agricultural production to meet increasing world food demand and contributing to sustainable economic growth and a European bio-based economy while maintaining and restoring ecosystem services under current and future climate change.

FACCE-JPI MISSION:To achieve, support and promote integration, alignment and joint implementation of national resources in Europe under a common research strategy to address the diverse challenges in agriculture, food security and climate change.

FACCE-JPI Funding

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