

## Landscape Analysis for an Agricultural Resilience Impact and Innovation Hub (AGRIIH) at Oxford

Condensed Report

Full report prepared for the University of Oxford January 2025

This report summarises our review of the research and innovation landscape in agricultural resilience.

## Contents

1. Executive Summary	3
2. Introduction and Objective	5
3. Research and Findings	6
4. Discussion	
5. Conclusion	



## Landscape analysis for an Agricultural Resilience Impact and Innovation Hub (AGRIIH) at Oxford

## I. Executive Summary

Agriculture is vital to the world, but lacks in resilience. The University of Oxford has world-leading expertise in many disciplines valuable to improving agricultural resilience, from plant sciences and ecology to behavioural sciences, and systems thinking. It has the vision for an Agricultural Resilience Impact and Innovation Hub (AGRIIH) to link its own agriculture-related research, connected disciplines, and form external partnerships to increase impact and innovation, resulting in greater resilience in agriculture in the UK and globally.

Red Kite researched the landscape of agriculture research, with a focus on resilience and innovation, through a combination of desk research and interviews, covering agriculture in the UK, Europe and the Global South.

We found strong evidence that **resilience** is an important topic in agriculture. The importance of resilience was emphasised in our interviews and other sources. People stressed that this was not a short-term topic "*Instability is going to increase, shocks are going to get worse, and we have to get ready for that.*" Climate change was the most often mentioned threat to resilience, particularly the impacts of too much or too little water. But social, political and financial aspects of resilience were mentioned as well, and how a drive for efficiency had reduced resilience.

Sources also noted the **system nature of resilience**: "*resilience is by default holistic, covering many bases*", and practitioners, academics and funding sources all noted value in a systems approach. Descriptions of the 'system' would include supply chain, economics, social and environmental impacts.

Many sources noted a **gap between research and its adoption**. Several root causes were identified, including poorly coordinated research that was often not aligned to stakeholder or farmer priorities, poor communication or knowledge exchange, and a failure to commercialise – the 'valley of death'. Farmers showed preference for innovation that fits into their existing systems, but were also interested in exploring new business models for resilient and sustainable agriculture where they recognise this is necessary.

Looking at the **institutional landscape**, The UK has 18 universities with significant agricultural research, and at least 16 related research institutes and other bodies. The universities are generalist, covering a wide range of agriculture-related research, whereas the institutes have more specialised roles. Internationally, we looked at several interesting institutions, most interesting of which were Wageningen University and Research in the Netherlands and the Danish Centre for Agriculture (DCA) at Aarhus University.

Wageningen is an acknowledged global leader in agriculture. It benefits from being the focus of resources in an agriculturally focused country, and has 7600 staff and 13000 students. Its 10 Research institutes have revenue of €419m, equivalent to 10 UK research institutes, but united in one group.

**DCA** is the closest match to AGRIIH we found. Its founding role was policy support, outsourced by the Danish Ministry for Food, Agriculture and Fisheries. It has expanded this into a hub for communication and collaboration with business and international partners. It regularly raises funds from foundations and international organisations to match Danish core funding for agricultural research, achieving strong leverage on the original funding.

In the **funding landscape**, UKRI was the largest funder of agriculture-related research. BBSRC identifies 'Sustainable agricultural systems' as a focus topic, and is likely to be interested in research in this area. NERC has also highlighted agriculture in its strategy, with other research councils funding social, economic and other aspects of agriculture-related research. We found small amounts of industry funding going to UK universities and institutes, but large amounts being spent overall. The challenge is to consider whether there are aspects of agricultural resilience research that are valuable to a commercial business, or to a consortium. Large foundations or donors are a proven source where there is a significant benefit to humankind, and could be an opportunity.

AGRIIH will be able to differentiate by using systems thinking to understand the full problem, by bringing Oxford's interdisciplinary expertise together, and by using Oxford's influence to reach beyond Oxford for collaboration and influence. By doing so it will be able to work with others to tackle bigger problems, with a higher chance of success, and to find solutions and innovations to make agriculture more resilient in an increasingly uncertain world.

## 2. Introduction and Objective

Agriculture provides the food and more for the world's eight billion people, but current agricultural systems are not sufficiently resilient, having been likened to 'flying with one engine'<sup>1</sup>. They are vulnerable to environmental, political and economic shocks, and longer-term pressures. At the same time, agriculture has a major impact on climate change and biodiversity loss, that must be addressed if we are to meet global carbon net zero and biodiversity recovery targets.

The University of Oxford is home to world-leading research in many disciplines linked to agriculture, from fundamental plant sciences, pure and applied ecology, to environmental research, economic and behavioural sciences. It has a vision for an Agricultural Resilience Impact and Innovation Hub (AGRIIH) that brings together these disciplines to 'generate a transformational shift in the scope of our agricultural research impact, by engaging industry and stakeholders to co-develop novel and industry-relevant research and innovation that transforms our agriculture for a resilient and sustainable future'.

The objective of this piece of work is to understand the research landscape in the area of agricultural resilience, to inform the development of AGRIIH, ensuring that it addresses key knowledge gaps and barriers to impact, and offers an effective and complementary addition to the agricultural research landscape.

#### Definitions

By "**agriculture**" we include all terrestrial cultivated crops and livestock for food and non-food products (e.g. also including forestry and fibre production etc). Aquatic farming is excluded from the scope of this project.

By "**resilience**" we mean the ability of agriculture to produce enough food and resources to meet our needs without degrading the environment and biodiversity, and to withstand and adapt to a range of environmental, economic and social changes. (i.e. broader than simply resilient to climate shocks.)

<sup>&</sup>lt;sup>1</sup> John Baffes, senior agricultural economist, World Bank in the <u>Financial Times, 29 January 2023</u>

## 3. Research and Findings

We conducted a programme of research using interviews and desk (website) research for the project, covering UK and international agriculture and institutions. We focused our research on UK and International agriculture research, resilience and innovation, and on Oxford's expertise and relative standing in the field.

Our desk research included publications about agricultural research from the Agricultural Universities Council UK, Centre for Effective Innovation in Agriculture (CEIA), Biotechnology and Biological Sciences Research Council (BBSRC) – the main science funding body for the area, UKRI, and the UK Agri-Tech Centre. International input came from the UN Food and Agriculture Organisation (FAO), CGIAR and AGRA documents. In addition, we reviewed the annual reports of UK 'pure play' agricultural research institutions and universities to understand where they received their funding from. These are referenced below, where relevant.

Our findings were presented and discussed with members of the AGRIIH Steering Committee on 17 January 2025.

Interviews						
<ul> <li>UK Agriculture</li> <li>UK Agri-Tech Centre</li> <li>Defra</li> <li>Earth Trust</li> <li>Entrade</li> <li>InnovateUK / UKRI</li> <li>National Farmers' Union (NFU)</li> <li>Royal Agricultural University</li> <li>Scotland's Rural College</li> <li>University of Nottingham</li> <li>Harper Adams</li> <li>CABI inc. the UK-CGIAR Centre</li> <li>International</li> <li>DCA, Aarhus University, Denmark</li> <li>Wageningen, NL (2 interviews)</li> </ul>	<ul> <li>University of Oxford</li> <li>Will Thompson (interdisciplinary ecology and social science)</li> <li>Lars Ostergaard (molecular plant science)</li> <li>Monika Zurek (food systems)</li> <li>EJ Milner-Gulland (ecology and conservation science)</li> <li>Jane Langdale (molecular plant science)</li> <li>Lexi Earl (Future of Food, Oxford Martin School)</li> <li>Steven Kelly (plant science spinout founder)</li> </ul>					

#### Table 1: Interviews conducted for the project

#### Agriculture-related research

#### Resilience

We found strong evidence that resilience is an important topic in agriculture. Sometimes this was described as sustainability, but the main difference being that 'resilience' is more dynamic and described



as the 'resistance to risks' which can be of many forms where 'sustainability' sometimes focuses on a more 'steady state' view.

In the UK, recent research by CEIA shows that the highest number of priorities for UK farmers and growers are in 'Sustainable agricultural systems'.



Figure 1: Farmer and Grower priorities by BBSRC focus area (CEIA)<sup>2</sup>

Internationally, studies of the agriculture and food system are explained in terms of resilience and risks. Food prices were already elevated before Russia's invasion of Ukraine, due to droughts and pandemicrelated hoarding by governments and businesses. Then crop nutrient prices soared because of Russia's position as the world's largest fertiliser exporter, while the jump in natural gas prices, a critical ingredient for nitrogen fertilisers, also piled pressure onto agricultural markets.

John Baffes, senior agricultural economist at the World Bank describes it as a resilience issue: "It's like flying with one engine, as long as that engine works it's fine, but if the engine stops then you have problems... If any of [these risks] materialise, we'll see a [rise in prices] very, very quickly."<sup>3</sup>

The importance of resilience to agriculture, and that this is not simply a fashionable trend in research, was emphasised in all our interviews.

- "Resilience is critical"
- "Resilience is **a more intelligent analysis** than simply 'sustainability' ...it recognises change rather than trying to halt it"
- "Resilience is a common feature of population biology (Darwin spoke about it), but it's only relatively recently post-Covid and Ukraine that the UN have put it on their agenda"
- "Resilience as a policy challenge has the potential to give **impact and meaning** to multiple disciplines"
- "Resilience research needs to be by default 'super holistic' covering many bases"
- "Resilience is hampered by lack of confidence of individuals to make the right decisions"

<sup>&</sup>lt;sup>2</sup> <u>UK farmer & grower research priorities</u>, Centre for Effective Innovation in Agriculture (CEIA) & partners, (Oct 2024)

<sup>&</sup>lt;sup>3</sup> Financial Times, 29 January 2023 <u>'Flying with one engine': why global food supplies are at risk despite falling crop prices</u>



- "Loss of crops largely due to flooding has highlighted our need to focus on resilience"
- "Resilience will always be there going forward water resilience in particular"
- "Instability and shocks are now the name of the game for the future"
- "We have been obsessed with efficient systems in the past but now **we must have efficiency** <u>and resilience hand in hand</u>"
- "Many things contribute together to create resilience it's not a single area of research"
- "Diversity delivers resilience agriculture has focused on efficiency for a long time which has driven monoculture and loss of diversity in the system"
- "Climate change is critical to resilience, but not the only aspect also market forces, policies, geopolitical, trade etc.."
- "For example, some farmers cannot take a loan based on a stable income climate, rainfall, prices, political instability [are resilience problems].

#### Table 2: Interview comments on resilience in agriculture

Climate was the most often mentioned aspect of risks to resilience, particularly the effects of too much, or too little water. It was described by one interviewee as "...the number 1 issue. It's the existential threat that is having impact now and not just in a few years or decades time". Some noted that a focus on efficiency alone in agriculture had reduced resilience, through reducing biodiversity, monocropping or tightening supply chains. In reality, both efficiency and resilience are needed.

The importance of biodiversity to resilience was emphasised, either as the resilience of a diverse ecosystem, or the fragility of a monoculture.

Several people noted that resilience was inherently multi-dimensional, and required consideration of wider social, economic and political systems to tackle. Emphasising that these issues are not going away, an interviewee from a major European University said, "*Instability is going to increase, shocks are going to get worse, and we have to get ready for that.*"

The social aspects of agriculture were also mentioned by several of our interviewees as contributing to overall resilience. One European academic commented "We should pay much more attention to the resistance to change than to innovation". In the UK the 2024 Autumn Budget reduced Agricultural Property Relief (APR) and accelerated removal of the Basic Payment Scheme (now capped at just £7.5k per business regardless of the size of the enterprise), which has undermined some farmers' ability to look forward and take risks. This was mentioned by some of our interviewees as a significant barrier to achieving agricultural resilience. It is an example of something (in this case a policy change) that has generated uncertainty in an already fragile financial situation for many farm businesses. It was stated that consequently "Some actions that will aid resilience for the business in the future carry risk and upfront investment now. ..... [but] there's a lack of appetite for risk right now, and that's a significant barrier to thinking and planning forward". This example emphasises the need for appreciation of the human aspect of building resilience into agriculture and how interactions with other aspects of the system can affect efforts to build resilience.

#### Systems thinking

We found strong evidence that a broad, 'systems thinking' approach, including supply chain, economic, social and environmental impacts, was seen as valuable. This came from practitioners, academics and research funders.

CEIA's research showed that there were many general farmer and grower priorities that matched the 'Agri-Food Net-Zero Network+' (AFN+) themes, and these were particularly in the wider 'system' for example 'institutional barriers to a systems approach' and 'optimising UK land use under changing climate'.



Figure 2: Farmer and grower priorities by AFN+ theme<sup>4</sup>

They also found a match with regenerative farming priorities on systems issues, noting "In particular, they are interested in understanding socio-economic barriers to sustainable practices and the value of environmentally sustainable farming.".



Figure 3: Comparison of Farmer and grower priorities with Regenerative farming priorities<sup>5</sup>

<sup>&</sup>lt;sup>4</sup> <u>UK farmer & grower research priorities</u>, Centre for Effective Innovation in Agriculture (CEIA) & partners, (Oct 2024)

<sup>&</sup>lt;sup>5</sup> <u>UK farmer & grower research priorities</u>, Centre for Effective Innovation in Agriculture (CEIA) & partners, (Oct 2024)



Our interviewees also emphasised the importance of the systems approach.

- "It is the system that produces the outcomes, and is the sum of its parts, and resilience is a product of the system."
- "We tend to create tools in the absence of understanding the broader question"
- "The presentation of integrated whole-system approaches is under-provided"
- "We need to instil systems thinking, because currently much agricultural research in the UK is very silo-based, not helped by lack of awareness withing Government of the broader complex system"
- "Technological advances alone won't solve the problem, instead we need to enhance the capacity of the <u>whole system</u> to respond" ... but "players [in the system] will fight hard not to give away power"
- "Each individual actor within a system will have a role to play and so any solution will need each actor to have actions"
- "Changing agriculture is not enough it won't change the food system. You need to address the vulnerabilities and problems within the whole system to have any impact on agricultural resilience"
- "If you want resilient systems, you need truly interdisciplinary research"
- "We need to get out of our comfort zones instead of stay in our discipline norms"
- "When we speak of food systems, it's all linked", but "everyone says that everyone else has to change first"

#### Table 3: Interview comments on the systems approach and interdisciplinarity

BBSRC, the Biotechnology and Biological Sciences Research Council, have also included the systems approach in their research priorities. However, these 'priorities' as written appear wide enough to capture almost any aspect of agricultural research.





<sup>&</sup>lt;sup>6</sup> Source: BBSRC Research in Agriculture and Food Security – <u>Strategic Framework</u> published July 2017

NERC, the Natural Environment Research Council, are involved jointly with BBSRC in 'Molecules to Landscapes', a  $\pounds$ 6 million project supporting whole-systems research to identify how the agricultural system can be a net provider of both agricultural and ecological services.

The necessity of systems thinking becomes clear when looking at global agriculture issues. A good example of this is in the Food, Fuel and Fertiliser Crisis: Situation Report, by AGRA<sup>7</sup>. This report describes, among other effects, how high fuel prices led to high fertilizer prices, which led to lower fertilizer use, which led to lower crop yields and hence higher food prices in sub-Saharan Africa. Higher fuel prices and trade restrictions also reduce the flexibility of trading food to escape this problem.

#### Research and its application

Agricultural Universities Council – UK (AUC-UK) in its 2023 Research Strategy, sets out a position that despite the UK having high levels of agriculture research, it has not achieved high levels of productivity gain.



Figure 5: Agricultural productivity growth vs. public R&D intensity<sup>8</sup>

<sup>&</sup>lt;sup>7</sup> Food, Fuel and Fertiliser Crisis: Situation Report -February 2023 Policy Brief, Dave Watson, AGRA

<sup>&</sup>lt;sup>8</sup> Source: Agricultural Universities Council UK - <u>Research Strategy</u> (May 2023)



The consensus view across AUC-UK and large parts of the industry, both UK and international, was that the gap is in 'adoption' of research and innovation. AUC-UK and CEIA research sheds light on the main causes of this adoption gap.

AUC-UK's stakeholder survey showed respondents considering that UK research was 'world-class', but poorly coordinated and poorly communicated. More than half the time, the research was considered not 'in touch with farmer and other stakeholder priorities' or not 'focused on the most important issues'.



Figure 6: Agricultural stakeholder views on UK agriculture research9

AUC-UK also examined previous reports, which highlighted the coordination and knowledge exchange (KE) issues. A lack of infrastructure and researchers was also noted.



Figure 7: Challenges highlighted consistently in previous reports on agricultural research and innovation, identified by the Agricultural Universities Council UK Research Strategy<sup>10</sup>

<sup>&</sup>lt;sup>9</sup> Source: Agricultural Universities Council UK - <u>Research Strategy</u> (May 2023)

<sup>&</sup>lt;sup>10</sup> Source: Agricultural Universities Council UK - <u>Research Strategy</u> (May 2023)

CEIA ran workshops with 92 farmers and growers to identify challenges, and the top priorities were all in the area of adoption of new techniques, rather than the new techniques themselves. 'Farmer-led innovation' and 'Future skills' were identified as priorities linked to adoption of new techniques.



#### Figure 8: Thematic analysis of challenges and needs proposed by farmers and growers<sup>11</sup>

Our own interviews also reflected this need to understand farmer priorities, and link research to these, and to practical needs. A representative sample of comments are shown below:

- General lack of forensic foresight with the industry to identify the issues of the future
- Need to ensure user testing is embedded from the start and to identify and identify the actual problem first before starting the research.
- Market feasibility of the outputs from research needed identifying [with the end user] earlier in the project lifetime –not at the end
- Farmer adoption is a tough nut to crack lots of fragmentation and a lack of trust and lack of understanding
- Farmers farm for different reasons and have different motivations
- Planning constraints can't always retrofit new tech into old buildings
- Support farmers on the journey and any research in this filed must be participatory and co-designed with farmers and advisers from inception

#### Table 4: Interview comments on linking research to practical agriculture

In parallel to the challenges of achieving farmer adoption of research findings and innovations, there are also problems in the **commercialisation** of research. This was flagged in the 2013 House of Commons Science and Technology Committee report 'Bridging the valley of death: improving the commercialisation of research'<sup>12</sup>. They concluded that "While our academic research is the jewel in

<sup>&</sup>lt;sup>11</sup> <u>UK farmer & grower research priorities</u>, Centre for Effective Innovation in Agriculture (CEIA) & partners, (Oct 2024) – based on 12 workshops involving 92 farmers and growers

<sup>&</sup>lt;sup>12</sup> https://publications.parliament.uk/pa/cm201213/cmselect/cmsctech/348/348.pdf



the crown of UK innovation activity, we have some concerns about how universities interact with the commercialisation of research". Issues with commercialisation exist in the agricultural sector. For some crops the number of potential customers can be limited making commercialisation a less profitable undertaking. For example, carrots are one of the major root vegetables in the UK (over 700,000 tonnes per year according to British Carrot Growers Association), but profit margins are low across the whole sector. This means that only the farmers with the most foresight and sufficient capital typically invest in innovation, even if it makes their business more resilient in the long term. More research is carried out 'invisibly' within private agribusiness as trials and bespoke solutions, discussed later in this report.

In summary, many of the problems can be linked to the way that some research projects are set up, with little involvement from end users at the outset. Another key area of failure is not appreciating the practical constraints that farmers experience in implementing change (personal motivations, learning styles, access to information, local conditions, financial, regulatory, etc.). The lack of a national advisory network was also referred to as a barrier to adoption. Scotland bucks the trend with SRUC providing a farm advisory service across the country, funded by the Scottish Government, and providing a link from lab to field.

#### Innovation

We live in a time of accelerating innovation, and much of it has application to agriculture. The UK Innovation Strategy (2021) identified seven technology families of 'UK strength and opportunity'. All of these have some linkage to increasing the resilience of agriculture.

#### UK Innovation Strategy – 7 technology families

- Advanced Materials and Manufacturing
- Al, Digital and Advanced Computing
- Bioinformatics and Genomics
- Engineering Biology
- Electronics, Photonics and Quantum
- Energy and Environment Technologies
- Robotics and Smart Machines

#### Table 5: UK Innovation Strategy technology families<sup>13</sup>

However, referring back to the priorities identified by CEIA workshops, few of them had "technology" as a clear driver, and those tended to be of relatively low priority. This does not mean that farmers were against innovation, but Adoption, and the linked topics of Farmer-led innovation and Future skills were the most numerous priorities. Innovations that would have low or helpful impacts to their farming (even if the science in those innovations was advanced) scored highly, such as Disease

<sup>&</sup>lt;sup>13</sup> <u>UK Innovation Strategy</u>: leading the future by creating it (July 2021)

detection, Nutrient management and New breeding techniques. System approaches and business management were also fairly important, e.g. Respond to regulation, Agri-business, Optimisation.







Similarly, a survey by UK Agri-Tech Centre about which 'technology trends' were best to address challenges in agriculture saw people choosing broad 'solutions' more than specific technologies.

Technology Trends	Percentage of respondants			
Sustainable Production	40%			
Food Security	38%			
Resilient Food Systems	31%			
AI & Machine Learning	28%			
Robotics & Automation	26%			
Alternative Feeds	23%			
Net Zero Technologies	21%			
Circular Economy	21%			
Genetic Technologies	18%			
Vertical Farming	15%			

#### Figure 10: Technology trends that will best address the challenges in agriculture<sup>15</sup>

Farmers also demonstrate their appetite for 'innovation that can be practically applied'.in grant applications. UKRI and Defra have been running the Farming Innovation Programme since 2021, and it.

<sup>&</sup>lt;sup>14</sup> <u>UK farmer & grower research priorities</u>, Centre for Effective Innovation in Agriculture (CEIA) & partners, (Oct 2024)

<sup>&</sup>lt;sup>15</sup> UK AgriTech Centre, '<u>The Future of UK Agri-Tech</u>' report (Apr 2024)



Farming Innovation Programme Grant winners					
A novel biopesticide for wheat acting against both     insect and fungal pests	• A fruit-scouting robot that monitors for optimal				
<ul> <li>Extracting value from onion waste</li> </ul>	<ul> <li>Using soldier flies for protein-rich animal feed</li> </ul>				
Methane reduction from beef sector through	from farm waste				
microbiome-driven breeding	<ul> <li>Protecting seeds against parasites and pathogens</li> </ul>				
<ul> <li>Developing chickpeas as a novel source of</li> </ul>	without pesticides				
domestic protein.	• Growing fruit and vegetables with natural daylight rather than glasshouses				

#### Table 6: Winners of Farming Innovation Programme grants<sup>16</sup>

has been over-subscribed. The projects show the wide range of practical innovations that appeal to the farmer-innovator teams that apply and are successful. Our interviews identified further areas for research – a mix of practical and strategic areas. There was particular interest in innovative business models that would enable more sustainable and resilient agriculture in a world where margins can be low, and the supply chain includes powerful processors and retailers. One of our interviewees described a "pressing need to move to a place beyond public subsidy to where we can deliver food production alongside environmental services on the land and both of these services get a good economic return". But to achieve this "requires a change in mindset and the development of new economic models".

- Tools to help practitioners/advisers quantify and manage risk
- New business models research to aid transition from public subsidy to a better economic model for farming is lacking
- Green finance currently no clear structured guidance, accreditation and governance at present
- Need to work on spotlighting trade-offs
- Combining high tech (e.g. GM/GE) innovation with "low tech" systems (need for long-term, multi-site comparable experiments)
- Less work has focussed on the Global South
- Ways to reduce waste (a critical pressure point in the food system)
- More resilient crops (although some interviewees argue this area is already crowded)
- Better understanding of behavioural change and inter-relationships amongst <u>all</u> actors

	Table	7:	Interview	comments	on	areas	that	require	further	research	to	improve	agricultural	resilience
--	-------	----	-----------	----------	----	-------	------	---------	---------	----------	----	---------	--------------	------------

<sup>&</sup>lt;sup>16</sup> UKRI Farming Innovation Programme; Further innovation grants coming soon – Farming

### Institutional Landscape

### **UK** Institutions

The UK landscape of agricultural knowledge is crowded with bodies from the discovery or creation of knowledge in research organisations, to the delivery and use of knowledge by farming practitioners.



Figure 11: UK Farm Knowledge Landscape<sup>17</sup>

Within this, we identified 18 universities with significant agricultural research, of which 3 were purely 'agricultural universities' and at least 16 research institutes, not counting all the diverse crop specific bodies. In addition, there are two important partnerships. The Agricultural Universities Council UK (AUC-UK) is a collaboration of 16 UK universities with agricultural schools or departments. They work together to coordinate teaching and research, "to make the biggest contribution we can to a resilient and sustainable future for agriculture, land management and food systems."

AUC-UK is not a corporate body, but part of CEIA, which is part of Royal Agricultural University. It is supported by Elizabeth Creak Charitable Trust and CEIA.

<sup>&</sup>lt;sup>17</sup> Farm-PEP <u>https://farmpep.net/topic/knowledge</u> accessed 29 January 2025



Universities with Agricultural research	Agricultural Universities	Research Institutes and other bodies
Aberystwyth (AUC)	Harper Adams (AUC)	• ADAS
<ul> <li>Anglia Ruskin (AUC)</li> </ul>	Hartpury (AUC)	• AFBI (NI)
Cranfield (AUC)	Royal Agricultural University	• AHDB
<ul> <li>Edinburgh (AUC)</li> </ul>	(AUC)	• CABI
• Hertfordshire (AUC)		• CEH
<ul> <li>Imperial College</li> </ul>		• FERA
• Leeds (AUC) (N8)		• James Hutton
<ul> <li>Lincoln (AUC)</li> </ul>		John Innes
Newcastle (AUC) (N8)		LEEP Institute
<ul> <li>Nottingham (AUC)</li> </ul>		• NIAB
<ul> <li>Plymouth (AUC)</li> </ul>		• PGRO & other crop specific
• Queen's Belfast (AUC)		bodies
<ul> <li>Reading (AUC)</li> </ul>		• Pirbright
• UEA		Rothamsted
<ul> <li>Warwick (AUC)</li> </ul>		Roslin Institute
		• SRUC <sup>18</sup> (AUC)
		UK Agri-Tech Centre
		• 3Keel

# Table 8: Significant agricultural universities and research institutes noting members of AUC-UK (AUC) and Northern 8 (N8) partnerships<sup>19</sup>

- Joint strategies to maximise public benefit from teaching and research
- Working together to ensure high quality pipeline of graduates and researchers
- Collate and contribute evidence to policy and public debate
- Speak with one voice to industry, government, and other sectors
- Work includes Research Strategy, Stakeholder Research Priorities feeding into this, and an agri PhD conference

#### Table 9: Areas of AUC-UK work<sup>20</sup>

There is also a 'Northern 8' or N8 partnership of 8 northern England research universities: Durham, Newcastle, Leeds, Liverpool, Manchester, Lancaster, Sheffield and York. Of these, Leeds and Newcastle are noted for agricultural research, although others have some activity. 'Grow Smarter' is one of the topics within the 'Net Zero' research theme of the N8 partnership<sup>21</sup>.

AUC-UK notes that as well as being diverse, agricultural research in each major research area is widely distributed. They used data from their 16 members to show that activity across research topics is widely spread across universities in their network, rather than being concentrated. Within each topic,

<sup>&</sup>lt;sup>18</sup> Offers university level courses

<sup>&</sup>lt;sup>19</sup> Red Kite research

<sup>&</sup>lt;sup>20</sup> AUC-UK website

<sup>&</sup>lt;sup>21</sup> <u>https://www.n8research.org.uk/research-focus/net-zero-north/nzn-grow-smarter/</u>



individual departments and scientists will have more specific areas of expertise, so universities and scientists will have specialisation at this more detailed level.



Figure 12: Number of Agriculture related REF UoA6 research outputs by topic and institution (each colour is one institution) from AUC-UK members<sup>22</sup>

This applies to universities, including the Agricultural universities, but in parallel the research institutes and other bodies each have a more specific focus. Pirbright on animal diseases, Rothamstead on crops and soil, UK Agri-Tech Centre on technology solutions, CABI on knowledge sharing for agriculture and environment worldwide. We note how this is different to France and the Netherlands, where expertise is concentrated in INRAE and Wageningen respectively.

We looked at the funding and sources for UK agricultural research bodies, including the 'pure' agricultural universities and several research institutes. We examined their annual reports to identify their total revenue, research funding and commercial funding. We were not able to analyse general universities in this way, because agriculture research funding in is not separated in the accounts.

Total institution income ranged from £20-90 million, these are not very large businesses. Research income per organisation ranged from very small amounts to £10 million, with Pirbright an exception at £15 million. We contrast this with Wageningen Research, which has an annual revenue of €419 million, of which €159m is for contract research (this is in addition to €495m revenue at Wageningen University).

Of this research income only  $\pounds$ 0.1-1.5m comes from industry-funded sources, as identified in their annual accounts. John Innes Centre identifies about  $\pounds$ 3m of 'Charity income' from several foundations,

<sup>&</sup>lt;sup>22</sup> Source: Agricultural Universities Council UK - <u>Research Strategy</u> (May 2023)

which appears to be funding 'Next Generation Infrastructure' of laboratories and plant growing facilities. Commercial research income ranges from 0.3% to 4.1% of total income for the bodies that declare it.



Figure 13: Agricultural organisation income showing commercial and research income<sup>23</sup>

The two Scottish bodies have developed commercial income from practical services. SRUC and James Hutton provide farm consultancy, veterinary services, lab services, soil and water analysis, and field trials for example.

Beyond these institutions and figures, there is a significant amount of commercial agricultural research in the UK. A very large amount of Research and Development (R&D) activity and funding also come from the private sector, and over the last decade Government funding has become increasingly 'collaborative' i.e. requiring industry match-funding. Farmers and growers are also continually carrying out trials, striving towards optimisation, which might not be viewed as research in academic sense because it rarely results in published results or papers, but is still a form of on-farm experimentation. As part of our research, we spoke to a private research scientist who carries out commercial consultancy work for growers, mainly in the high value horticultural sector. They stated that they have "predominantly always done their own research because they never wanted to share their results with others, certainly not the 'big guys'". They went on to say that "it was difficult to find common ground issues that

<sup>&</sup>lt;sup>23</sup> Red Kite analysis of annual reports (Latest financial year published, usually year ending in 2023)



were not business sensitive or competitive" for research, and that whilst "the UKRI projects are sometimes millions, the amount spent by individual businesses is unquantifiable and they will never declare it, but it is large. They have to demonstrate innovation continually with customers or lose contracts". Identifying precompetitive research questions where there is a strong business case for industry funding, while also of interest to academics can be challenging. Another consideration with industry funding is pace. One of our interviewees stated that "the pace of academic research can be too slow – typically 2-3 years because it will involve a PhD student, yet the industry needs solutions more quickly". Although we note that many agricultural trials, particularly if studying environmental impacts, will necessarily take a multi-year timespan. Significant money also goes into agricultural research and development from private sector companies such as the agrochemicals giants, including Syngenta and BASF. Syngenta alone spends \$1.4billion per year on R&D. Whilst much of this would have been directed to new product development and formulation, some however will also go towards the corporate responsibility activity of these companies into research, field trials and advice under the banner of sustainable food systems. For example BASF's 'Sustainable Food Supply' work currently focusing on digital solutions that manage and optimize feed formulation while minimising the environmental impact.

#### UK Case study: Cambridge University and NIAB partnership



The University of Cambridge Department of Plant Sciences, and NIAB (National Institute of Agricultural Botany) founded a joint venture in 2020, the Crop Science Centre.

The aim is a coalition of international expertise in plant sciences in Cambridge with a focus on real-world impact. It translates the University of Cambridge's strong fundamental plant research into new, sustainable approaches for farmers, processors and consumers. It recruits and trains the best young researchers from

around the world in interdisciplinary science. Funders include Gates Foundation, UKRI, NIAB Trust, UK Aid, and the University's Potato Growers (CUPGRA). The latter is a route to industry partnerships, with member including potato growers, agronomists, packers, processors. Applied Crop Research - integrated innovation and knowledge transfer hub now has £33m turnover (y/e Mar 2024)



#### International institutions

Each major nation will have an institutional landscape as rich and diverse as the UK's. We have not attempted to map all of these, but to focus on some of the major institutions that have particular relevance. Each of these is described in brief below, and in more detail in a supplied Annexe.



- Wageningen University and Research, Netherlands
- Aarhus University, DCA (Danish Centre for Agriculture)
- CGIAR, Global
- AGRA, Africa
- INRAE, France
- Teagasc, Ireland

#### Table 10: International institutions studied for this research

We also note: ETH Zurich, a research university with a strong agricultural sciences programme. Stockholm Resilience Centre, an initiative founded in 2007 on the principle that "the biosphere, society and the economy should be studied as one system to address the complex challenges that face humanity".

Wageningen University & Research in the Netherlands stands out. It was mentioned by many other interviewees as *the* leading institution in agriculture, and frequently as a collaborator. Some interviewees just mentioned the name, and left it as understood that Wageningen was strong across the board. Others implied their strength in all areas of agriculture. Our two interviews with three senior staff at Wageningen confirmed that they have capability across the range of agriculture and that they are often collaborating across the institution and with other universities, global organisations, and commercial agriculture and food businesses.

- "Wageningen has a very strong structure and framework."
- "Wageningen always comes up as having a strong presence in resilient and sustainable agriculture."
- "[At international conferences] Wageningen is always there with good solid stuff."

#### Table 11: Interview comments about Wageningen University & Research

Wageningen has 7600 staff, and 13,000 students at a university and research institute dedicated entirely to food and the 'living environment'. It operates in two parts, Wageningen University, which focuses on education but performs some research as other general universities do, and Wageningen Research, which comprises 10 Research institutes.



Figure 14: Wageningen University and Research income 2023 €<sup>24</sup>

Wageningen have managed to retain and grow a substantial commercial research income. In 2023, Wageningen raised  $\in$ 159m for contract research, including  $\in$ 79m from commercial sources – 9% of the combined organisation's total funding. They achieved this over many years, with the benefits of being a single large institution, the focus of capability, in an agriculturally focused nation – compared with the UK, where the same capabilities are spread over perhaps 20 or 30 organisations of different types. They are an active collaborator and close to practical farming, for example through Foodvalley NL<sup>25</sup>, a collaboration between Wageningen University and Research, agrifood companies and local government (the Province of Gelderland) to create an ecosystem for sustainable food production.

There are also signs that they are very commercially minded, to the extent that some research has led to controversy. In 2020, research about bee colony collapse disorder came under academic and public scrutiny around its independence and validity, due to its funding by Bayer, a major producer of neonicotinoid pesticides, and other questions have been raised.<sup>26</sup>

**DCA at Aarhus University** is the closest match we found to AGRIIH at the other institutions. Our DCA interviewee noted existing collaborations in a 'triangle' with Wageningen and INRAE, and expressed interest in collaboration with Oxford.

<sup>&</sup>lt;sup>24</sup> Wageningen University & Research <u>Facts and Figures</u>. Financial figures source: Annual report 2023

<sup>&</sup>lt;sup>25</sup> <u>https://foodvalley.nl/en/</u>

<sup>&</sup>lt;sup>26</sup> https://www.desmog.com/wageningen-university-research/



DCA was formed when the Danish of Ministry Food, Agriculture and Fisheries outsourced its policy support to the university, and transferred the staff. DCA now conducts Policy Support, Communication and Collaboration activities



- In **Policy Support** (7 people), it receives about 250 requests per year from the ministry, coordinates responses from researchers, and also puts them into the public domain in most cases.
- In **Communication** (9 people), it communicates the University's research and policy responses, promoting potential for commercial research and collaboration
- In **Collaboration** the In Industry/international co-operation team (6 people) invite collaboration DCA is very successful in leveraging core research funding (total €15-20m/year) with additional funding from foundations (e.g. Nobel Nordisk, IKEA) and EC Horizon Europe (AgroEcology, FutureFoodS). It also gains industry research funding.

**CGIAR**, formerly the Consultative Group for International Agricultural Research, is a global partnership that coordinates funding for agricultural research for development. It aims to increase funding, reduce duplication and provide stability for agricultural research for development. It has always been funded by a combination of public and foundation sources.

It started with Rockefeller Foundation and Mexican Government founding the International Rice Research Institute (IRRI) in 1960 and the International Maize and Wheat Improvement Center (CIMMYT) in 1963. Since then it has added 12 other research centres. Today, after the USA Government (at \$126m) its biggest funder is the Bill & Melinda Gates Foundation (\$100m). Total funding was \$830m in 2023.

Results of its programmes include Crop genetic improvement e.g. nutritional value & disease resistant varieties, Pest management, Improvements to livestock & fish production systems and improved natural resource management. It uses a 'Strategy and Results Framework' across all its programmes to ensure value from its funding.

**AGRA** is an African-based non-profit organisation 'Sustainably growing Africa's food systems'. Its vision is to contribute to a food system-inspired inclusive agricultural transformation across Africa, to reduce hunger, improve nutrition, and adapt to climate change. Its approach is very practical. It works with the local private sector and smallholder farmers, understanding how they operate and what they need, empowering them to produce sufficient, healthy food – but it also works at the state and regional policy level.

It's annual funding of \$128m (2023) is provided by states, international agencies and large foundations including Bill & Melinda Gates Foundation and The Rockefeller Foundation. It works in Seed systems, Sustainable farming, Inclusive markets and trade, and Policy and state capability.

**INRAE** in France is the National Research Institute for Agriculture, Food and Environment. It combines capabilities which in the UK are spread across several '£50m' institutions into one €1 billion institution.



It has also developed many partnerships, quoting more than 400 'socio-economic partners' including commercial partners from large corporates (Tereos, Danone, EDF, Suez, Veolia) down, shared labs, and start-ups created. It records €25m income from partners, €8m from services and products and €4m from licences and patents.

**Teagasc** in Ireland is the state Agriculture and Food Development Agency. It has three main roles, research, knowledge transfer and operations. Out of total €232m income (2023), it records €5m from collaborative research and €7m from research fees and services.

Teagasc has many collaborations, mostly academic and institutional, and a number are international. A list of livestock collaborations includes universities in UK, France, Sweden, USA, Canada, Australia, and New Zealand, and Wageningen in Netherlands.

### Oxford

Oxford ranks top in the Times Higher Education (THE) World University Rankings.

Oxford also ranked very highly in Biological Sciences, and Earth/Environmental Sciences in the 2021 REF. However, it did not submit to REF 2021 for Agricultural and Veterinary Sciences.

By Aspect	Subject area (2024)		
• 1st Overall	Arts & Humanities	4th	
1st for Boscorch Environment (a perfect	Business and Economics	5th	
Ist for Research Environment (a perfect	Clinical & Health	1st	
100)	Computer Science	1st	
• 5th for Teaching (96.8)	Education	3rd	
8th for Research Quality	Engineering	4th	
<ul> <li>20th for International Outlook</li> </ul>	Law	7th	
<ul> <li>Lower ranked (but very high scoring at</li> </ul>	Life Sciences	3rd	
97 3) for Industry	Physical Sciences	8th	
	Psychology	(not listed)* <sup>27</sup>	
	Social Sciences	3rd	

#### Table 11: Times World University Rankings 2025<sup>28</sup>

<sup>&</sup>lt;sup>27</sup> A strange omission as Oxford has a high-quality Psychology department that we would be expected to be ranked.

<sup>&</sup>lt;sup>28</sup> https://www.timeshighereducation.com/world-university-rankings/latest/world-ranking (Accessed December 2024)





Figure 15: Biological Sciences REF 202129



Figure 16: Earth Systems and Environmental Sciences REF 2021<sup>30</sup>

Aligned with its REF results, Oxford has a strong reputation in plant sciences and ecology. All five research sections in the Biology department perform high quality research that contributes to agricultural resilience:

- Behaviour & Biomechanics
- Ecology & Conservation
- Evolutionary Biology

<sup>&</sup>lt;sup>29</sup> <u>https://results2021.ref.ac.uk/</u>, Red Kite analysis

<sup>&</sup>lt;sup>30</sup> <u>https://results2021.ref.ac.uk/</u>, Red Kite analysis



- Microbiology & Infectious Disease
- Molecular Plant Biology

The Martin School Future of Food programme, and Charles Godfray, are also well-known in both academia and industry. As shown in the Times Higher Education (THE) ratings, Oxford is strong the fields with the clearest interdisciplinary links, the social sciences, business and economics, and climate science – with resources including the School of Geography and Environment, the Environmental Change Institute, Smith School of Enterprise and Environment and the Said Business School.

The University also has useful connections to agriculture-related activities that are based in or near Oxford. The Oxford Farming Conference<sup>31</sup> (and its spin-off the Oxford Real Farming Conference<sup>32</sup>), an important annual event for policy-makers and practical farmers, although not directly linked to the University. The Ellison Institute for Technology, newly based in Oxford includes 'Food Security & Sustainable Agriculture' as one of its 'high-impact programs in four humane endeavours'<sup>33</sup>, and has a strategic alliance with the University<sup>34</sup>. Nearby in Oxfordshire are CABI and the Centre for Ecology and Hydrology (CEH) at Wallingford, and a number of businesses and charities that integrate agriculture with sustainability with various approaches, such as the Earth Trust at Little Wittenham and FarmED at Shipton-under-Wychwood.

Oxford is well reputed for its 'soft power' and convening power, and its ability and willingness to tackle difficult problems. The Smith School of Enterprise and Environment, and the Martin School both embody this willingness to tackle the 'big problems' of the world. As Vice-Chancellor Professor Irene Tracey said in her annual Oration 2024, "It's simple: our role is to strive for the seemingly impossible. We don't do easy."<sup>35</sup>

Oxford is also well noted for innovation, and university spin-outs. Oxford and the surrounding area are home to many business start-up accelerators and business parks that would be suitable for new agriculture-related businesses – several in Oxford, plus Begbroke, Culham, Milton Park, Harwell and smaller ones in other towns.

<sup>&</sup>lt;sup>31</sup> <u>https://www.ofc.org.uk/</u> (7-9 January 2026 theme is 'Growing Resilience')

<sup>&</sup>lt;sup>32</sup> https://orfc.org.uk/

<sup>&</sup>lt;sup>33</sup> <u>https://www.eit.org/programs</u>

<sup>&</sup>lt;sup>34</sup> https://www.ox.ac.uk/news/2024-12-03-university-oxford-and-ellison-institute-technology-join-forces-transformative

<sup>&</sup>lt;sup>35</sup> https://www.ox.ac.uk/news/2024-10-08-vice-chancellors-oration-2024



## 4. Discussion

Based on the evidence, we can draw out the following implications for AGRIIH, bringing together Oxford's expertise in agricultural resilience and innovation to develop new partnerships.

#### AGRIIH concept

The AGRIIH concept was seen, both externally and internally as valuable, performing several useful roles, and there is evidence that at least one similar model has been successful.

Internal stakeholders see its value in improving links between disciplines, both closely and less closely linked to agriculture, building on the existing networks such as Future of Food. It would enable more impactful research, by facilitating interdisciplinary links and identifying interdisciplinary and collaborative projects, including those incorporating systems approach. External stakeholders see the benefits in enabling more information sharing and collaboration in cultivating of a more open, user-focused approach to research and innovation.

#### Focus on resilience and innovation

Evidence from both desk research and our interviews shows that resilience is an important topic today, and expected to remain important for decades. With greenhouse gases inventories still rising, climate resilience will certainly remain important, and it is difficult to see political, social, technological or ecological risks reducing in impact.

Innovation will be important, but the approach is important. There are a number of possible approaches for AGRIIH, which are not mutually exclusive:

- Focusing research or innovation efforts on **'solving problems'** so there is already a 'pull' demand for the solution using Oxford's strength in innovation and problem solving.
- Including 'adoption' as an interdisciplinary aspect of previously 'pure' research studies using Oxford's strength in social sciences, for example behavioural science and economics may be useful drivers.
- 'Systems thinking' research to understand the system as a whole, and how the social, economic and environmental aspects interact, to achieve better outcomes using Oxford's strength in systems thinking.

#### Interdisciplinary approach

Our sources agreed that an interdisciplinary approach is needed to maximise the changes needed to agriculture to make it more resilient. This included both topics that were 'close' to agricultural sciences, e.g. plant biology, ecology, climate science, geography, and those that are 'further away', e.g. business and economics, behavioural sciences, politics. Several of our interviewees stressed that there is huge value in bringing in different perspectives, importantly partners outside what might traditionally be



regarded as the agricultural sector. "You don't need to be an expert [in the whole system] but you do need to understand there are links".

Many of the sources we spoke to agreed that good interdisciplinary research requires, time, listening, and open-mindedness "You need to know what people are doing – good coffee is needed."

They also emphasised the importance of a good research question. Hence, "if you design your question to deliver impact, then this can lead to very powerful interdisciplinary research" and "mindset – problem orientation, not publication".

#### Collaboration potential

Potential for collaboration with other academic institutions is high. There will be value in partnering with institutions with complementary expertise and facilities, and interviewees from other leading agricultural research institutions saw mutual value in partnering with Oxford, particularly in bringing Oxford's academic excellence in plant sciences and 'systems thinking', and its ability to bring a wider group of stakeholders together including policy shapers. "*Policy bridging – this is very strong.*" said one UK body with international links. There may be value in exploring opportunities with local/regionally located agricultural institutes or organisations to create a regional collaboration which could bring new opportunities and fill possible gaps in practical expertise, or access to facilities not currently within the university. This could also to extend to partnering with knowledge exchange communities with established networks and links into the farming community.

## 5. Conclusion

Agriculture needs to become more resilient, and the experts we talked to, and other sources, pointed to the need for a 'system view' and interdisciplinary collaboration to solve the difficult problems that are faced. The University of Oxford can play a key role in this, because it brings together core sciences, with expertise in system approaches necessary to solve complex interlinked problems in agriculture. To do this, it will need to bring together transdisciplinary teams, from inside and outside the university. AGRIIH will bring together Oxford's expertise in agriculture and connected subjects, to work openly and effectively with partners, to co-create integrated ecological, technological and behavioural solutions that make agriculture more resilient in an increasingly uncertain world.