AgriTechE: Back to the Future

The responses below were received from researchers based on the Norwich Research Park (June 2024). The most recent Research Excellence Framework (REF2021) ranked our research excellent in Agriculture, Food and Veterinary Science (Unit of Assessment 6) as #1. This outcome reflecting direct contributions from The University of East Anglia, The Quadram Institute, and The Sainsbury Laboratory, and further associated contribution from The John Innes Centre and the Earlham Institute in terms of the wider NRP agrifood research environment.

Comments have been arranged to provide flow to the document. The order of the material reflects this, rather than a ranking of importance. Attribution of comments is provided. If you wish to follow up with individuals, they can be contacted by email.

What has been the most surprising development or project in research in the past 10 years?

Who are you, Institute, Keyword(s)	Response
Neil Ward ENV/UEA *Net zero, food and land*	The net zero by 2050 commitment, transposed into law in 2019, will transform food, farming and land use over the next two decades. We will have to produce food in the UK for a population that is 10% larger, on perhaps as much as 30% less agricultural land, while not becoming more dependent upon imports.
Andrew Lovett ENV/UEA *Natural Capital* *Multifunctional landscapes*	The last few years have seen substantial initiatives regarding nature markets. This is a big change in agri-environmental policy, in terms of sources of funding, the timescales involved and potential rewards. This sector could substantially change how farm businesses operate in many parts of the UK.
Rachel Warren Tyndall Centre/UEA *Climate-Agriculture* *Carbon Cycle*	The last few years have seen increased awareness of the linkages between climate change resilience of natural and agricultural systems, loss of natural capital above and below ground, carbon sequestration, and agricultural productivity. Interdisciplinary thinking is becoming essential as no discipline is an 'island'.
Brian Reid ENV/UEA *Soil science* *Soil health* *Carbon*	There has been a marked-up kick in interest in soil science. This has been driven by the existential threats of climate change and biodiversity loss; and the realisation that soils have an enormous capacity to deliver nature-based solution to abate these. Opportunity to harness the soils as reservoirs for carbon storage and in so doing to increase soil (and wider ecosystem) health has gained political traction.
Falk Hildebrand QIB/EI NRP *Metagenomics*	Metagenomic sequencing has given us a completely new perspective on the incredible diversity of the soil microbial world, with often 10,000 of different species in a tiny soil sample. This has for example shown that there is an extensive chemical warfare between fungi and bacteria that can be observed at a global scale.
Richard Harvey CMP/UEA *AI* *Agri- robotics*	In general, the most staggering scientific advance has surely been AI. I think it's fair to say that Agriculture has is not particularly fast adopter of AI but this is probably because of the way the money flows in agriculture – large margins are available at the end of the retail chain. So, sure enough it is supermarkets and food retailers who have invested heavily in automation.

	UEA Lead for Agriforwards Doctoral Training Centre – aiming to train 50 PhDs in agri-robotics.
Corrado Di Maria ECO/UEA *Financial incentives for transition*	The one thing that has become increasingly clear across the spectrum is that the transition from an industrial/extractive to a sustainable agriculture requires significant changes. Political will is needed, but the engagement of the farming and more broadly rural community with these themes is crucial. One important element in the latter is the provision of sufficient incentives to invest and work for change. Financial instruments such as carbon credits, payments for ecosystem services, markets for nature within the biodiversity net gain frameworks are just the first step in this direction.

What is the biggest challenge for researchers today (for example in terms of projects, funding, dissemination)?

Who are you, Institute, Keyword(s)	Response
Brian Reid ENV/UEA *University financing*	The financial model that underpins UK Universities is unsustainable. The cap on fees, that has not been linked to inflation, has resulted in real term cut to the sector year on year. The current £9,250 set in 2017/18, with inflation index should now be C. £14,000. Carrying this level of underfunding across large cohorts of students, and when set against rising costs and utility process is bring the sector to a crisis point. If we seek to lead the world in research and innovation and to develop a talent pipeline of graduates and postgraduates, the situation requires redress.
Neil Ward ENV/UEA *Lack of co-ordination across UKRI investments*	The UK research councils spend hundreds of millions each year on food research, but there has been insufficient strategic co-ordination across disciplines and insufficient investment for long-term strategic change. At the same time, the research and innovation system has become too complex and fragmented given the scale and urgency of the challenges faced.
Jake Malone JIC *Timescale for academic funding decisions*	In addition to the points above, an issue with funding allocation is the length of time taken between (academic) grant submission and award. Typically, the process lasts around a year for an award that might last 3 years, with a 20% success rate. In practice this makes it difficult either to plan strategically, or to respond quickly to new opportunities.
Rachel Warren Tyndall Centre/UEA *Talent recruitment and retention* *Research renumeration* *Job security*	Various colleagues and I have noticed how difficult it seems to be to attract good candidates to postdoctoral research positions these days. In recent years my colleagues and I have found it increasingly difficult to recruit the skilled postdoctoral researchers that are essential for conducting high quality research. So far this has not impacted our research because we have managed to retain existing highly skilled research staff, but if/when those staff leave e.g. for permanent positions/due to family/location related reasons, it could be very difficult to replace them in a cost-effective fashion. The cost-of-living crisis has made post-doctoral positions in the UK unattractive from a financial point of view, as salaries have not been increased; in addition, a career in academia

	is not attractive to young people, due to the well-publicized problems with university finances and academic pensions. If I were 23 today finishing a PhD, I'm not sure I would choose an academic career in the UK. I would have felt it was too financially risky.
Rachel Warren Tyndall Centre/UEA *Financial constraints* *Workload* *Impacts on well-being*	Academics in the UK generally work in an increasingly financially constrained environment leading to increased workloads for teaching and admin, whilst high competition for grant funding leads to inefficiencies in the use of precious time. Such financial constraints can lead to poor salaries, high workloads and reduced well-being.
Andrew Lovett ENV/UEA *Length of funding*	In my experience the development of trust is critical to successful farmer engagement and dissemination activities. It requires locally relevant data and insights, but it also takes time, so projects lasting 2- or 3-years struggle to achieve much. Frameworks for delivery of longer projects are needed.
Falk Hildebrand QIB/EI NRP *Adverse BREXIT outcomes*	My observation is that the UK has an incredibly good reputation for researchers internationally and has many very high quality research labs, innovation and the right motivation for doing ground-breaking science. However, new restrictions for international staff to come to the UK after BREXIT and finding excellent staff has become more difficult.
Richard Harvey CMP/UEA *Support for small farms to access an adopt IT*	The IT research environment has almost unlimited funds, unlike other academic areas, but that money is in or from industry – thus much work is either directed or biassed towards a particular user's views or needs. In agriculture, I worry that this will lead to vast investments in the end of the food chain and very little help small-scale farmers and/or farmers in the global south. Thus, the challenge for technological research is to not forget critical user groups.

If you could pick any, what research area would you prioritise for agriculture for the next 10 years and why?

Who are you, Institute, Keyword(s)	Response
Rachel Warren Tyndall Centre/UEA *Land Use and Net Zero* *Reliant farming systems*	The need to explore how to manage land to deliver food sustainably and in a climate resilient fashion, whilst restoring natural ecosystems has never been more important. The rapidly declining insect populations which are at the bottom of the food chain threatens the fabric of our natural ecosystems and need to be restored, whilst at the same time finding methods to manage crop pests in a sustainable fashion despite climate change induced increases in pests and diseases. The necessity of reducing food waste to reduce the size of this challenge is paramount, and this requires addressing at all stages of the agricultural production system.
Corrado Di Maria ECO/UEA	Returning to the idea of financial incentives and markets, all of these instruments are under-researched and poorly understood.

Financial incentives for transition/ Market design	None of these mechanisms works without proper design to deliver benefits for the farmers nor for the natural environment. Multidisciplinary work by economists, biodiversity/conservation experts and data scientists is a very promising area. Using eDNA/AI to generate maps at reasonable costs and designing markets to facilitate the meeting of demand and supply within exchanges with sufficient depth will make the transition to sustainable farming much cheaper and effective.
Andrew Lovett ENV/UEA *Interactions between different component systems in farm businesses*	Data from the Farm Business Survey indicates that income from food production is now often less than half of that for the total farm business. There needs to be more research on the interactions between the different systems that farm businesses are involved in (e.g. also tourism, energy generation) and the consequences that these may have for business viability and the achievement of different policy objectives.
Richard Harvey CMP/UEA *Quantum computing* *IT*	Agriculture presents few fundamental technical problems. Instead, it creates problems of scale and efficiency. Thus, building an autonomous tractor is quite feasible but building one to a price, robustness, and reliability to be useful to one of the agricultural sectors – that's problematic. This means that agricultural scientists should remain supportive of basic research in quantum computing, information theory and autonomy (to mention a few) since that work will help us build better systems. However, I would also like us to focus on the economic trap in which small-scale regional farmers are squeezed dry while middle-men and distributors make tidy margins. Abalobi (abalobi.org) is an example of a technical approach to this problem – it provides traceability and an economic platform for small fishers. If we want net zero, healthy farm infrastructure and high quality natural capital assets then we must enable revenue flows directly into farms. IT can do this.
Neil Ward ENV/UEA *Emissions from livestock*	Emissions from farm livestock account for around 60% of agriculture's emissions. Mindful of the agricultural livelihoods at stake, how can we evolve the UK livestock industry within the constraints of the UK's 2050 net zero commitment, while at the same time improving public health and freeing land for other uses including sequestration.
Brian Reid ENV/UEA *Soil health* *Soil carbon*	Understanding soil health and how to improve this cornerstone of our ecosystems – this needs to be a priority. Soil is the foundation of terrestrial life. If we can optimise this there will be manifold wins. However, soils are diverse, and therein lies the inherent problem that not all soil will have the same level of optimisation. Soil health is not a one size fits all set of benchmarks. Research to provide better understanding of the "saturation" limits for soils to store carbon and more precisely determining soil carbon storage permanence. These are needed to robustly quantify net-zero contributions from soil and our landscapes.
Jake Malone JIC	Plants secrete around 20% of their total fixed carbon into the soil, to recruit beneficial microorganisms and to shape their associated

Understanding and exploiting microbial recruitment by plants	rhizosphere microbiome. However, evidence is accumulating that modern crop varieties have a suboptimal relationship with their soils, recruiting low-diversity microbiota and obtaining fewer benefits from them than landraces. There is huge potential to exploit this relationship for sustainable agriculture, with opportunities to improve both plant (e.g. biofertilisation, biocontrol) and soil (bioremediation, enhanced microbial diversity) health. This could take place through targeted manipulation of the soil microbiome, or by plant genetic manipulation to incorporate pathways that enable microbial communication.
Falk Hildebrand QIB/EI NRP *Soil microbiomes AI*	The microbial diversity is still completely under researched, although these organisms are central to global nutrient flows. Even relatively "simple" microbial ecosystems, such as the human gut microbiome, are not well understood, our current insights are correlative at best, predictions are difficult and currently often enough guesswork. To understand and model the hugely important microbial soil ecosphere, new experimental approaches are needed, and these will likely heavily depend on advanced AI algorithms.