LINCOLN AGRI-ROBOTICS

Building the Future of Agriculture

'The world's first global centre of excellence in agricultural robotics'

UNIVERSITY OF LINCOLN

Lincoln Agri-Robotics

UKRI Research England

WHO WE ARE

Lincoln Agri-Robotics (LAR) is the world's first global centre of excellence in agricultural robotics (UK Innovation Strategy, July 2021), funded by UKRI's Research England as part of their Expanding Excellence in England (E3) fund.

LIAT

The Lincoln Institute for Agri-Food Technology (LIAT) is based at the University of Lincoln's Riseholme campus. It is a specialist research institute that aims to support and enhance productivity, efficiency, and sustainability in food and farming.

L-CAS

The Lincoln Centre for Autonomous Systems (L-CAS) specialises in perception, learning, decision-making, control and interaction for autonomous systems such as robots, and their integration in applications including personal robotics, healthcare, agri-food, security, and intelligent transportation.

Lincoln Agri-Robotics has secured millions of pounds of collaborative grant funding, including major awards from UKRI.

LAR

Lincoln Agri-Robotics (LAR) bridges and expands the strong collaborations that exist between these two leading research groups at the University of Lincoln: the Lincoln Institute for Agri-Food Technology (LIAT) and the Lincoln Centre for Autonomous Systems (L-CAS). Drawing on our network of academic excellence, industry partnerships, and funding providers, LAR is working to drive robotic innovation and technical advancement in agriculture.

Expanding Excellence in England (E3) Programme

This funding is awarded by Research England to higher education departments that are small but delivering research excellence. Funded research units are supported to expand, increase their capacity, and grow sustainably. Aiming to fund strategic expansion of England's research capacity, E3 delivers government priorities through transformative impact.

IN THIS GUIDE

WELCOME

Dear Reader,

Our exciting Lincoln Agri-Robotics (LAR) centre bridges and expands the strong collaborations that exist between two leading research groups at the University of Lincoln (UK): the Lincoln Institute for Agri-Food Technology (LIAT) and the Lincoln Centre for Autonomous Systems (L-CAS).

LAR researchers are at the forefront of driving robotic innovation and technical advancement in agriculture, addressing the critical technology needs for transformation of the food chain ('from farm to fork'), with the aim of enabling innovation to improve productivity, efficiency, resilience and sustainability.

Our centre draws on a network of academic excellence, industry partnerships, and funding organisations. LAR takes an innovative and open-minded approach to collaboration with horticultural, agricultural and technology businesses, food processing and supply chain operators, farming communities and government bodies. We deliver interdisciplinary research, commercial activities in collaboration with other schools, centres and institutes at the University of Lincoln, and other Higher Education Institutes, research organisations and industry partners, both in the UK and internationally.

This brochure highlights our history, identity and successes. We hope you enjoy reading!

Simon and Elizabeth

Professor Simon Pearson
Director of the Lincoln Institute
of Agri-Food Technology (LIAT)

Professor Elizabeth Sklar
Research Director at the Lincoln Institute
of Agri-Food Technology (LIAT) and lead
Professor for Lincoln Agri-Robotics

Professor Simon Pearson is the Director of the Lincoln Institute of Agri-Food Technology (LIAT). Simon oversees the delivery of cross-disciplinary projects such as Lincoln Agri-Robotics to benefit the agri-food sector, and sets the strategic direction for the team.

In recent years, Simon's research interests have centred around the use and deployment of innovative robotic systems and autonomous vehicles in the agri-food sector. For example, Simon's involvement in optimising the use of remote sensing information has enabled the development of yield forecasting systems to drive intelligent on-farm decision-making.

His research interests also include the impacts of environmental physiology such as light manipulation and modified atmosphere packaging on fresh produce and ornamental crops.

Simon has played an important role in advisory boards and strategic task forces with the aim of informing government about the future needs of the agricultural sector. Topics include automation in horticulture and achieving net zero.

Prior to joining the University, Simon worked as a scientist at the University of Reading, held a technical role with Marks & Spencer and was Commercial and Managing Director for a large UK farming company.

Professor Elizabeth Sklar is Research Director for the Lincoln Institute for Agri-food Technology (LIAT) and is a lead Professor for Lincoln Agri-Robotics.

Elizabeth worked as a software engineer for over ten years in industry before holding several academic positions. These include positions at Columbia University and the City University of New York, which preceded her appointment as Head of the Centre for Robotics Research (CoRe) at King's College London.

Elizabeth's research primarily investigates the implementation of AI-based methods in the context of multi-robot teams, human-machine collaboration, and data-backed decision making. Since joining LIAT in 2019, Elizabeth has been exploring the application of these methodologies within the agri-food pipeline.

Elizabeth is a former Trustee of the RoboCup Federation, founder of RoboCupJunior, former member of the Board of Directors for the International Foundation for Autonomous Agents and MultiAgent Systems (IFAAMAS), and current editorial board member for Current Robotics Reports.

TIMELINE

Since our inception in 2016, LIAT has fostered a diverse, interdisciplinary team working together on robotic solutions to challenges facing the agricultural sector. These efforts have gained momentum through funding that has allowed us to build our facilities, infrastructure and capacity – which in turn enables new partnerships, attracts new funding, helps us nurture new talent, and scaffolds contributions to world-leading intelligent robotic solutions for the wider farming community.

2016

The Lincoln Institute for Agri-Food Technology is created

2019

Lincoln Agri-Robotics project secures E3 development funding

April 2019: EPSRC Centre for Doctoral Training in Agri-Food Robotics: AgriFoRwArdS, a collaboration between the Universities of Lincoln, Cambridge, and East Anglia, launches. The Centre provides fully-funded opportunities for students to undertake MSc and PhD study, to become the next leaders in agri-food robotics.

June 2019: University of Lincoln secures funding for Lincoln Agri-Robotics via the Research England Expanding Excellence in England (E3) Funding Programme, recognising small and excellent higher education research units and supporting expansion of their activity.

August 2019: Lincoln Agri-Robotics launches. This includes recruiting Professors, Lecturers, Post-Doctoral Research Assistants, Operational staff and PhD students, the renovation of Riseholme Hall, and procurement of technical equipment to support infrastructure development.

2020

Launch of Agri-Tech Eagle Lab Farm with Barclays

October 2020: In partnership with the University of Lincoln, Barclays launches the first Agri-Tech Eagle Lab Farm on the University's Riseholme campus to boost the future of UK agriculture. The lab offers workspace, expert support, and resources for agri-tech start-up businesses.

2021

2022

2023

2024

Riseholme Hall renovated; first spin-out agri-tech company

Outreach activities at Downing St and internationally

University receives Queen's Anniversary Prize for HE

July 2021: LAR hosts a mini conference to foster new inter-disciplinary collaborations.

July 2021: Renovation of Riseholme Hall is completed, offering upgraded working facilities for University staff engaged in agri-robotics and technology research.

October 2021: Launch of FruitCast Limited, the first spin-out company of the University of Lincoln, providing a one-of-a-kind AI-enabled data analytics platform for soft-fruit growers.

October 2021: The University of Lincoln invests in upgrading Engineering Workshops on the Riseholme campus to provide state-of-the-art facilities for the current and future growth of agri-robotics research.

November 2021: COP26. LIAT's researchers exhibited technology developed by Lincoln Agri-Robotics team.

May 2022: Professor Simon Pearson is invited to attend 10 Downing Street for the UK Farm to Fork Summit.

June 2022: LAR mini conference is attended by students from international institutions with talks from guest academics.

July 2022: Professor Simon Pearson co-chairs a review of automation in horticulture alongside the Rt. Hon. George Eustice MP, Secretary of State for Environment Food and Rural Affairs. The review explores requirements for accelerating development of automation technologies across horticulture.

April 2024: UKRI AI CDT in Sustainable Understandable agri-food Systems Transformed by Artificial Intelligence (SUSTAIN) launches, a collaboration led by University of Lincoln, with Universities of Aberdeen and Strathclyde and Queen's University Belfast.

November 2023: TikTok post showcasing agri-robotics ranks top 4 in ads in the Technology category.

January 2024: LAR host a mini conference attended by LAR staff past and present to showcase achievements in agri-robotics research throughout the project lifetime.

February 2024: Lincoln Agri-Robotics team members attend Buckingham palace to receive the Queen's Anniversary Prize for Higher and Further Education.

QUEEN'S ANNIVERSARY PRIZE

The University of Lincoln has been awarded the Queen's Anniversary Prize, the highest national Honour awarded to UK colleges and universities, for its work supporting the success and sustainability of the UK's food and farming industries through innovations in research, education, and technology.

AN EXEMPLAR FOR THE E3 FUNDING PROGRAMME

LIAT has been an exemplar for the E3 funding programme and has demonstrated best practice in rapidly scaling-up a small research group while maintaining research excellence, generating local, national, and international impact, and establishing a sustainable institute.

— Professor Dame Jessica Corner FMedSci, MAE, RN, Executive Chair of Research England

The Queen's Anniversary Prize for Further and Higher Education is the highest National Honour for UK universities and colleges. The award represents a major accomplishment for the University and, as Vice Chancellor, I would like to express my gratitude to everyone who has supported the development of our exceptional provision in these disciplines, notably through the Lincoln Institute for Agri-food Technology. Our award is all the more remarkable given LIAT was founded less than a decade ago. It is now widely recognised as one of the leading centres for agri-robotics and related research in the world.

— Professor Neal Juster, Vice Chancellor, University of Lincoln

The Queen's
Anniversary
Prizes

2023

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WE ARE IMMENSELY PROUD, THRILLED AND HUMBLED TO HAVE WON THE QUEEN'S ANNIVERSARY PRIZE

OUR RESEARCH

LIAT's key subject pillars are robotic phenotyping, selective harvesting, crop care, sustainability, productivity and people, and rural policy and the food environment. This interdisciplinary approach encourages collaboration across academic disciplines, to achieve the best results for the future of agriculture.

Part of LIAT, our research at Lincoln Agri-Robotics centres around three grand challenges and a number of core technologies.

Selective Harvesting

What it is: Developing systems which identify harvest ready crops to enable reliable and consistent picking and harvesting.
Our Goal: Reducing the reliance on manual picking of crops by developing automated robotic platforms that can pick soft fruit at the optimum time.

Crop Care

What it is: Ensuring the protection of crops from pests, disease, weather and nutrient deficiencies.
Our Goal: Enhancing modern precision agriculture techniques to drive productivity by optimising the micro-environment of individual plants rather than assuming the collective crop is a uniform mono-culture.

Phenotyping Robotics

What it is: Measuring and analysing plant traits such as growth rate, colour, shape, leaf and root characteristics to understand the influence of environmental factors on plant varieties.
Our Goal: Offering a route to automate phenotyping at scale to select for desirable characteristics within the plant breeding process.

Core Technologies

- **Mobile Autonomy**
- **Manipulation and Soft Robotics**
- **Sensing and Perception**
- **Fleet Management**
- **Human-Robot Collaboration**
- **Systems Integration**

Together, these grand challenges work towards a collective objective to understand how humans and technology interact with the world through research on critical issues including sustainability, resilience, values, integrity and trust.

Across all challenges, Carbon Net Zero is a key consideration.

OUR FACILITIES

LIAT is based at the University of Lincoln's Riseholme Campus, a 200-hectare estate which features woodlands, parkland, watercourses, a mixed-enterprise working farm, large field trials sites, robotics labs, engineering workshops and teaching spaces. LIAT has received multi-million-pound capital investment to develop state-of-the-art facilities and infrastructure.

The E3 funding for Lincoln enabled investment in our facilities to secure a home for agri-robotics research into the future.

Riseholme Hall Renovations

Once the official residence for the Bishop of Lincoln, Riseholme Hall is a Grade II Listed building at the heart of the University's agricultural campus. It was renovated in 2020 creating new and improved offices, meeting rooms and teaching and lab spaces.

Before Renovations

After Renovations

Renovated office

Renovated lab and teaching space

Renovated meeting room

Polytunnels

**Strawberry Trials Site
& Food Handling Unit**

A series of protected growing spaces and trials areas for both ground and pot trials. Our latest addition, Polytunnel 9, has state-of-the-art design features for creating a protected growing environment, and optimising light levels for crops.

Polytunnels allow for continuously growing crops for robotic trials, and dedicated space allocation for funded research projects.

This facility is an invaluable asset for multiple UKRI-funded projects which focus on AI and robotics solutions for farming and food production.

The robotic trials area comprises a scaled-down, commercial strawberry production unit and food handling building for use by non-destructive trials vehicles.

The strawberry farm supports the University's ongoing work to improve productivity, efficiency, and sustainability through innovation, and has been featured on BBC Countryfile a number of times – most recently in October 2021.

Special features include:

- Strawberries grown on raised, tabletop beds
- Collaborations with Saga Robotics, Berry Gardens Growers Ltd
- Research in robotics for fruit picking and transportation to fruit handling / packing unit
- Research in robotics image recognition technology

Excess produce is donated to local organisations and charities, which offer affordable food and meals with a focus on reducing waste.

Walled Garden

Refrigeration Research Centre

The demonstration plots in our Walled Garden offer robotic trials areas for developing technology. The site features annual crops in growing beds, which have been created to dimensions compatible with robotic vehicles up to 2m wide. The garden has also been used for vision-guided weed detection research in collaboration with Garford Farm Machinery and Saga Robotics and is actively used to support a variety of professional short courses.

The Refrigeration Research Centre is used for testing technology in a retail environment. Imitation supermarket refrigeration precisely models the dynamics of a typical supermarket.

Projects can examine the impact of mass refrigeration on the UK's carbon footprint and develop innovations to reduce environmental impact. For example, one project explored how to modify refrigeration control in proportion to the available energy on the National Grid – optimising food temperature control to prolong shelf life as well as reducing energy used. The project was funded by Innovate UK, and involved Tesco, IMS Evolve, and the Grimsby Institute as collaborators.

Another recent project, led by innovative start-up Hubl Logistics, investigated the potential for alternative mobile refrigeration units. The project is now developing solutions for the temporary storage and transport of temperature-controlled goods.

Mobile 5G-SA Mast

As part of the Lincoln Agri-Robotics project a private mobile 5G-SA (stand-alone) mast has been installed on site. 5G capability is set to transform farming and agriculture in the future and is used by agri-robotics researchers at the University to enable high-speed communications across the site.

- 5G can enhance precision agriculture by allowing data to be transmitted and processed in real time.

- Crops can be treated with precision rather than treating an entire field as one.

- 5G enables the use of robots to scan crops using AI to analyse colouring, size, shape and type; this identifies weeds, spraying needs and could inform harvest time.

Other benefits of 5G-enabled farming are still being explored and understood. Our private 5G-SA system can be transported to enable research at other farms across the UK.

Flux Tower

The flux tower is seen as the state-of-the-art in technology for measurement of carbon fluxes from cropping systems. Having a flux tower allows LIAT to compare and contrast different soil and farm management practices on two fields over time. This represents significant investment at the Riseholme site in agricultural carbon research, as well as a collaboration with the UK Centre for Ecology & Hydrology (UKCEH).

Agroforestry Area

Our agroforestry area allows for trialing the sustainable farming technique of growing trees alongside crops. This has benefits for soils, biodiversity, water infiltration, and farm diversification.

Planting in 2018 was supported by the Woodland Trust.

Engineering Workshops

The refurbished engineering workshops consist of teaching space overlooking the walled garden, offices for Technicians and Engineers, a large engineering space split into bays for dedicated project work and collaborative research with businesses, and a separate robotics lab. The setup provides large open-plan spaces for scaling, testing and trialling robotics.

With renovations in 2020 and 2021, the Engineering Workshops represent the University's continued investment in the future of agri-robotics research.

Plowright House

Large Trial Fields

A shared space home to both the Barclays Eagle Lab Farm and University robotics researchers.

Barclays Agri-Tech Eagle Lab Farm offers agri-tech entrepreneurs, individuals and businesses co-working and office space, innovative tools, mentoring and coaching from business growth specialists and experts, access to events and the latest thought leadership and the right network to innovate and scale.

While the Eagle Lab Farm is a self-contained entity, the University has a suite of multifunctional work spaces, including an indoor hard-surfaced area for robotic trials and demonstrations, and a small workshop where researchers can carry out 3D printing, small construction, and assembly tasks.

The large trials fields are used to grow crops to support research projects concerning target species such as wheat, beans and linseed. One area is home to a BEIS funded research project. In collaboration with Terravesta, the University is carrying out research into the role of biomass crops such as miscanthus in the UK's net zero ambitions.

Natural Flood Management Demonstration Site

A natural flood management demonstration site with examples of various methods that could be adopted by farmers to manage flood risk. The installation was funded by the Environment Agency and features leaky barriers, diversion channels and attenuation ponds, which help to slow down the flow of water when heavy rainfall occurs. The site is used for teaching and demonstration and there is considerable wildlife activity in the area. In recent years, the site has helped to avert a number of flooding events.

Multi-Purpose Trials Area

Once used as a sports pitch, this area has been re-purposed to support the University's growing number of agricultural research projects. This fenced area is used for student projects and container trials. The artificial surface can support lightweight robotic vehicles.

KEY PARTNERS

Connecting academic expertise with industry partners to pursue world-class research not only advances state-of-the-art agri-food technology, but improves sustainability, resilience, innovation and business growth. Our dedicated partners play a key role in making our research possible by offering resources, collaboration, insight and expertise. Working together, we can translate innovation into real-world impact.

Thorvald is an advanced multi-functional autonomous platform supporting a number of LAR's agricultural projects.

THORVALD

NIAB

WOOTZANO

PILKINGTON

PGRO

placeuk

UK Agri-Tech Centre

CLOCK HOUSE FARM EST. 1903
Growing a better tomorrow

mtc Manufacturing Technology Centre

FruitCast

AGRI·TECH CLUSTER DELIVERY

With the enhanced capabilities of LAR, the University of Lincoln now leads a regional and national cluster of synergistic projects. The research cluster works with industry partners to support the development and deployment of agricultural robotics – generating positive economic impacts, and influencing policy.

Agri-Tech Cluster Success

149	£100m	250
projects secured	**in delivery funding**	**industry partners**

Since its inception in 2016, LAR and its partners have grown into the largest Agri-Technology Institute, supporting local industry and impacting agriculture both nationally and internationally. Now world-leading, the LAR research cluster has helped secure 149 Agri-Tech projects worth over £100m in total. These involve over 250 unique partners in industry – from micro businesses to global Tier 1 companies – as well as research and university centres, government agencies, and third-sector bodies in the UK, Europe, and the Americas.

The team also lead two growing MSc programmes in Agri-Food Technology and Sustainability, and co-lead a BSc in Robotics and MSc in Data Science and Applied Analytics.

THE WORLD'S MOST SUCCESSFUL AND COLLABORATIVE RESEARCH CLUSTER IN AGRICULTURAL ROBOTICS

LAR continues to support other major cluster projects, including Barclays' Eagle Farm Lab – which leads national agri-tech start-up support – and CERES Agri-Tech, led by Cambridge University. Spin-off projects by CERES at LAR focused on the automation of mushroom harvesting (Agaricus Robots) and robotic automated fruit prediction (FruitCast).

Two major recently-funded initiatives ensure LAR continues to grow. These include Place Based Impact Acceleration Account (PBIAA) funding from EPSRC, and Connecting Capability Funding (CCF) from Research England. Collaborative funding will help transform early-stage academic innovation and technology into commercially attractive opportunities. The LAR team, together with partners Cambridge Enterprise Ltd. and the Universities of Cambridge and East Anglia, will work with civic and global partners, industry, farmers, and growers to develop infrastructures, networks and skills.

The drive provided by the establishment of LAR continues to act as a nucleus for a much larger cluster of Agri-Tech projects. LAR has been the key enabler because it created a team with the scale to support multiple partnerships with industry, academia and government. Having been named 'the world's first global centre of excellence in agricultural robotics' in the UK Innovation Strategy (2021), LAR's ambition is to remain the world's most successful, collaborative and progressive cluster in agricultural robotics.

Recently-awarded projects will develop:

- The world's first open development platform for agri-robotic crop harvesting *(AGRI-OPENCORE, Professor Grzegorz Cielniak)*

- New benchmarks for nitrogen use efficiency *(NUE-Profits, Professor Grzegorz Cielniak)*

- Automated crop grading for delicate produce such as strawberries and grapes *(Qualicrop, Professor Grzegorz Cielniak)*

- The world's first AI enabled self-propelled robotic crop sprayer *(Robo-sprayer, Professor Timothy Gordon)*

- A scalable plant mapping system for improved yield forecast models *(FinerForecasts, Associate Professor Shaun Coutts)*

- The world's first commercial mushroom harvesting robot *(Agaricus Robotic Harvester, Professor Simon Pearson)*

- A whole systems approach towards climate-resilient, controlled-environment agriculture *(Climate SAFE, Professor Simon Pearson)*

- Collaborative human-robot picking / transporting teams for the soft fruit industry *(Co-FRUIT, Professor Elizabeth Sklar)*

START-UP INCUBATION

Our first spin-out company, FruitCast Ltd, launched in Autumn 2021. Created by LIAT PhD student Raymond Martin, who developed automated robotic fruit counting and analysis tools to improve the reliability and accuracy of harvest prediction, FruitCast is on a mission to revolutionise the farming industry with farm digitisation and yield forecasting as-a-service.

FruitCast Ltd

This unique AI-enabled data analytics platform brings unparalleled accuracy to soft-fruit growers, empowering operational teams to optimise farm labour, scheduling, and supply chain resources. The platform does this by non-destructively measuring individual fruit numbers, weight, and maturity of millions of berries per day. Combined with other data sources, FruitCast's algorithms can predict yield up to six weeks ahead.

FruitCast has received funding from three Innovate UK projects over the course of two years, totalling over £2m. These projects are allowing the company to further develop their FruitCast system so it can be released commercially in 2024.

FruitCast in Numbers

£13.6m	10%	£6m
in increased sales and prices (or £2.9k/ha)	decrease in imports, equating to £5.1m (or £1.1k/ha)	in savings given 20% waste reduction

FruitCast's Founder and Chief Technical Officer, Raymond Martin, completed his PhD with the University of Lincoln, supported by the Collaborative Training Partnership for Fruit Crop Research (CTP FCR) funded by BBSRC and Industry.

Improving Resilience for Strawberry Farms

FruitCast benefits growers and farmers, contributes to the sustainable intensification of food production and accelerates the net-zero transition. Our plan is to reduce yield forecast error to less than +/-15% at plant level, three weeks in advance – unlocking significant productivity, sustainability, and resilience gains for UK strawberry farms:

- Fewer distress sales (20-25% price reduction)

- Stronger supply consistency, customer relationships and confidence

- 5% increased sales and prices, totalling to £13.6m (or £2.9k/ha)

- 10% decrease in imports (approximately 19,000T and £51m in UK shoulders) equating to £5.1m (or £1.1k/ha)

- 10% enhancement of labour scheduling, where labour accounts for 42% of costs, equivalent to £27.9m

- 20% waste reduction and increased shelf life (from WRAP@18KT/year), amounting to £6.0m (or £1.2k/ha)

The number of jobs created by FruitCast currently stands at sixteen.

FruitCast

Funded by Innovate UK:

£425K (Fruitful Forecasts)
£996K (Crop Census)
£806K (Finer Forecasts)

10% enhancement of labour scheduling

16 new jobs created as of 2024

TEACHING

LAR has contributed to the expansion of educational programmes delivered by the university to develop new skillsets and 'future leaders' who will drive innovation in the agricultural sector.

LIAT provides academic leadership in education through delivery of impactful and sector-relevant teaching in food, farming, robotics and sustainability. Programmes integrate biological, physical and social science, removing barriers between disciplines and developing skilled, employable graduates who are adaptable and socially responsible.

MSc Agri-food Technology

Addresses key challenges aligned with the agri-food sector around land and water use, climate change, sustainability, health and wellbeing.

MSc Data Science and Applied Analytics

Develops understanding around designing data science tools, their implementation and evaluation, analytical aspects of big data, and their meaning and importance to both businesses and the public sector.

MSc Sustainability

Develops technical knowledge, leadership and business skills needed to embed and create sustainable practices, products and services.

MSc Robotics and Autonomous Systems

Equips students with knowledge and skills needed to develop advanced solutions for the global industry in Robotics and Autonomous Systems (RAS), and other sectors where RAS skills are increasingly sought.

LIAT collaborates with Schools and Centres across the University to deliver shared undergraduate and postgraduate teaching programmes, as well as professional short courses for the agri-food industry.

BSc (Hons) Robotics

Innovative project-based learning that provides a conceptual and methodological grounding in robotics, with training in state-of-the-art practices and techniques deployable in real-world settings.

Professional short courses (e.g., BASIS)

Deliver higher-level skills to the agriculture and food sector in areas such as soils and water, sustainable land management, and carbon.

Bespoke management and leadership short courses

Deliver focused management and leadership programmes in agriculture, agri-food supply chains and allied service and professional sectors.

A comprehensive selection of executive education short courses aimed at the agri-food supply chain. The suite of courses focusses on varied topics such as developing management and leadership, embedding sustainability principles and understanding data-driven decision making.

STUDENT ACHIEVEMENTS

The E3 award enabled Lincoln Agri-Robotics to shape the future talents of five PhD students with a clear focus on designing and building intelligent agricultural robots.

Yoon Ju Cho

My PhD research focused on field-based plant phenotyping assisted by a mobile robotic phenotyping platform to evaluate radiation use efficiency in wheat, utilising 3D and spectral imaging techniques. Although my primary background was in crop science, this multidisciplinary project has facilitated my acquisition and application of machine learning techniques to develop sophisticated crop modelling. I also had the opportunity to enhance my professional network and gain a broader perspective by participating in international and national conferences.

Laurence Roberts-Elliott

My PhD, funded by a LAR studentship, has focused on developing a multi-robot system for mapping soil properties in arable fields. This work aims to enable precision land management, to reduce inputs and negative environmental impacts of agriculture. I have investigated the effectiveness of combining existing and bespoke methods of informative path-planning and multi-robot coordination to autonomously decide where soil measurements should take place, and which robots to allocate to these measurement tasks.

Vishnu Rajendran Sugathakumary

In November 2020, I enrolled as a PhD candidate at LAR, embarking on a research endeavour dedicated to the development of a soft, customizable tactile sensing skin. The primary aim of this investigation was to develop such a technology and augment haptic sensations for strawberry-picking robotic end effectors. Within the esteemed research environment at LAR, I had the privilege of accessing world-class facilities which enabled the comprehensive in-house development of the sensing technology from inception to completion.

> ## MY TENURE AT LAR HAS UNDOUBTEDLY BEEN ONE OF THE MOST ENRICHING EXPERIENCES OF MY PROFESSIONAL CAREER
>
> — *Vishnu Rajendran Sugathakumary, University of Lincoln*
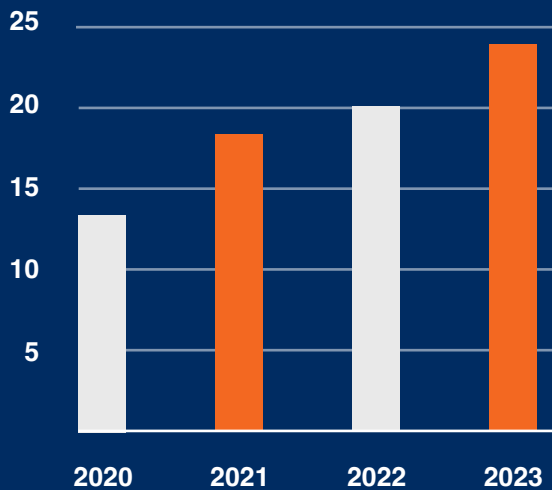
Rajitha De Silva

My PhD project focused on vision-based navigation for agricultural robots in arable fields. I have developed an AI system that can detect crop rows in any crop field and autonomously drive a robot along those rows for precision agricultural tasks. This system underwent extensive development and testing, involving over 100 hours in fields around Lincoln. The facilities at the Riseholme campus proved invaluable in supporting my research. As a PhD student at LAR, I had the opportunity to attend multiple international conferences, delivered several presentations, showcasing my research and its contributions to the field of precision agriculture.

Srikishan Vayakkattil

As a dedicated PhD student, I specialise in soft robotics with a focus on developing a revolutionary soft haptic probe. My research involves creating a system that harnesses the power of touch to comprehend and adapt to its environment. In contrast to conventional soft sensors, my approach integrates predictive models to determine optimal geometrical and mechanical parameters, significantly enhancing the efficiency of the probe. Additionally, my work extends to computer vision, where I strive to identify mechanical parameters from visual data such as videos and photos of objects, contributing to the advancement of tactile perception in robotics.

OUR ACHIEVEMENTS IN NUMBERS

Successful Funding Applications

| 2020 | 2021 | 2022 | 2023 |
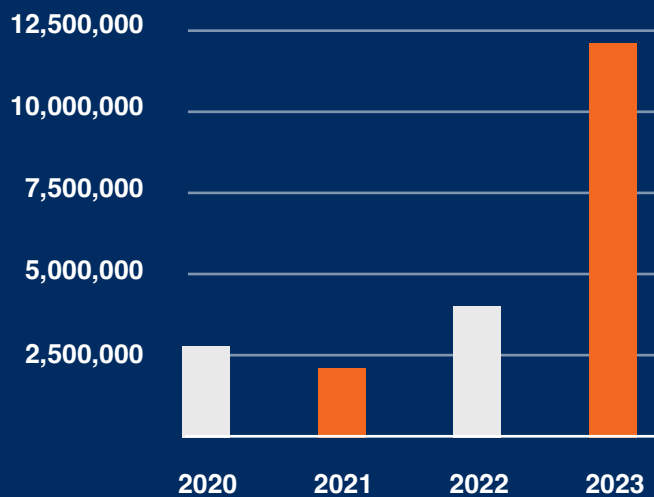
Research Income Awarded

| 2020 | 2021 | 2022 | 2023 |

2019-2023

66	87	19
Conference Presentations	**Publications**	**Workshops Held**

8	Professors
14	Senior Academics
8	Early Career Researchers
15	Post-Doctoral Resarch Fellows
4	Technical Staff Members
15	Professional Service Staff

Diversity

34%
Female

23%
Minoritised Ethnic

2023

£12,194,658

in Project Funding Awarded

Public Engagements (by year)

Year	
2023	
2022	
2021	
2020	

0   20   40   60   80

Press Coverage (by year)

Year	
2023	
2022	
2021	
2020	

0   50   100   150   200
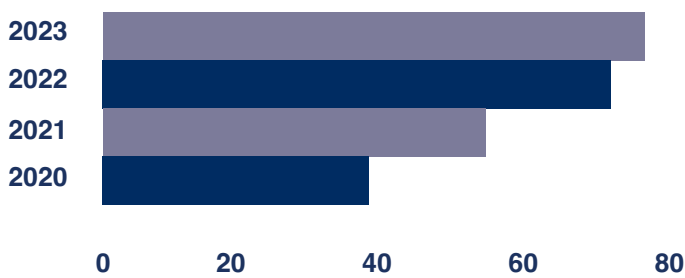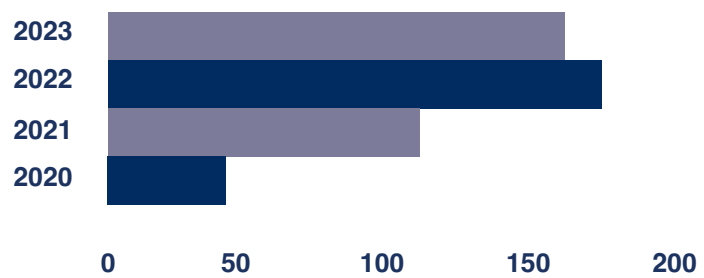
KEY PROJECTS

SUSTAIN PhD Programme

£10.9m
in Funding Awarded

HEI Collaborators

Queen's University Belfast
University of Aberdeen
University of Strathclyde

Funded by

UK Research
and Innovation

UKRI AI Centre for Doctoral Training in Sustainable Understandable agri-food Systems Transformed by Artificial INtelligence (SUSTAIN)

Data-driven AI can transform food production – reducing greenhouse gas emissions and waste, stabilising supply chains, enhancing plant and animal breeding, and enabling fairer sharing. This requires a new generation of researchers, trained by a PhD programme that combines the expertise of soil, plant and veterinary scientists with that of AI and social scientists – and teaches ethical and sustainable AI delivery. SUSTAIN's PhD students will emerge ready to translate research into innovative technologies and responsible practices.

Director: Prof. Simon Parsons
Deputy Directors: Prof. Elizabeth Sklar,
Prof. Georgios Leontidis (University of Aberdeen)

EPSRC Centre for Doctoral Training

£7.6m
in Funding Awarded

HEI Collaborators

University of Cambrdge
University of East Anglia

Funded by

UKRI Engineering and Physical Sciences Research Council

EPSRC Centre for Doctoral Training in Agri-Food Robotics

With a focus on robotics within the agricultural sector, the Centre provides fully-funded opportunities for students to undertake MSc and PhD study, training them to become the next leaders in the agri-food robotics community.

Director: Prof. Marc Hanheide
Deputy Director: Prof. Fumiya Iida (University of Cambridge)

LINCAM Ceres Agri-Tech Place-Based Impact Acceleration Account

£4.9m
in Funding Awarded

HEI Collaborators

University of Cambrdge

LINCAM focuses on sustainable growth: enhancing businesses, driving social inclusion, and reducing environmental impacts. LINCAM will catalyse a world-leading AgTech cluster in the Greater Lincolnshire and North Cambridgeshire Fens (LINCAM) AgTech region – accelerating the impact of AgTech emerging from Higher Education Institutes in the UK, and working with civic partners to develop supporting infrastructures, networks and skills.

Project lead: *Prof. Simon Parsons*
Co-Investigators: *Prof. Louise Manning*

Funded by UKRI Engineering and Physical Sciences Research Council

Glasshouse Research Facility

£2.2m
in Funding Awarded

The Glasshouse Research Facility will be a new high-tech glasshouse R&D facility catalysing growth and productivity in Greater Lincolnshire, specifically for businesses developing technologies and processes for the high-value glasshouse horticultural sector. It will trial and demonstrate new products and develop practical solutions to Agri-Tech problems, increasing research and innovation to raise overall productivity.

Project lead: *David May*
Co-Investigator: *Prof. Simon Pearson*

Funded by Greater Lincolnshire Local Enterprise Partnership

£1.5m
in Funding Awarded

HEI Collaborators

University of Cambridge
Cambridge Enterprise
University of East Anglia

Agri-Tech Global

This project has a vision for a global Agri-Tech cluster for the Greater Lincolnshire and East Anglian region, focusing on international research translation and knowledge exchange methodologies that deliver food system impacts through sustainable growth and foreign direct investment (FDI).

Project lead: *Prof. Simon Pearson*

Funded by UKRI Research England

£1.4m
in Funding Awarded

Industry lead
APS Produce Limited

AGRI-OPENCORE

AGRI-OPENCORE will create the world's first open development platform (software and hardware) for agri-robotic crop harvesting.
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Academic lead: *Prof. Grzegorz Cielniak*
Co-Investigators *Prof. Marc Hanheide, Prof. Elizabeth Sklar, Prof. Simon Parsons, Prof. Louise Manning, Dr Gautham Das, Dr Leonardo Guevara*

Funded by UKRI Innovate UK

£943k
in Funding Awarded

Industry lead
AgAnalyst

NUE-Profits

From Nitrogen Use Efficiency to Farm Profitability (NUE-Profits) uses plants as sensors to provide farmers with a management tool for better nitrogen utilisation, providing more profit and environmental gains.

Academic lead: Prof. Grzegorz Cielniak
Co-Investigators: Assoc. Prof Iain Gould, Prof. Louise Manning, Dr Oorbessy Gaju, Prof. Simon Pearson

Funded by UKRI Innovate UK

£529k
in Funding Awarded

Industry lead
Xihelm

Qualicrop

Qualicrop will develop and introduce farm-gate, just-in-time automated crop grading for delicate produce (e.g. strawberries & grapes), adding value for tight-margin growers and ultimately disintermediating an inefficient supply chain, lowering costs to consumers.

Academic lead: Prof. Grzegorz Cielniak
Co-Investigators: Prof. Simon Pearson, Dr Junfeng Gao

Funded by UKRI Innovate UK

£247k
in Funding Awarded

Industry lead
ARWAK Ltd

ARWAC Attack Blackgrass in Farming

This project lays the foundation for next-generation robotic vehicles powered by renewable energy and tooled to control blackgrass. It drives productivity and contributes to Net Zero Agriculture by removing fossil fuels from key farming operations.

Academic lead: Assoc. Prof Shaun Coutts
Co-Investigators: Prof. Elizabeth Sklar, Prof. Mini Rai, Prof. Simon Pearson

Funded by UKRI Innovate UK

£212k
in Funding Awarded

Industry lead
FruitCast Ltd

FinerForecasts

FinerForecasts will leverage FruitCast's ability to quickly and cheaply measure crop state from videos to make plant-level forecasts possible at commercial scales.

Academic lead: Assoc. Prof. Shaun Coutts
Co-Investigators: Prof. Grzegorz Cielniak

Funded by UKRI Innovate UK

£134k
in Funding Awarded

Industry lead
Agaricus Robotics Ltd

Agaricus

This project aims to develop the UK's first intelligent mushroom picking robotic system that offers improved productivity, de-risked labour availability, increased yield and reduced food waste.

Project lead: Prof. Simon Pearson
Co-Investigators: Dr Junfeng Gao

Funded by UKRI Innovate UK

EVENTS

Our engagements take many forms, including industry events, robotics demonstrations, hosting a variety of agricultural groups and welcoming policy makers. Engaging with the local community not only allows us to highlight current projects, but also to educate and inspire future researchers and collaborators.

Some of our highlights:

LIAT Breakfast Briefings

During less busy times in the farming calendar, the LIAT team host topical Breakfast Briefings open to the farming community. Since 2019, the University's academic colleagues and invited speakers have led sessions on specialist subjects:

Sustainable farm energy
Carbon farming
Herbicide resistance and mechanical control
Robotic phenotyping
Planning now for the future landscape of farming
Farming in a changing climate
Phenotyping for efficient use of nitrogen in wheat
Climate action and sustainable agriculture
Strategic tasking in agricultural robotics
Innovation in Agriculture
AI for sustainable Agriculture
Decarbonising the Food Chain from Farm to Fork
Accelerating development of robotics for agriculture: Agri-OpenCore project

Groundswell

This event attracts those with an interest in food production and the environment, including farmers and growers. LIAT hosted a stand to engage with conversations about regenerative farming.

Fruit Focus

The fruit industry's premier event combines networking and the latest sector information. LIAT attended in 2021.

CropTec Show

Annual event offering business links and emerging technology for agronomists, farmers, and growers alike. LIAT have forged new business relationships and engaged future potential students annually at CropTec since 2019.

Cereals

With a focus on the future of arable farming and 450 exhibitors, this now-annual event brings together research and development and the arable farming industry. The University takes this opportunity to showcase LIAT's cutting edge agri-robots.

REAP

Agri-TechE's flagship event saw its tenth year in 2023. This immersive event puts farmers' challenges at the forefront and connects them with new and innovative technologies. LIAT have had a presence in numerous previous years.

Lincolnshire Show

Organised by the Lincolnshire Agricultural Society, the annual event is a celebration of all things Lincolnshire, including history, machinery exhibits, livestock, and food. With over 60,000 visitors each year, the University is a committed stand holder. In June 2023 the University demonstrated a multi-purpose dynamic platform (Boston Dynamics' Spot), used for research into field surveys.

Fresh Produce Consortium (FPC)

The FPC deliver an agri-tech conference and careers event each year. As well as sponsoring the event in 2022, the event was jointly delivered by the Lincoln Agri-Robotics team in 2021. Exhibitors include businesses and organisations with an interest in innovative agricultural technology; attendees include industry representatives and undergraduate students.

2020

- Professor Elizabeth Sklar was a panellist for International Foundation of Robotics Research (IFRR) Colloquium on Robotics and Agriculture.

2021

- Associate Professor Marcello Calisti was Chair for the RoboSoft International robotic competition 2021.

- Professor Simon Pearson took part in a round table for Digital Catapult and the UK Government, focussed on the Natural Environment (including Agriculture, Farming, Climate Change and Conservation).

- Professor Elizabeth Sklar led a citizen science project for LAR focused on engaging citizens by asking them to send us photographs of local crops to help build a machine learning data set.

- Jo Churchill MP (Parliamentary Under-Secretary of State at Defra) visited the LIAT team at Riseholme and saw Lincoln's agri-robotics technology in action.

2022

- Professor Simon Pearson co-chaired the Defra Automation Review with The Rt Hon George Eustice MP, involving conversations with growers and industry, roundtable events and report writing.

- LIAT partnered with TedX Brayford Pool to host a Salon and Adventure *The Way We Eat,* where University staff interacted with the public to explore key topics around food, agriculture and technology.

LAR has been involved in more than 300 events and public engagements.

- Computer Scientist and PhD student Katherine James presented her research on machine vision solutions to biological challenges, spanning both the agricultural and conservation sectors at the University's TedX Brayford Pool event.

- The Robot Highways project, funded by Innovate UK, and led by Professor Marc Hanhiede, delivered the largest robot demonstration of integrated robotic services in a soft fruit farm environment.

2023

- Professor Simon Pearson was involved in an independent review of government's progress towards achieving net zero, led by the Rt Hon Chris Skidmore OBE MP and published in March 2023.

- Representing LIAT, Professor Simon Pearson was invited to the Horticultural Sector Committee at the House of Lords. This was a valuable opportunity to influence the early stages of the inquiry.

- Professor Grzegorz Cielniak gave an invited talk titled *The Use of Robotics in Viticulture* to over 160 attendees from the British wine-making industry.

- Professor Simon Pearson met with Prime Minister Rishi Sunak, who was keen to gain insights into current food system challenges.

- The Rt Hon George Eustice MP visited the University's Riseholme campus to tour the facilities used for research into agri-robotics and technology.

- CDT PhD student James Heselden presented an overview of a strawberry logistics project for Jim McMahon MP (Shadow Environment Secretary 2021-2023).
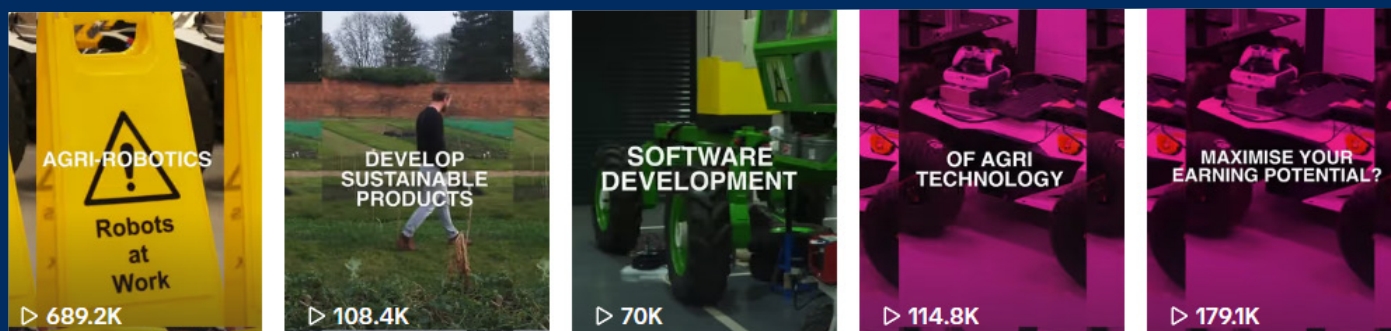
SOCIAL MEDIA SUCCESS

LIAT worked with specialist agricultural marketing agency Hillsgreen as part of our engagement activities. Following the success of an initial campaign, Hillsgreen was tasked with coordinating and delivering another – this campaign aimed at raising awareness about LIAT's programs, facilities, and research excellence.

Social Media Success		
515k	**Top 21%**	**6,459**
impressions	click-through Rate (TikTok)	clicks

Hillsgreen says:

We tailored content to resonate with a younger audience. Engaging short video showcased the exciting aspects of agri-tech research. Paid promotions on TikTok resulted in viral content, significantly boosting awareness among a demographic crucial for shaping the future of the agri-sector.

Further content on Meta, TikTok and LinkedIn showed agri-tech advancements and the societal impact of LIAT's research. The campaign successfully elevated brand awareness, reaching an audience beyond traditional student recruitment. Click-through rates were notably high.

Prospective students and collaborators were directed to detailed information about LIAT's projects, facilities, and research outcomes – fostering a deeper understanding of the institute's contributions to the agri-tech sector, and drivng more enquiries about their research facilities.

HILLSGREEN

A LOOK TO THE FUTURE...

Our mission is to expand our capability and further embed the Institute in civic society regionally, nationally and internationally – moving from local to global as we strive to solve the challenges of agricultural sustainability.

Regionally, we are creating an agri-tech innovation cluster (Agricultural Growth Zone) in the north of our county. We have a joint vision with the Local Enterprise Partnership, County Council, District Council, Agricultural Society, and agricultural FE College to stimulate regional economic growth.

The development of high-skilled jobs and advanced technologies will attract new talent to our region. By establishing a national Centre of Excellence, we will attract businesses who may co-locate with the Institute – further developing our model of partnership-based research, technology transfer and economic impact.

By 2040, we aim to reach internationally competitive scale in Agri-Food technology – the first institution in the UK to do so – based upon our growing international links and reputation.

Throughout our development, we have combined an integrated focus on local needs with addressing globally significant problems, for the benefit of UK PLC and humanity as a whole. We will continue to work from local to global as we strive to solve the worldwide challenges of food security and sustainability in the future.

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