

# Bioscience for a Better Tomorrow

ibers  
RESILIENT CROPS  
CNYDAU GWYDN



# Welcome to IBERS

Institute of Biological,  
Environmental  
& Rural Sciences





The world has a finite area of land to feed, fuel and clothe a growing population, while at the same time reducing greenhouse gas emissions and safeguarding biodiversity. With over a hundred year history of working to improve grassland agriculture, IBERS research aims to make farming more productive, beneficial to society and protective of our environment.

At the institute, we conduct cutting-edge fundamental and applied research that underpins the breeding of new and improved varieties of crops, makes agriculture more sustainable, and enables industry to develop new processes and products.

In the heart of Wales, IBERS' unique location and ecosystem of capabilities allows our students and researchers to conduct hands-on research and training in plant genetics, agriculture, ecology, biotechnology, and environmental science. Enabling study of our environment, habitats, and food systems from summit to sea and from field to fork.

IBERS core research is focused on making crops more resilient to climate change, improving crop quality, safeguarding genetic diversity, capturing carbon, and understanding the wider interactions between agriculture and the environment.

We work closely with industry to tackle global challenges, engage with policymakers and the wider agricultural community to better understand the critical issues, and then work collectively to find solutions and apply our bioscience to help build for a better tomorrow.

**Professor Iain Donnison,**  
IBERS Director





**FUNDAMENTAL  
PLANT, ANIMAL  
AND ENVIRONMENTAL  
RESEARCH**

**+**

**IMPROVING  
AGRICULTURAL  
PRODUCTIVITY AND  
SUSTAINABILITY**

**+**

**CONSERVING  
GENETIC RESOURCES  
FOR FUTURE  
GENERATIONS**

**+**

**BREEDING THE FOOD,  
FIBRE AND FUEL CROPS  
OF TOMORROW**

**+**

**FINDING BIO-BASED  
ALTERNATIVES TO  
CARBON INTENSIVE  
PRODUCTS AND  
PROCESSES.**

## Developing the crops of tomorrow

Drawing on over a hundred years of genetic resources, safeguarded in our Seed Bank storage facility, our researchers and commercial partners are constantly striving to develop new and improved varieties of grasses, cereals, and legumes. Using our unique combination of state-of-the-art controlled environments and experimental field plots, spread across multiple sites, altitudes, and continents, we are working to make crops more resilient by introducing greater crop diversity and building better resistance to periods of drought or flooding.

## Making agriculture more sustainable

Our agricultural research aims to improve the sustainability of our food and farming systems by working with farmers to help reduce the need for inorganic fertilisers, reducing emissions from livestock production, and developing alternative protein sources to imported soya used in human and animal food. We are also developing better biomass crops to more effectively capture and store carbon from the atmosphere, working collectively to help society take the next critical steps toward a Net-Zero future.

## Developing enabling tools and technologies to make that happen

Our researchers continually develop and adapt 21st century tools to target challenges in plant science, breeding, and biotechnology. We apply the latest scientific and IT tools such as multi-spectral imaging, robotics, machine learning and artificial intelligence to speed up conventional breeding, and access traits previously inaccessible to crop breeders. We are developing next generation field monitoring tools to enable smart and precision agriculture, and working to find novel biotechnology solutions to convert plants to products and turn waste into wealth.



# The IBERS ecosystem

IBERS researchers work on a wide range of different plants, animals, and agricultural systems, but its core research is centred on meeting the challenges of grassland farming and the science that underpins the breeding of new and improved varieties of oats, forages, legumes, and energy crops.

Based at the Gogerddan campus outside Aberystwyth, IBERS provides national capabilities in grassland and plant breeding science that includes its Seed Bank, the National Plant Phenomics Centre, the Grassland Research Platform, and the biorefining pilot facility.

This unique research ecosystem enables us to develop the crops of tomorrow, helps make agricultural production more sustainable, and helps develop enabling technologies to achieve those aims. By improving field monitoring, making agriculture more precise, and finding new ways to convert plants to products, we are working to reduce our environmental footprint and our reliance on fossil-based fuels and materials.

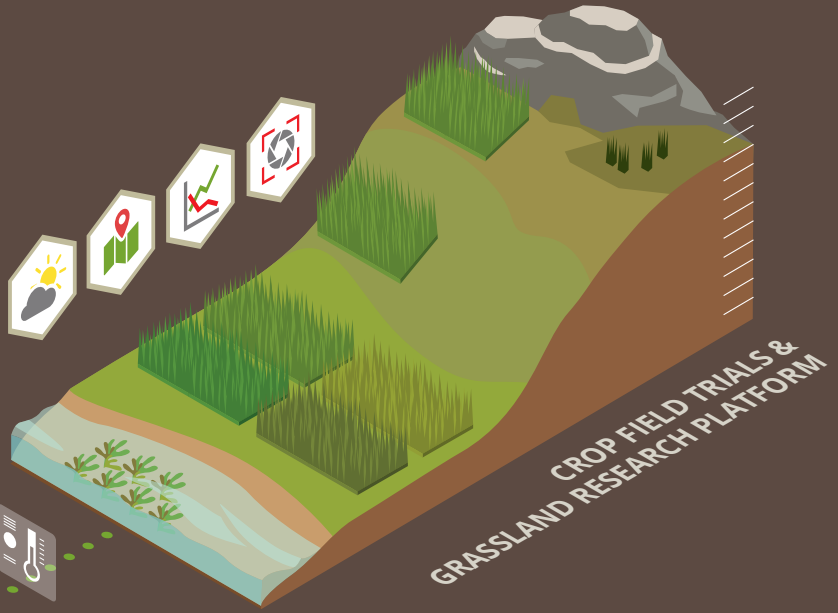
A vital part of the IBERS ecosystem is our relationships with longstanding industrial partners, farmer networks and outreach teams who help us better understand the challenges facing modern agriculture and help us get new crop varieties, farming practices and industrial processes out of the laboratory and into the real world.



# ibers

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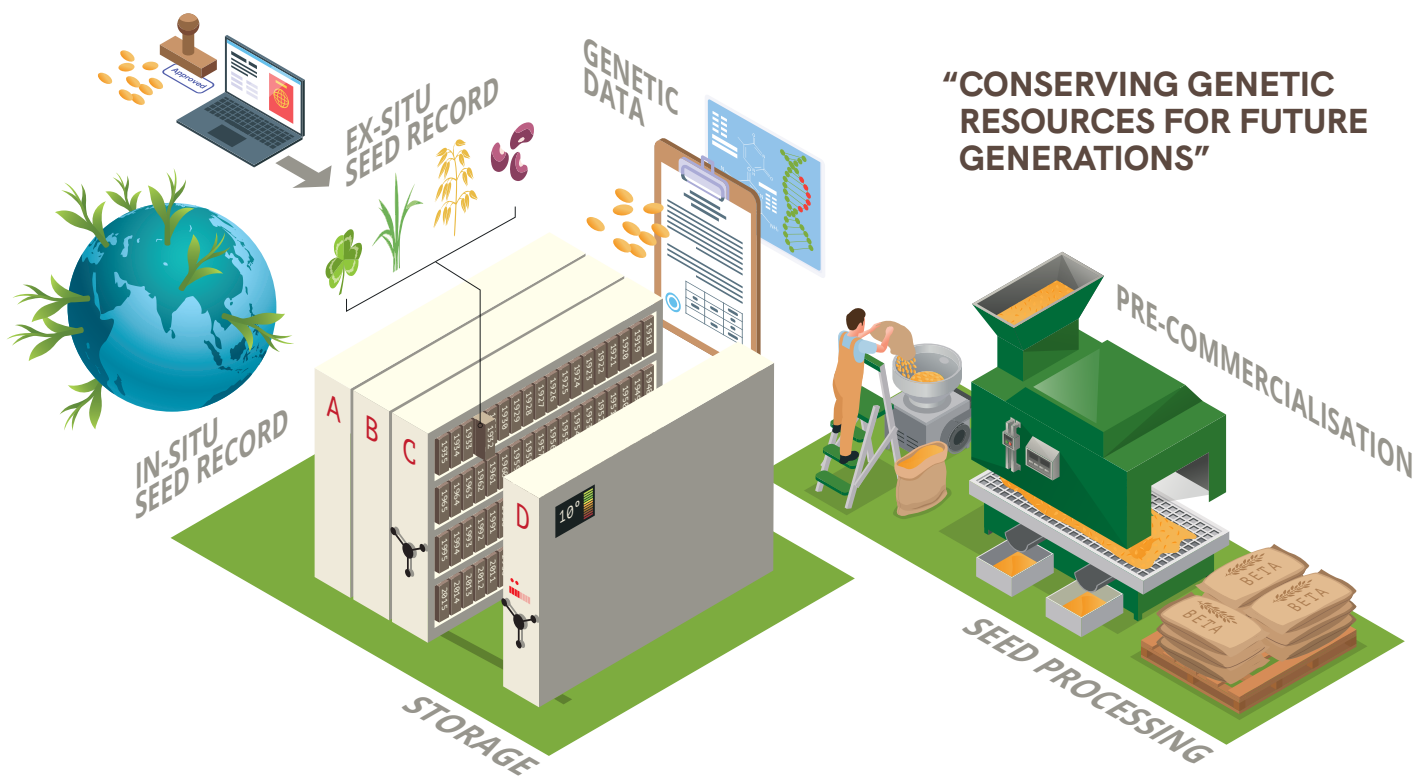
## OUR ECOSYSTEM



# IBERS Seed Bank

At the heart of the institute, the IBERS Seed Bank safeguards one of the world's largest collections of seeds from grasses, clover, oats and miscanthus. Plant seed from all over the world has been collected and stored at the institute since 1919. The Seed Bank currently holds over 43,000 accessions and is designed to provide safe storage of plant material for 100 years or more; safeguarding genetic resources for study and use by future generations of plant scientists and breeders around the world.

The IBERS Seed Bank is one of only a few quarantine facilities in the UK permitted to handle exotic plant material and manages plant passport data for these collections. The facility also manages the UK National Inventory and contributes to international genetic resources databases, such as the European EURISCO catalogue and the Genesys global gene-bank, established by the FAO to conserve crop diversity and keep crop genetic resources available globally for the future benefit of mankind.







## Safeguarding biodiversity in-situ and ex-situ

Traditionally, gene banks have focused on ex-situ conservation methods that use breeding and maintenance of species outside their natural ecosystems. This has been a vital means of protecting endangered species and safeguarding genetic resources, but those genetic resources can become effectively frozen in time, and large populations of a species are not able to continue to thrive and adapt. The IBERS team has been working closely with the UK and the European communities on developing in-situ conservation approaches that conserve biodiversity in its natural habitat. Helping to protect biodiversity and helping it to thrive where it belongs and naturally strengthening ecosystems.

## Genomics - Supporting plant genetic research and crop breeding

IBERS genomics research enables a better understanding of the genetic diversity of our target crops, how genes regulate plant growth and determine specific traits or characteristics. Using genetic resources, including within the IBERS seed bank, our cutting-edge research is able to examine commonalities and differences in genomes across different varieties, helping us to direct the breeding of new crop varieties that can better perform under challenging conditions of current and future climates.

# The National Plant Phenomics Centre

Plant breeding relies on observing differences in the way plants grow, identifying the desirable characteristics or traits, such as harvestable yield, drought tolerance or nutritional quality, and understanding how these traits are controlled by genetic and environmental influences.

The National Plant Phenomics Centre is a state-of-the-art facility that brings together biologists, engineers, computer scientists, and mathematicians to investigate how genes and the environment

interact and give rise to characteristics (or phenotypes) of different plants.

Our controlled environment glasshouses, high-throughput automated growing facilities and field monitoring drones, coupled with multispectral imaging, robotics, and machine learning (a branch of artificial intelligence) allow IBERS researchers to apply 21st century technology onto a hundred years of experience of grassland science and plant breeding.

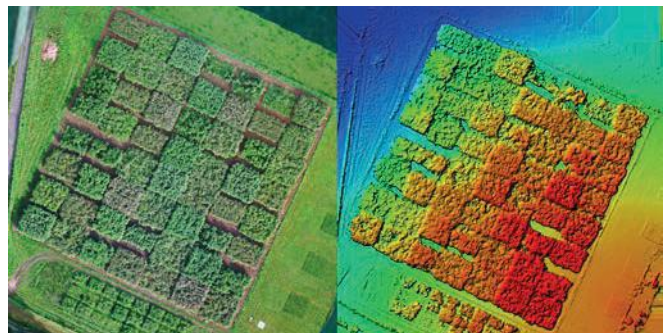




For much of human history many of the traits used in plant breeding have been selected by eye. Digital imaging technologies now enable plant breeders to observe plants with a hundred different eyes. For example, eyes that can see in multiple spectrums, give a birds-eye view over fields, see through plant tissues and even through the soil to observe how root structures grow.

Use of the latest imaging technology coupled with machine learning, enables IBERS researchers to capture a vast array of imaging data from large numbers of plants in a short space of time. Such technologies facilitate work to be done in months that would previously have taken many years using traditional plant breeding approaches.

Developmental stages during the life of a plant can be captured, in three dimensions, and changes modelled over time. This allows a whole new range of traits to be measured that have previously been inaccessible to plant scientists and breeders. The phenomics centre therefore carries out research that furthers our fundamental knowledge of plant science, speeds up crop breeding and builds datasets that can be applied to multiple crops and used to develop new machine learning systems and AI applications to further accelerate progress.



# Grassland Research Platform

Our grassland research scientists, industrial partners, and farming networks are working to enhance the sustainability of grassland agriculture and help deliver net-zero food and farming systems by 2050. A total of 47 forage crop varieties (e.g. perennial ryegrass, red and white clover) have been developed that IBERS science has helped underpin and are commercialised by long-term commercial partners Germinal Horizon.

We work with industrial partners from across the agricultural supply chain and conduct participatory research with farm businesses to gain better insights into their real-world challenges, the barriers to change, and focus on the science that is most needed to better support our agricultural communities. Taking a whole farm systems approach, our multidisciplinary research teams work closely with farmers to help deliver more productive, resilient, and sustainable agri-food systems.

Currently livestock systems occupy about one third of available agricultural land globally, contribute to 40% of the value of agricultural outputs, and one third of the protein consumed by humans (FAO, 2019). Increasing demands for animal products and also plant-based alternatives are predicted to continue due to population growth and increasing consumption per capita.

There is an increasing need to better understand the impact of livestock farming on the environment and find ways to reduce its environmental footprint over the whole system. This includes the breeding of more resilient forage crops that are better tailored to ruminant diets. In addition, forage crops can be processed to provide feed for monogastric animals and pulses grown to provide alternative protein sources for animals and humans.

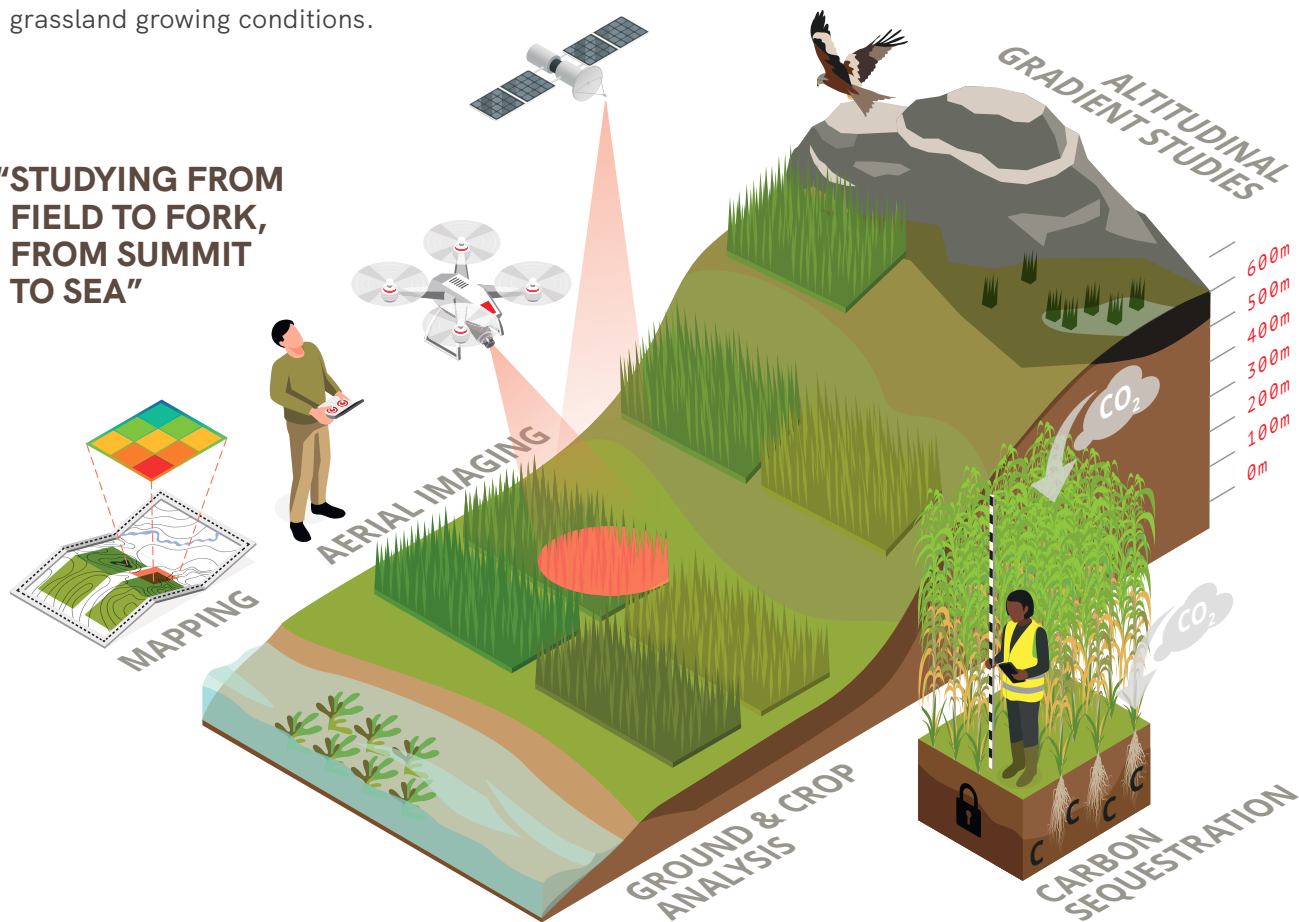


IBERS core research is centred on meeting the challenges of grassland farming and the science that underpins the breeding of new and improved varieties of forages, legumes, and energy grasses.

IBERS has access to over 1,000 hectares of grassland that is managed by Aberystwyth University and used for farming and environmental research. IBERS altitudinal gradient trials are spread across multiple sites and altitudes (0-600 m), selected to account for both upland and lowland systems and to be representative of 60% of all UK grassland growing conditions.

The experimental and observational datasets obtained from these sites, which include the Pwllpeiran upland research platform and Trawsgoed farm, are critical to understanding crop resilience, untangling genetic and environmental influences on crop performance, and better understanding grassland agricultural systems. This long-term information is needed to provide a robust evidence base to inform policy in changing atmospheric, economic, and political climates.

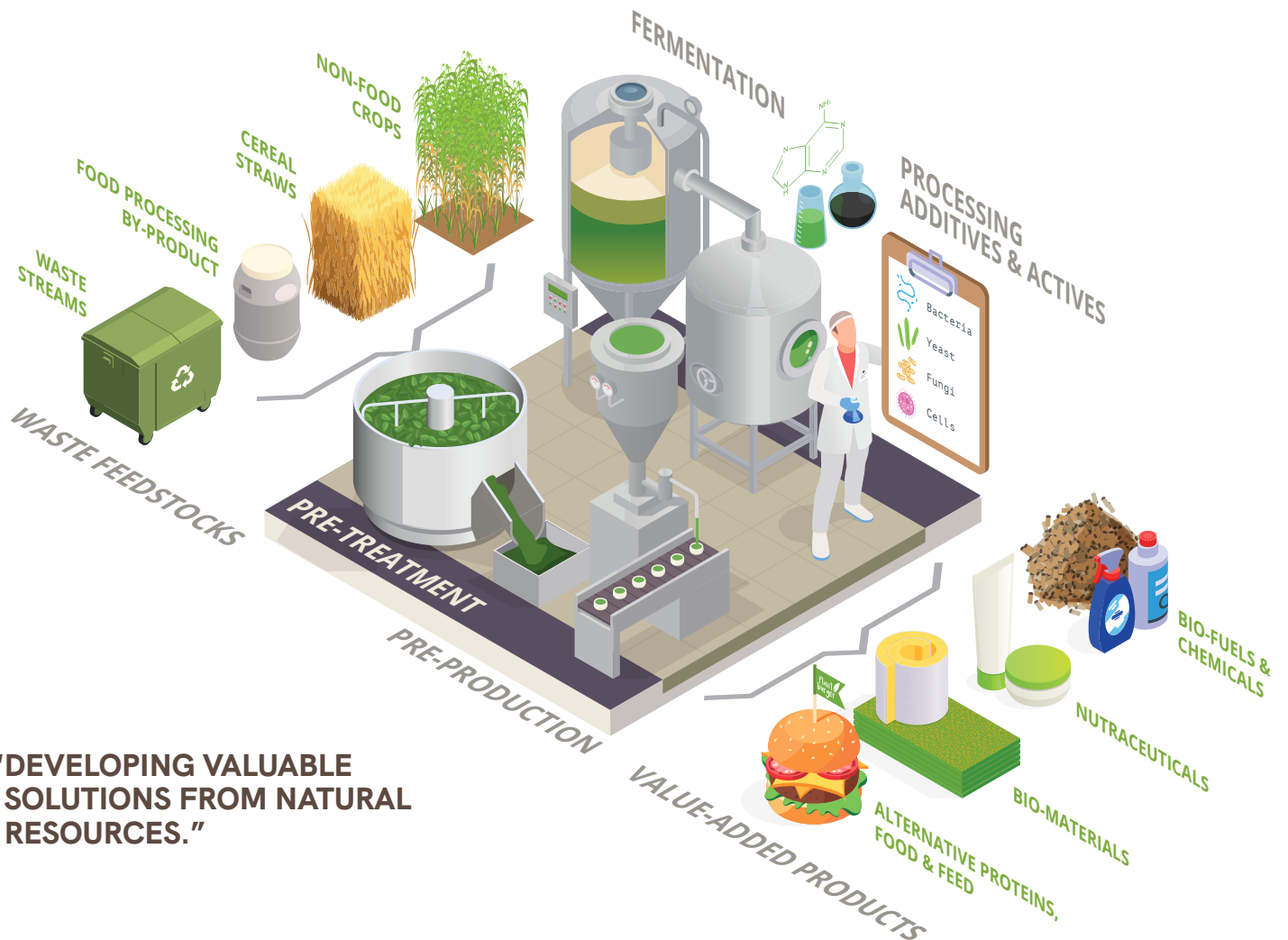
**“STUDYING FROM  
FIELD TO FORK,  
FROM SUMMIT  
TO SEA”**



# Biorefining

Biorefining is a way to convert organic material into a range of useful products such as food additives, fuels, chemicals, and materials. IBERS biorefining pilot facility applies the latest innovations in bioprospecting, synthetic biology, biomass

processing, fermentation, anaerobic digestion, and thermal conversion to add value to underutilised resources from agriculture, food production, and manufacturing.



**“DEVELOPING VALUABLE SOLUTIONS FROM NATURAL RESOURCES.”**



The facility focuses on supporting applied research and industrial collaborations through our research team and working in partnership with AberInnovation, the co-located Innovation and Enterprise Campus. A range of biological organisms can be used in our fermentation systems which can be tailored to convert a wide variety of organic materials such as grasses, energy crops, cereal straws, seaweeds, and industrial co-products into useful end-products, and their conversion processes optimised. A wide array of different pretreatments and downstream processes can be applied, and experiments performed at scales that range from small laboratory testing all the way up to pre-commercial scales (TRL 1-5).

Our biorefining team has over a decade of experience in applying biotechnology solutions to real-world problems, and has assisted in hundreds of collaborative projects, both within the UK and around the world, to help researchers and businesses to take the first vital steps toward commercialisation of their products or processes.

## Commercial partnerships

We have worked with **Quorn Ltd** to extract flavour enhancement compounds from their food-grade process side streams that enabled them to reduce the salt content in some of their products by up to 35%.

Our work with **Fiberight Ltd** has supported development of a process to convert black bin paper and card waste into free sugars that can be fermented into lactic acid, a platform chemical used to make biodegradable plastics, at a 1,000 litre scale.

Xylitol is a natural sweetener proven to prevent tooth decay and obesity in children, without the downsides of other artificial sweeteners. IBERS spinout company, **Arkitek-Bio**, has developed a process for producing xylitol from agricultural straws using a biological production process that is more environmentally friendly than the conventional chemical catalysis methods.

# Strategic crop breeding & plant research



Perennial ryegrass  
*Lolium perenne*



Oats  
*Avena sativa*



Miscanthus  
*Species/hybrids*



Clover  
*Trifolium repens*



Field bean  
*Vicia faba*



Hemp  
*Cannabis sativa*



Clover  
*Trifolium pratense*



Pearl millet  
*Pennisetum glaucum L.*



Macroalgae  
*Multiple genera*

## Forages

Forage crops play a crucial role in livestock agriculture, providing feed for animals and contributing to the overall productivity and sustainability of the livestock industry. IBERS has a long history of forage crop research, improving genetic traits for enhanced yield, nutritional quality, and environmental resilience. IBERS science underpins 47 ABER varieties of grass and clover on

the current UK National Variety List, commercialised by our long-term partner Germinal Horizon Ltd. Through interdisciplinary and commercial collaborations, IBERS aims to advance sustainable and resilient forage crop systems to support livestock agriculture and provide the science needed to support breeding and commercialisation of new varieties.



## Healthy Grains

IBERS research and breeding teams are working to improve the nutritional composition and health benefits of cereals and pulses. Our work involves genetic enhancement of grains to improve yield, milling quality, resistance to pests and disease, environmental stresses, and improved nutritional qualities to contribute toward healthy balanced diets.

- **Oats** have been bred at the IBERS site for over 100 years and we currently have 27 varieties of oats on the UK National list. These include both spring and winter oats and husked and naked varieties. Our commercial varieties collectively comprise 80% of the winter oats grown in the UK, marketed by our long-term commercial partner Senova Ltd. IBERS researchers are working to produce new varieties with improved nutritional qualities such as higher  $\beta$ -glucan content which has been proven to help lower cholesterol.
- **Pulses** (field beans and peas) introduce a much-needed nitrogen fixing crop for arable rotations and give a high-protein product for human nutrition and animal feed that is more sustainable than imported soya alternatives. We currently have five winter field bean varieties on the UK National Variety list which are marketed through a long-term agreement with commercial partner UK Pulses and comprise 75% of the market share of seed production.
- **Pearl millet** is a staple crop for more than 200 million of the world's poorest and most nutritionally insecure people. IBERS is working with partners to develop new varieties that are better adapted to local growing conditions, have higher nutritional value, and low-GI varieties to help address the global issue of diabetes.

## Industrial Crops

IBERS researchers also work on a range of industrial crops for fuels, chemicals, materials, dietary supplements, and pharmaceuticals.

- **Miscanthus**, a biomass crop to capture carbon emissions from the atmosphere and provide an alternative to fossil fuels, chemicals, and materials. Seven new varieties have been registered for intellectual property protection under the European system for plant breeders and are licenced to Terravesta for commercial deployment.
- **Hemp** is used to make a wide range of products from clothing to building materials, food, and medicines. IBERS researchers are investigating the potential for improving the fibre quality, oil and protein content of the seed, and boosting the health benefits by improving antioxidant and anti-inflammatory properties.
- **Macroalgae** are marine crops used in numerous sectors including food, farm and pet feed, fertilisers, nutraceuticals, textiles, printing, and pharmaceuticals. IBERS researchers are working on biofertiliser properties of seaweeds, identifying applications for problematic macroalgae blooms, and working with commercial partners for pilot-scale processing trials and developing macroalgae-based plastic films to replace fossil-derived food packaging.

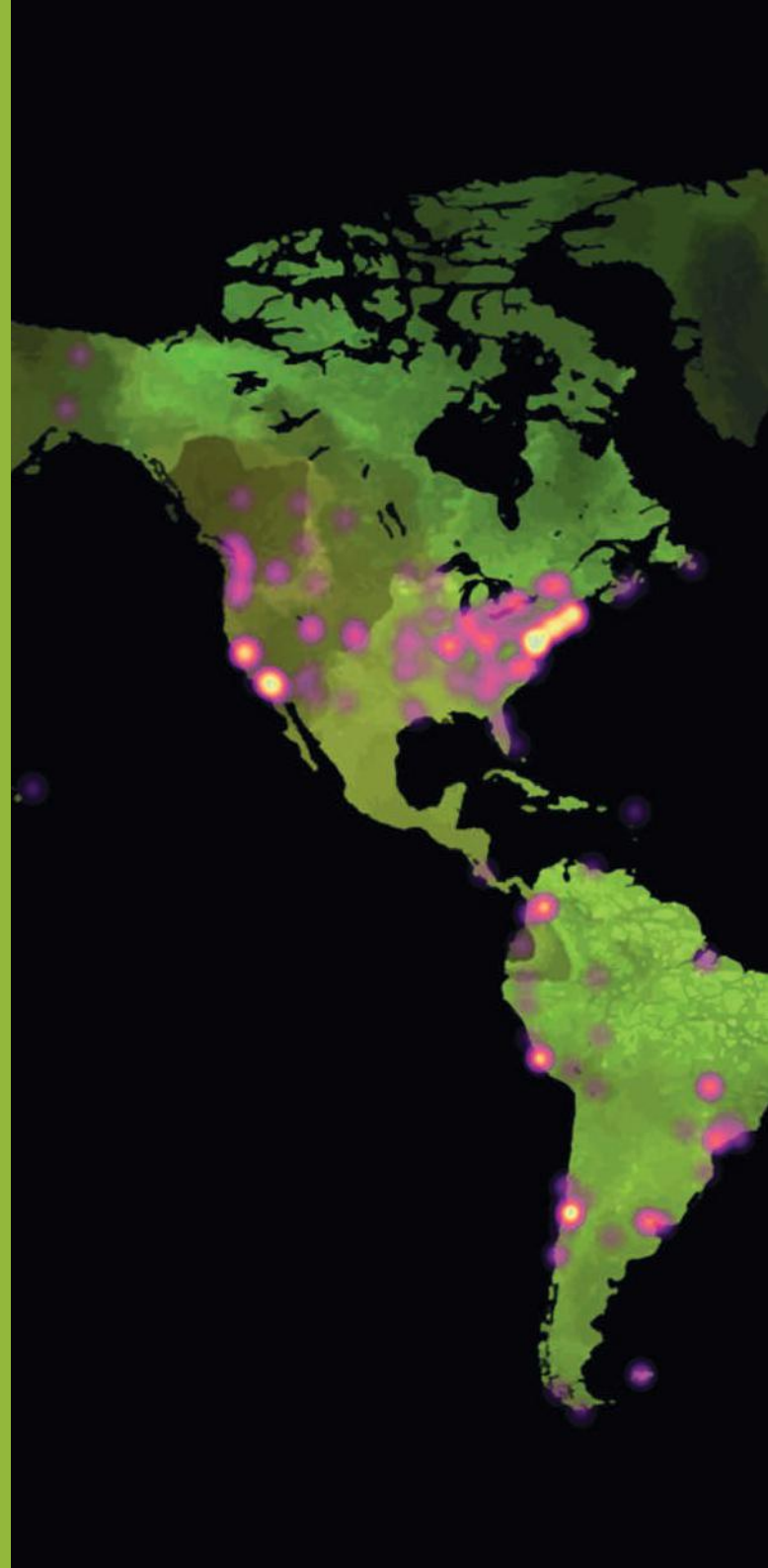
# Global Reach

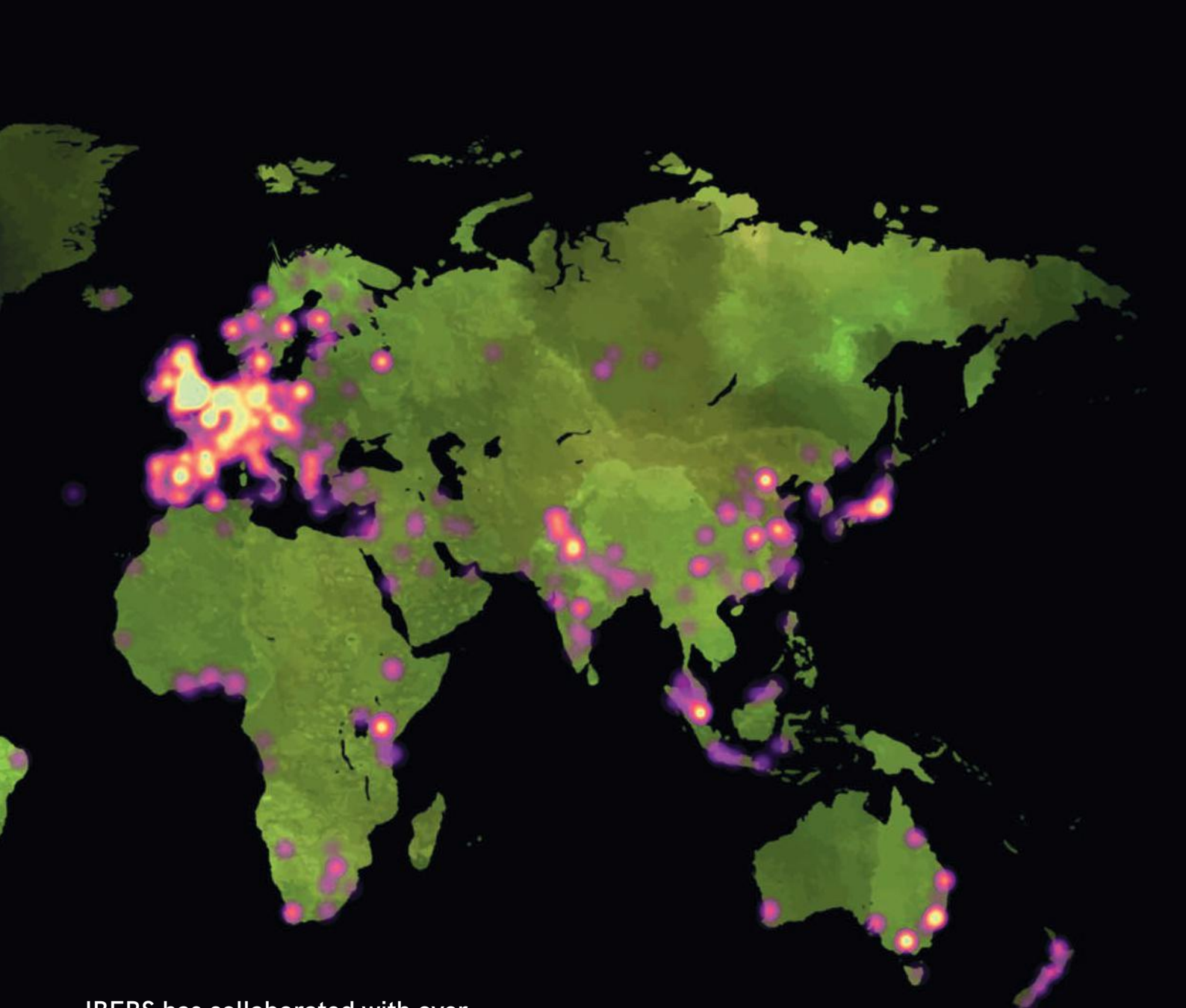
The Institute of Biological, Environmental and Rural Sciences (IBERS) is an internationally recognised research and teaching centre that provides a unique research capability to tackle global challenges. Our facilities and expertise form an essential component of international research infrastructure for plant phenotyping (EPPN/IPPN) and part of a global network of seed banks, dedicated to the conservation and sharing of genetic resources (EURISCO).

We are a member of the European Plant Science Organisation (EPSO), the Centre for Innovation Excellence in Livestock (CIEL), and an active collaborator on numerous projects within the EU Horizon research programme. Beyond Europe, we have developed long-term partnerships with institutions in Australia, Brazil, Canada, China, India, Japan, Korea, Taiwan and the United States.

Through our national and international collaborations, we seek to further our knowledge of grassland habitats, farming systems, and crop genetic resources; working in partnership with academia and industry to develop new innovations in bioenergy, agriculture, and biobased technologies to tackle the global challenges of the 21st Century:

- **Climate change adaptation and mitigation**
- **Making agriculture more sustainable**
- **Producing healthier food**





IBERS has collaborated with over 1,000 institutions around the world.



## National Plant Phenomics Centre

IBERS hosts the National Plant Phenomics Centre (NPPC), an automated system for non-invasive longitudinal phenotyping for up to 3,400 individual plants. The NPPC allows populations of crops, and other plants, to be assessed by non-invasive imaging technologies to record shoot growth and development, water content, photosynthetic activity, temperature and root development.

For more information visit:  
[plant-phenomics.ac.uk](http://plant-phenomics.ac.uk)

[aber.ac.uk/en/ibers](http://aber.ac.uk/en/ibers)

 [@ibers\\_aber](https://twitter.com/ibers_aber)



## IBERS Distance Learning

IBERS distance learning offers a range of training opportunities to develop skills and gain qualifications relating to the Agrifood sector. Providing flexible courses for those already working in the sector or looking to start a new career.

For more information visit:  
[ibersdl.org.uk](http://ibersdl.org.uk)

Contact us via:  
[dl-enquiries@aber.ac.uk](mailto:dl-enquiries@aber.ac.uk)  
or **01970 823244**

 +44 (0) 1970 823000

 [ibrstaff@aber.ac.uk](mailto:ibrstaff@aber.ac.uk)



## IBERS Knowledge Exchange Hub

Provides digests of the latest research and runs demonstrations and events to keep the farming community up to date with policy and outputs from the global scientific community.

- Farming Connect aims to help revitalise rural communities and provide support for agriculture and forestry in Wales.
- Biomass connect aims to support development of the UK biomass industry.

For more information visit:  
[www.aber.ac.uk/en/ibers/working-with-industry/ke-hub](http://www.aber.ac.uk/en/ibers/working-with-industry/ke-hub)



## Aber Innovation

Providing support for businesses seeking to develop new products and processes in the agri-tech, food, drink and bio-economy sectors.

For more information visit:  
[aberinnovation.com](http://aberinnovation.com)

Contact us via:  
[innovate@aber.ac.uk](mailto:innovate@aber.ac.uk)  
or **01970 621809**



IBERS is a BBSRC strategically funded Institute, and a National Capability in Grassland and Plant Breeding Science.