Eastern England Agritech

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Case Study Overview

Characteristics and history: Agricultural activity in Eastern England primarily focuses on crops, with livestock (predominantly pork and poultry), and some aquaculture in coastal areas. While most of the activities described in the definition of agritech occur to some degree in Eastern England, stakeholders indicated that the area had particular specialisms in *crop and biosciences* underpinned by strong research capacity in universities and research centres; *food and beverage processing*, with a large sectoral presence and recently established research centres; *controlled environment farming* (including vertical farming); and *sensors, robotics, and automation*. A recent report placed the area's agricultural output at £5.1 billion in 2019, noting that this accounts for a quarter of the English total and that the food chain supports over 150,000 jobs across the region (New Anglia LEP et al. 2021).

There is considerable expertise in the area in related industries such as ICT, space and satellite applications, and artificial intelligence. These certainly have made contributions to agricultural development in the area; however, their applications are much broader than agriculture and significant agriculturally-focused sub sectors have yet to coalesce in this area. Although there are notable complementarities between the areas of excellence noted above (e.g., robotics and automation are used in vertical farming; crops and biosciences are responsive demands to the food processing industry, etc.), this has not translated into significant synergies in the form of strategic partnerships and widespread ongoing collaborative research.

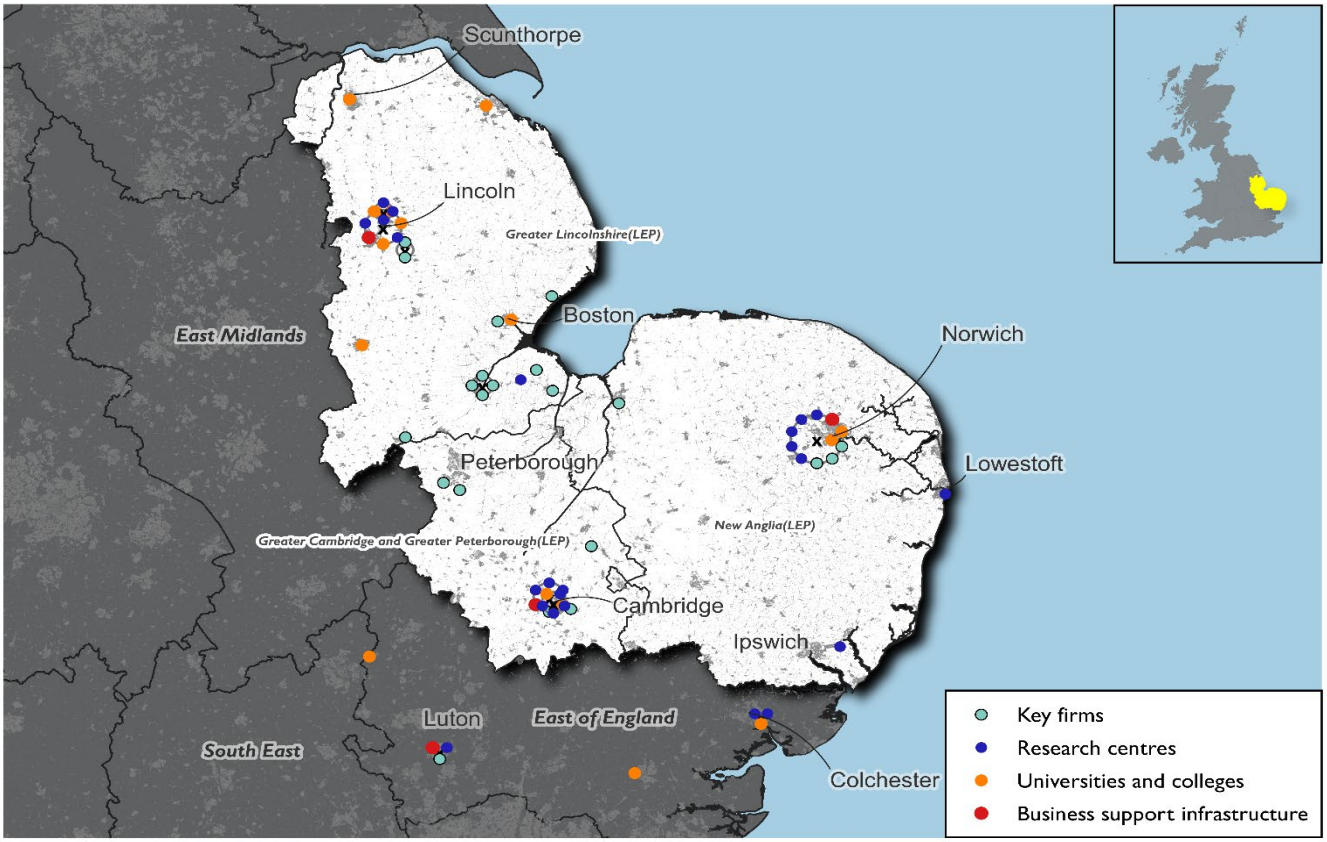

Figure 1: Eastern England Agritech map.

Geography and size: This study began from a loose geographical definition of Eastern England with the aim of refining that definition through our discussions with stakeholders. Opinions differ as to the precise geography of agritech in the area, with some adopting definitions that encompass the entire scope of agricultural activities and others that focused on what they perceived as centres of innovation in and around Lincoln, Norwich, and Cambridge. In this study, we interpret the geography as encompassing a core set of counties - Lincolnshire, Norfolk, Suffolk, and northeastern Cambridgeshire - while acknowledging that agricultural activities, supply chains and synergies also extend south into Essex, west into Hertfordshire and Bedfordshire, and northwest into the East Midlands.[1] That said, this definition is somewhat problematic since some knowledge producing universities and Rothamsted Research (Hertfordshire) is another significant research and business support organisation even though it is located outside of this core geography. Also notable is that this geography does not map neatly to current governance mechanisms such as Local Enterprise Partnerships (LEPs) and Combined Authorities. Core LEPs include Greater Lincolnshire LEP, the Cambridgeshire and Peterborough Combined Authority, and New Anglia LEP, each of which has its own interpretation of the agritech sector and its contribution to its economic development planning.

Areas of potential future growth: Agritech was described as a dynamic and growing sector by stakeholders in the area. In terms of areas of potential future growth, stakeholders focused on both core technologies and practices.

- Controlled environment farming - vertical farming and glasshouses for applications locally

[1] Previous studies have used these more expansive geographies while also acknowledging the difficulty in establishing firm boundaries (see Policy Links 2016). As another example, SQW (2017) uses an alternative definition that excludes Lincolnshire.

and in challenging environments in the context of climate change and Net Zero objectives.

- Alternative proteins - experimenting with and producing alternative proteins.
- Farming and food waste reduction and processing - seeking efficiencies in food production to reduce waste, develop more resource efficient crops and processes, and innovation to expand markets for agricultural products.
- Biological crop protections and plant engineering - related to resource efficiency, responding to climate change, and increasing hardiness to pests - includes cell and gene editing (GE) and genetic modification (GM). Changes in UK regulations around GE and GM anticipated after exit from the European Union may create space for significant growth and innovation in this field.
- Satellite applications - remote monitoring of crops and livestock permit precision farming.
- Digitalisation - encompasses a broad set of opportunities around data marshalled from many applications: from predictive and precision farming and supply chain management, to better navigation of logistical and regulatory challenges, among many others.
- Automation - has increasingly been developed for and adopted in farming both in relation to emerging practices (e.g., vertical farming) and to mitigate labour challenges.

The diversity of areas of potential growth is a great asset for agritech as a sector but also highlights how fragmented it is as well. While it is again worth noting that there are synergies between them, many of these are innovations, practices, or technologies that are conceptualised (and funded) as distinctive activities. Importantly, these growth areas can yield benefits for local producers and processors; their primary value will likely come from international markets.

Reflections: It is difficult to describe agritech in Eastern England as a cluster, because of the distributed geographies that it inhabits, the wide variety of activities that fall under its umbrella, and the current state of development of synergies between them. While there is no shortage of governance entities and industry associations that champion aspects of agritech, a shared vision has only recently begun to emerge. In 2021, the three LEPs that we have designated as core collaborated on a document to guide investment entitled "Agri-food in Eastern England: An Investment Opportunity", highlighting their intention to work together to grow the sector. However, while the document features core assets in the region and some broad collective objectives, interviews suggested that the LEPs (and industry organisations) were generally pursuing their own strategies, even though they duly acknowledged the benefits and need for collaboration. This is covered in more detail under the heading of governance, below. It is also worth noting that other, overlapping agritech-related clusters are developing on the area's flanks - most notably the Crop Protection cluster in Buckinghamshire Thames Valley, Hertfordshire, Oxford and Thames Valley Berkshire that is being created as a candidate for a high potential opportunity (HPO) zone.

Core Assets

Market structure and anchor firms: Because agritech encompasses so many different elements of the value chain (see Figure 2), it is difficult to provide a thorough accounting of notable anchor firms or a detailed description of the sectors' structures. Some respondents remarked that the area lacks large domestic agritech firms, and is instead dominated by large international players like Syngenta, Bayer, Dow, and Cargill. Others contrasted the structure with the pharmaceutical industry, in which large domestic firms and foreign anchor firms are more embedded in the ecosystem and do more horizon scanning and R&D that engages local SMEs.

Respondents tended to focus on the firms in subsectors of agritech that were most relevant to them. Those focused more on biosciences and technologies noted domestic SMEs such as Tropic Biosciences, Leaf Expression Systems, Colorifix, Phytoform Labs, Olympus Automation Ltd, and Alltech. For instance, those focused more on the food production side were more apt to list large food producers such as Dyson Farming, Gs Growers, Burgess Farms, the Bom Group. On the food processing side, interviewees named several firms including Greenyard, Plant and Bean, Princes, Branston Potatoes, Staples Vegetables, Worldwide Fruit, AH Worth, Bakkavor Plc, FESA, Karsten UK, Pinguin, and Premier Foods. Retailers such as Sainsbury, Waitrose, McCains, and others are not locally based, but exert influence on the value chain.

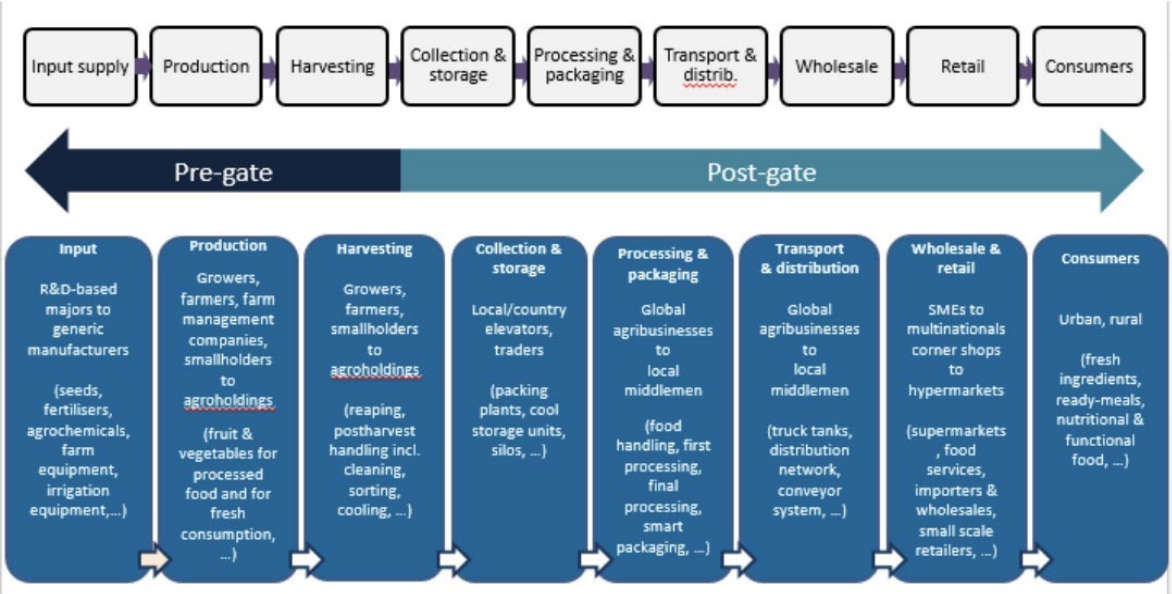

Figure 2: Different elements of the Agritech value chain. Source: Policy Link 2016.

Market structures play a strong role in stimulating demand and creating an environment for innovation. The area undeniably has an impressive roster of companies active and innovating across the value chain and many more SMEs that were not mentioned or in the process of developing, particularly on the technology side of the equation. Interviewees described a community of farmers ranging between established 4th or 5th generation family farms (which can be very large and significant producers) and industrial operations. The former was described as having varying degrees of openness to technological and process innovation and engagement with research infrastructure, while the latter were characterised as having their own internal programmes and not drawing extensively on locally-generated innovations. One respondent noted that with respect to plant sciences, food processors much further along the value chain were significant actors in shaping innovation and demand. In their view, this was creating a structural reorganisation on the production side - with producers aligning with specific processors and clusters of producers and processors in one location forming compressed supply chains - to respond to processor and retailer demands.

This highlight suggests distinctions in the demand profile for different technology types, what drives that demand, and the actors within the market with the capabilities (and willingness) to access innovation or engage in their own development processes. The degree to which firms developing technology have been able to penetrate local markets is unclear from this sample and is an area for future research. However, the markets for those technology solutions are global. This suggests a role for support mechanisms that leverage existing market structures to maximise innovation and adoption

locally while recognising that local absorption is not crucial for the development of international opportunities.

Higher education and training institutions: Universities and colleges in the area have strong research and training programmes in agriculture, biosciences, and emerging agritech fields due to the area's historical specialisation. Note that each institution has programmes in plant and crop science and biotechnology. Much of the world leading research is conducted in specialised research centres listed in the next section.

- **University of Lincoln** delivers "advanced, multi-disciplinary research and innovation across the entire food chain, providing cutting edge solutions to improve the sector's productivity, sustainability, safety, and resilience, while enabling new product development" (New Anglia LEP et al. 2021). The ***National Centre for Food Manufacturing (NCFM)*** provides training for food industry employees and businesses. The university has a specialist MSc programme in Agri-food technology and hosts the ***Lincoln Institute for Agri-Food Technology (LIAT)***, supporting research in the areas of artificial intelligence, robotics, engineering, crop science, environmental sustainability, food manufacturing, product development and supply chains to support and enhance the future of food and agriculture productivity, efficiency, and sustainability. LIAT engages in several partnerships such as ***Lincoln Agri-Robotics (LAR)***, the world's 'first global centre of excellence in agricultural robotics' (UK Innovation Strategy, July 2021). This initiative brings LIAT together with the Lincoln Centre for Autonomous Systems (L-CAS) to support robotic innovation and technical advancement in agriculture, through a network of academic excellence, industry partnerships, and funding organisations. The university is also host to ***Barclays Eagle Labs Farm***, which provides space to support entrepreneurship and includes a robotics lab, a demonstration packhouse, and a model refrigerated supermarket aisle. The university is also a partner in ***AgriFoRwArdS*** (see below).
- **Lincolnshire Institute of Technology** is a collaboration between the University of Lincoln, employers and colleges across Greater Lincolnshire to meet the higher-level engineering, digital and manufacturing skills of the region's agritech sectors. The partnership brings together the University of Lincoln, Grimsby Institute of Further and Higher Education, DN Colleges Group (North Lindsey College), Bishop Burton College (Riseholme College), Boston College, Grantham College and University Centre, Lincoln College, Lincoln UTC, University Campus North Lincolnshire, Bakkavor Plc, and Olympus Automation Limited, with the support of the Greater Lincolnshire Local Enterprise Partnership, Siemens Energy UK, and CATCH.
- **University of East Anglia (UEA)** hosts an MA in Agriculture and Rural Development and specialisms in health and nutrition, environmental and biological sciences, responses to climate change, understanding consumer behaviour, competition and regulation, and data. It is home to the ***Broadland Food Innovation Centre***, an £11.4m ERDF funded project supported by New Anglia LEP and delivered by UEA, Broadland District Council, and Hethel Innovation. The initiative provides food and drink SMEs and the broader sector with support to grow and test new food items and to develop local supply chains. The initiative also supports a ***Food and Drink Innovation Cluster*** for Norfolk and Suffolk, which aims to facilitate knowledge exchange, R&D collaboration, new business, and supply chain opportunities.
- **University of Cambridge** hosts numerous plant science and agritech departments and programmes. In addition to world-leading departments of Plant Sciences and Genetics the university is also home to the ***Sainsbury Laboratory***, ***Crop Science Centre***, and ***Cambridge Global Food Security Research Centre***. The ***Cambridge Conservation Initiative***, a collaboration between the university and nine leading conservation organisations, leads agritech projects focused on food security and biodiversity. The Computational Biology

stream at the ***Cambridge Centre for Data-Driven Discovery (C2D3)*** offers courses in computational biology using mathematical and computational methods to analyse large amounts of complex data and synthesising them into useful system-wide models of biological processes.

- **City College Norwich** is participating in the co-creation of a New Anglia technical curriculum in Agritech (among other subjects) with a coalition of colleges in the area. It works closely with employers and industry associations to fill skills need in the area.
- **AgriFoRwArdS** is a collaboration between the Universities of Lincoln, Cambridge and East Anglia, and focuses on robotics within the agricultural sector. The Centre provides fully funded opportunities for students to undertake MSc and PhD study, to become the next leaders in the agri-food robotics community. In 2021, the programme had £6.9m of funding to support 50 PhDs, all co-sponsored by industry (New Anglia LEP et al 2021).

There are several other universities that contribute to the Agritech economy in the area that, while not physically located within the case study geography, are significant enough to mention:

- **Writtle University College:** Writtle is one of the oldest specialist institutions in the UK and offers a range of land-based, environmental, animal and sport courses at various levels of academic study including postgraduate, undergraduate, further education, short courses and apprenticeships.
- **University of Essex:** The plant group at Essex is working with farmers and growers to find new ways of improving crop yield, thanks to a deeper understanding of photosynthetic and plant responses to the environment. The ***Essex Plant Innovation Centre (EPIC)*** brings together the research skills, expertise and technologies across our science faculty (Life Sciences, Computer Science and Electronic Engineering) together with the Institute for Analytics and Data Science (IADS) and Essex Business School to address the grand challenges facing farmers, technologists and all those in the agricultural and horticultural sectors.
- **Anglia Ruskin University: (**Essex, Cambridge and Peterborough). Hosts the ***Global Sustainability Institute*** and is leading an initiative to create an ***Agri-Food Tech & Sustainability Consortium*** around their new campus in Peterborough.
- **Cranfield University:** (Bedfordshire) The Environment and Agrifood Theme combines research groups with 50+ years of experience in contributing to societal challenges such as sustainability, enhancing natural capital and future global food systems resilience. Cranfield is also a partner in two Agritech Centres; Agri-EPI and CHAP. University facilities combine research and development capabilities in agriculture, in multiple configurations, to address the importance of soil resources and sensing and analysis of big-data.

Other research and anchor organisations: In addition to the research institutions and programmes hosted at universities and colleges (above), the area hosts five of the eight national strategic sites supported by the Biotechnology and Biological Sciences Research Council (BBSRC). These research centres have close connections with one another and with associated universities. However, it is notable that these tend to specialise more on plant and crop science than on enabling agritech technologies, such as data analytics, robotics, machinery, etc.

- **Norwich Research Park** is one of the most significant concentrations of food, genomics, and health technology research in the UK. It is home to over 40 companies that are translating concepts developed through science research into viable commercial propositions. It is a partnership between the John Innes Centre, Quadram Institute, Earlham Institute and The Sainsbury Laboratory; with University of East Anglia (UEA) and Norfolk and Norwich University Hospitals NHS Foundation Trust (NNUH), supported and funded by The John Innes Foundation and UKRI Biotechnology and Biological Sciences Research Council (BBSRC).

- **John Innes Centre** was founded in 1910 and established in Norwich in 1967. It is an independent international centre of excellence in plant science, genomics, and microbiology. Its core departments focus on biochemistry and metabolism, cell and developmental biology, computational and systems biology, crop genetics, and molecular microbiology.
- **The Sainsbury Laboratory** is based at Norwich Research Park and hosts research projects that take fundamental scientific discoveries from the laboratory to the field with the aim of reducing worldwide losses to crop diseases. Current projects include the discovery, engineering and deployment of novel immune receptors in crops, as well as genome editing tools that will enable the generation of novel alleles for crop improvement.
- **Quadram Institute** is an interdisciplinary institute that conducts research at the interface between food science, gut biology, human health and disease, and is based at the Norwich Research Park.
- **Earlham Institute** is based at the Norwich Research Park and has a core mission to unravel the scale and complexity of living systems to understand, benefit from, and protect life on Earth. It brings together multi-disciplinary expertise in the life sciences with engineering, computational science, and biotechnology.
- **Rothamsted Research**[2] is a world-leading, non-profit research centre that focuses on strategic agricultural science to the benefit of farmers and society worldwide. The scientists at Rothamsted use data, expertise, and technologies to improve crop performance, resilience, and value. Its research tackles weed, disease and insect resistance to agrochemicals, improves soil health, enhances natural capital, reduces agriculture's carbon footprint, and adds novel nutritional and bioeconomical value to crops and other products. ***Rothamsted Agritech Business Centre*** is located on the same campus and offers office, lab space, and business support services to agritech and agrifood businesses through an innovation hub and incubation space.
- **NIAB** has several locations in Eastern England including its headquarters in Cambridge and the Eastern Agritech Innovation Hub. Its research and support offerings span the crop improvement pipeline; from underpinning research required to develop higher yielding, more climate resilient crops through to the extensive trials data, agronomy expertise and advice needed to ensure these advances are transferred effectively onto farms.

Support structures and infrastructure: Much of the innovation and commercialisation process is supported by the numerous universities and research centres. Several of these have dedicated incubation spaces and offer support and technology transfer services (e.g., Rothamsted, Norwich Research Park). Consequently, there are relatively few standalone support structures. ***CERES Agritech*** brings together five leading UK universities (Reading, Hertfordshire, Lincoln, East Anglia, and Cambridge, as well as three research centres (Rothamsted, John Innes, and NIAB) to provide translational funding and commercialisation expertise and drive agritech innovations to market. Other initiatives include six **Food Enterprise Zones (FEZs)**, each of which has a different specialism and aims to support innovative businesses in collaboration with local councils and affiliated research organisations and universities. As with other assets, there is no shortage of initiatives and support across the area. Where respondents felt that there may be gaps was particularly on the financing side, where there is a perception that there are wide differences in access to resources based on area of research (e.g., controlled environment farming is currently attracting a lot of public and private investment while other areas do not receive as much) and a lack of support for SMEs looking to scale. On this latter point, all of the incubation facilities that we interviewed reported being at capacity while

[2] Rothamsted is technically located outside of the geographical footprint of the area of study but was mentioned so frequently as a partner and knowledge generating asset by actors we interviewed that we have included it here.

fielding frequent requests for support. This suggests that there is an opportunity to either expand existing incubation offerings (which often requires access to lab spaces or test facilities/land) and/or provide related business support in other ways.

Finance: Funding and finance are perennial challenges for innovation support. The most frequently mentioned sources of business support were CERES Agritech (listed above) and Innovate UK. However, these were both characterised as "oversubscribed". The 2017 SIA mentions several sources of funding:

- Anglia Capital Group venture capital
- Cambridge Agritech investment syndicate
- Adapt Cocoon Equity

It is perhaps notable that none of these were mentioned by name; only Anglia Capital Group appears to be active. This suggests that angel and venture capital is relatively difficult to access, a sentiment that is confirmed by several people we interviewed. One summarised the situation:

> *Well, you have angel networks, you have VC funds, but you also have high net worth individuals. [But it] takes a long time to see investment return. This was traditionally not an area where a lot of investors were interested, because you know, they need within five, seven years to have the return on investment. [Now] there is a lot more interest in agritech, because of the global challenges and because they also realise this is an exciting area with a lot of technologies. But yes, there are private sources of finance, but not enough. We need to do more education with the finance sector and explain how this market works. You know, what are the kinds of business models and how they can create return on investment.*

As this statement suggests, some observers noted some momentum in investment but also argued that this has not been evenly distributed. Areas such as controlled environment farming (vertical farming) have received more attention than others. One of the areas LEPs also noted, that while they do not have much funding for agritech themselves, they do try to signpost to different pots of money, such as the EURDF Low Carbon Innovation Fund that supports sustainable agriculture. Their impression was that many companies lacked crucial information about what funding might be available and that where they were aware of opportunities they did not always have the skills to put together a strong bid, which created an additional barrier to funding innovation.

Reflections: Overall, the area has a strong foundation of support organisations and knowledge generating assets across the wide range of types of activities and specialisms in the agritech space. The area is host to world-leading research capacity and innovative research centres. There is a considerable critical mass of firms across all areas of growth potential listed. However, the lack of large domestic leaders on the technology side was noted as a potential weakness in the sector's structure. This was less pronounced on the food production and processing side, although larger actors tended to be international firms. Some strong support structures have emerged in partnerships between universities and from partnerships between local councils and universities. But these are relatively new and may not be established, sufficiently resourced, or numerous enough to effectively support the broad geographies and diversity of industries. There also appears to be high demand for access to funding and finance that is not currently being met by either private sources, existing consortia, or Government. Given the strength of core assets, however, there is no shortage of partners that would lend expertise to the co-design and implementation of support programmes.

Skills

Talent pool: Talent was regarded as a complicated issue in the area, with various different patterns and challenges across the different types of activities. Generally, interviewees reported that the area had a great depth of research and innovation skills, in part generated by the strong research organisations and higher education institutions in the area. There is particular, world-class strength in bio- and plant sciences, and emerging strengths in robotics generated and attracted by research labs and university research groups. Gaps were specifically identified in a few fields such as engineering, bioinformaticians, software engineers, around digital skills more generally, and lower skill gaps on the logistics side (e.g., LGV drivers). A recent report noted that between 2019-2021 there was a decline of more than 100,000 workers travelling from EU8 countries, down 12% (Partridge & Partington 2021). Rising labour costs have increased demand for automation and the technical skills to adopt and implement new systems. The most commonly cited gap, however, was in business skills. As one interviewee put it:

> *We have a lot of researchers and I guess, agronomists, and chemists and you know, product developers, but we don't have people who are implementing this in the business.*

Another noted:

> *The problem that I'm facing at the moment is that I have technical expertise, which is kind of overflowing. I have no business expertise at all [...] And we need if we're going to have a strategy for the UK, we have to be investing in training the next generation of business leaders for this new agri business.*

This shortage of people who can understand not only the science and technology, but also the business models and industry structure and markets, creates barriers to innovation and adopting innovation. It also limits the ability of firms to access resources as dealing with funders also requires specific skillsets. Some respondents reflected that agritech was not attracting business talent because of perceptions that it is not a "sexy" sector and because the science and technology expertise required to succeed in that environment is intimidating. Similarly, even where management talent is attracted to these sectors, it is often inexperienced as more mature sectors are more effective at attracting more senior C-suite talent.

Local skills provision: As noted above, local universities and postdoctoral programmes through research organisations generate world-leading research and innovation talent. While much of that talent is retained locally, because of the prestige of these institutions some of that talent is exported internationally. For similar reasons, these institutions also attract talent from around the world to conduct research. Local colleges were also seen as fertile sources of talent in technical and agricultural technology fields. These colleges were identified as potential sources to feed gaps in digital skills and to inject more workers with the willingness and technical ability to seek out and adopt new technologies in food production. City College Norwich is developing a digital lab that will possibly contribute to these efforts, and colleges across the area are engaged in consultation exercises with local employers to fill skills needs. As the agrifood sector has evolved, colleges and local councils have produced a variety of skills analysis documents (see Easton College et al. 2021; New Anglia LEP 2022; New Anglia LEP 2017), which confirm that many of these skills gaps are well-recognised and being addressed through local skills strategies.

Respondents made two related observations about skills and training needs in the area. First, they noted that the food production and agricultural segments of the agritech market have increasing demands for upskilling. Again, as demands for automation and technologies for crop monitoring, water use control, and other innovations increase, so too will demand for people with the skills to deliver and implement these tools. Part of the equation will be in upskilling the existing workforce of farm

managers and farm workers. While the demand may be there, employers do not always have the resources to invest in training or upskilling or the knowledge of what programmes exist or support they might be eligible for. Secondly, there is a growing recognition that training has tended to occur in silos, but that model may no longer be appropriate for an increasingly technologically integrated sector. As one observer argued:

> *You do need people who understand the soil science and can do the agronomy, you do need people who can drive the tractors, you do need people that can harvest and sell on the crops, and they do go past the farm gate. But if you teach all of those things in isolation, you'll never get innovation or a broad understanding, because it was a tractor driver, you need to understand the soil science to understand why you're doing certain things. And you need to understand why you're harvesting at a particular time at a particular quality, because of where it goes out of the farm gate. And I think we've probably for a number of years in education, because that's how qualifications were driven down with very, very narrow occupational routes, we kind of lost some of that breadth.*

Consequently, linking training and upskilling programmes and work experiences may yield innovation benefits and future-proof the agritech workforce.

Reflections: The skills profile in agritech in Eastern England is relatively strong. However, this section has highlighted some notable gaps. For the most part, these can be (and are being) resolved by concerted action by local councils, LEPs, and area colleges and universities. As related above, these efforts may benefit from being designed holistically in order to ensure that workers understand the systems within which they are operating and increase opportunities for innovation. Public support may play a role in increasing knowledge about and access to training and upskilling opportunities. There may also be an opportunity to work with higher education and further education colleges in the area and around the country to provide specialised management training to fill the significant gap in business skills identified.

Knowledge Exchange

Firm research and development practices: It is difficult to paint an accurate picture of firm R&D practices across such a wide variety of subsectors and activities. Those we spoke with thought that firms in the area were relatively active in research and innovation activity. Respondents would point to food producers using new equipment or techniques (e.g., automation or sensors or crop imaging) but it was unclear whether this represents real innovation for the producer or was really just a form of technology adoption. On the production side, there were clear examples of innovation occurring where farmers were involved in co-developing tools, around vertical farming, and in creatively using waste products. Even in technology adoption, some people we spoke with described reluctance to make investments. Others suggested that producers didn't always have good access to information about innovations that might benefit their businesses. Another barrier to investing in R&D is who might benefit from that investment. One respondent explained that changes in the breeding cycle (for example) take a long time to show results and that value gets fragmented between different players in the value chain. In these cases, the burden of risk and the bulk of the cost falls on the breeder doing the R&D, while retailers and customers reap a majority of the benefits. Sustaining R&D in this area may require that the different members of the value chain work together to both determine what types of research would make the most difference and to collaboratively fund the work. However, this type of risk-reward structure only affects some areas of agritech - although where it does, it creates constraints on R&D behaviour.

Knowledge sharing and flows: With such a wealth of knowledge generating research institutions in the area it is no surprise that the potential for knowledge sharing and flows is relatively high. The research institutions that we spoke with reported high levels of demand from firms and cited frequent interactions between researchers and industry. Generally, those relationships were described as effective collaborations with one respondent stating that research is "translating brilliantly" into the local market. However, others responded that research was not focused on producing solutions for the local market and that they would work with firms wherever made sense for product or process development. Only conversations with individual researchers and their counterparts would reveal what barriers or challenges emerged in these processes and the balance of commercial or collaborative partnerships that are local. Respondents cited various bodies (predominantly the AgriFood Industry Council) as important sources of information flows feeding back intelligence about advances in research and innovation activities to the various different groups of stakeholders. That said, some did highlight that information about activities across the area and different subsectors of agritech could potentially be easier to access and that there was still a need for a potentially national level organisation that could pull together information, and expertise about activities in different places, in one place. While some thought about enhancing this capacity at the regional level, others saw advantages in organising better nationally to support connections between actors domestically and to serve as an interface with global markets.

Knowledge access and cultures: Respondents reported few significant barriers to knowledge sharing and that cultures of collaboration are relatively robust. The degree to which this is true will vary by subsector. However, due to the strong communities that exist around research organisations, proprietary projects take place in the context of tight knit networks of researchers, which facilitates broader knowledge sharing. Again, brokers like the research organisations themselves and bodies like the AgriFood Industry Council function as gateways through which firms and other researchers can gain access to knowledge and as disseminators of that knowledge. There was a feeling that more could be done to expand access and give firms and researchers more resources (and incentives) to share or seek knowledge from peers and providers in the area.

> *[We need to support] industry to realise the kind of research base research assets we have, but also some of the innovative companies we have in the region. So actually, whilst we've got the sort of research stuff that many businesses don't know about we've also got companies that the farming community have no idea about that could massively benefit their company, with game changing agritech solutions. So they might just go to the University of Lincoln, which is great, just because we work really closely with them. Because they don't know that there are actually companies in their own county or the next county that are doing some of the stuff that they really need.*

One research organisation reported that they felt that while they built internal networks well, they were not as externally facing as they could be. This is a potential area for improvement.

Firm network relationships: The people we spoke with had the most insight about interfirm networks in collaborative projects oriented around research infrastructure. Outside of these, farmers were reported to be quite well networked and frequently working in "clusters" (usually meaning groupings of affiliated operations).

Reflections: World-class research organisations are significant assets in innovative regions. However, there is no guarantee that, in the absence of concerted effort, the benefits of that research will be absorbed locally. These centres attract researchers from all over the country and the world, and the results of their efforts are similarly transmitted through national and international knowledge networks. While local firms that are able to access these assets can benefit from collaborations and

being early adopters of commercialised researchers, it seems likely that many firms lack the capacity to navigate these relationships and that finite capacity at the research end may limit the potential for partnerships. This may also be an issue on the food production side, where large global firms and processing operations either have their own internal R&D programmes or contain their innovations within increasingly vertically integrated supply chains. Almost all agreed that there was scope to increase knowledge exchange behaviour in the area.

Networks of Coordination

Agritech in Eastern England has several prominent networking organisations. The principal ones are:

- **Agritech-E:** is a business focused membership organisation, supporting the growth of a world-leading network of innovative farmers, producers, scientists, technologists and entrepreneurs who share a vision of increasing the productivity, profitability and sustainability of agriculture. This organisation was previously Agritech East but has rebranded in order to serve a broader national group of stakeholders. Because this group covers a broader geographical area than others on this list, it has the potential and ambition to function as the cluster organisation and convener for the region.
- **Norfolk and Suffolk Agrifood Industry Council:** A council made up of members of industry, government, and the research community to support the ambition of providing strong and clear leadership for the industry to drive forward the aspiration to be recognised as the UK's leading region.
- **UK Food Valley:** An initiative of the Greater Lincolnshire LEP, UK Food Valley aims to support growth and encourage inward investment through promoting the scale, breadth and importance of the food sector to the area, and by ensuring that existing food sector companies and new investors are supported.

Another network of interest in the area is **TechEast**, a community of startups and scaleups, later stage companies, investors, academia and government in the tech space in Eastern England concentrated in Norfolk and Suffolk. However, agritech companies are not strongly represented among members. TechEast leaders recognise the importance of the agrifood sector in the area but also reported some difficulties in connecting with more agritech focused groups.

Reflections: The area is divided between three LEPs and at least four counties (as we have defined it). Political fragmentation is often a problem in these situations. While the Eastern England geography exhibits some of this, there is also evidence of collaboration and coordination between the different governance entities. For instance, each LEP has its own initiatives and plans around agrifood, highlighting their own strengths and investment priorities. However, each is aware of the interrelationships and interdependencies between geographies and describes regular coordination with counterparts in other LEPs. The recent joint production of an investment strategy for agrifood in Eastern England (New Anglia LEP et al 2021) is testament to that approach. Agritech-E and the Agrifood Industrial Council were also described as cluster convenors, although were seen more as forums through which information about innovation in the area is disseminated rather than strategic leaders. Finally, it is notable that most of the initiatives in the area focus on agri*food* rather than agri*tech*. This may be more than just semantics. In the former, the focus is on the food production, processing, and distribution value chain, in which technology can play an enabling role. In the latter, the technology itself is the focus and of value to international markets, and innovations are co-

developed, tested, and adopted by local members of the broader value chain. These differences may be significant in terms of the strategic evolution of the tech side of agritech.

Discussion: Innovation opportunities and support needs

Evolution and market opportunities: In line with the discussion in the previous section's reflections, the evolution of the market will depend largely on the focus of support. It seems likely that it will continue to develop strengths in its three core strengths of controlled environment farming; crop and plant sciences; and robotics, automation, and sensors. There is an opportunity to strengthen support for innovations for international trade as well as localised adoption. As the post-Brexit regulatory environment on cell and gene editing relaxes, public support may contribute to revitalising and enhancing world-leading expertise in this area.

Resilience: Brexit has created a number of challenges that can threaten the viability of agrifood activities. As export markets contract and logistical challenges mount, firms require different tools and skills to optimise market strategies. Similarly, labour market shortages have increased costs of production. Finally, climate change and environmental stresses, such as this summer's drought conditions, strain yields and create issues for the domestic food supply chain. Energy issues will also stress producers' bottom lines. Fortunately, all of these challenges also create opportunities, many of which are already being embraced by firms in the area. Innovations using big data and digital tools are helping to navigate logistics networks and are optimising food storage regimes to maintain the quality of foods in transit, in storage, and on shelves. Labour market shortages are encouraging innovations in robotics and automation and accelerating their adoption. Researchers are working on drought tolerant and resistant crops, developing smarter irrigation systems, and learning how to do more with less. The combination of market, regime, and environmental challenges are significant and may change the structure of the agritech sector in the medium term, but can be mitigated through coordinated strategy and support.

Areas of potential support and intervention: Agritech in Eastern England has strong foundations. The most significant areas of intervention include:

- Meeting demand for incubation space and business support services for emerging firms: The strong research capacity in the area already has infrastructure in place to develop market opportunities and to broker relationships between partners locally and globally. However, those running programmes report high demand for access, which suggests that there is a potential pipeline of firms that is not currently being served by existing resources. Intervention might include a mix of additional support to existing programmes[3] or the creation of new entities in collaboration with governance partners.
- Strengthening the innovation pipelines of existing research strength: Increasing how much research is translated locally at scale is another area of potential intervention. While research programmes report a high level of translation already, there is likely scope to increase adoption, co-creation, and scaling. Robotics and automation, and digital and data are the two areas that are most ripe for this as these can be applied across crop types and cost and logistics challenges may be generating increasing demand. Seizing these opportunities and supporting firms that can deliver solutions to do so at scale may be an effective way to both grow the agritech industry and secure food value chains.
- Supporting and developing external markets for technology: Many of the innovations

[3] Note this may be complicated and involve coordination between funding councils (such as the BBSRC) and potentially accessing other national funding streams.

generated within the area have potential applications in international markets. Helping firms develop global networks and to access international markets is another area where firms could use business support.

- Training the next generation of agritech leaders: The lack of experienced, tech-, and market-savvy leaders in the agritech sector is a barrier to growth and innovation. This could be resolved through specialist agritech management training programmes at area universities that provide work experience and exposure to the wide range of technologies employed in agrifood businesses. The importance of food, the imperative to reduce carbon emissions across the value chain through innovation, and connections to next generation technologies such as AI may help attract new talent to the sector.
- Consolidating networks around a strategic vision for the industry: Existing networks appear to be strong and thriving. Encouraging even more collaboration between initiatives can help multiply the impact of investments and ensure that support is available to enterprises across the area. Collaboration on developing an actionable vision for the development of agritech, and particularly going deeper on how the technology aspect of the industry can be supported, is a next step to demonstrate to firms and investors that agritech is a strategic priority.

Reflections: Agritech in Eastern England is evolving rapidly and has an excellent potential for growth. The area has many of the raw materials to fuel that growth and to seize emerging market opportunities. The sector will benefit from ongoing national attention to net zero goals, rethinking regulations on gene editing post-Brexit, and investments and initiatives in the space sector, which will likely improve downstream applications. Engaging closely with LEPs, Agritech-E, and research organisations around the area will be crucial to designing effective interventions.

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About the Innovation Caucus

The Innovation Caucus supports sustainable innovation-led growth by promoting engagement between the social sciences and the innovation ecosystem. Our members are leading academics from across the social science community, who are engaged in different aspects of innovation research. We connect the social sciences, Innovate UK and the Economic and Social Research Council (ESRC), by providing research insights to inform policy and practice. Professor Tim Vorley is the Academic Lead. The initiative is funded and co-developed by the ESRC and Innovate UK, part of UK Research and Innovation (UKRI). The support of the funders is acknowledged. The views expressed in this piece are those of the authors and do not necessarily represent those of the funders