

Making ‘smart specialisation’ smarter: an industrial-innovation system approach

THE CASE OF AGRI-TECH EAST

A report for the UK Department for Business, Innovation & Skills (BIS)

Policy Links, Centre for Science, Technology & Innovation Policy (CSTI),
University of Cambridge

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Note: This report was commissioned and completed before the United Kingdom European Union membership referendum of 23 June 2016. While the results of the referendum have important implications for the report, the ideas here presented remain highly relevant to UK regional development policy efforts.

Preface

‘Smart specialisation’ is a conceptual and policy approach that aims to help regions participate in today’s highly competitive global environment by taking advantage of their *distinctive* industrial and innovation strengths to identify promising areas for future regional specialisation. The merits of this approach are widely recognised but taking it into practice has proved rather problematic. Some of the key challenges policy makers face in formulating effective smart specialisation strategies are the difficulty to make sense of increasingly complex industrial systems, the lack of internationally comparable data at the regional level, and the lack of practice-oriented frameworks to support industrial and innovation capabilities.

This exploratory project has been conceived in collaboration with the UK Department for Business, Innovation & Skills (BIS) to explore new approaches to support smart specialisation efforts by UK regions. The project suggests an ‘industrial-innovation system’ approach to structure more granular smart specialisation analyses and to guide ‘smarter’ choices. A case study in the agri-tech industry in the East of England (with a focus on crops) has been conducted to illustrate the suggested approach and test the emerging concepts. This investigation has been done in collaboration with Agri-Tech East, a cluster organisation that serves the agri-tech business and research communities in the East of England.

In conjunction with other projects commissioned by BIS, it is expected that the findings of this report will help regions reveal opportunities for maximising the impact and efficiency of public funding, in particular EU instruments for, or related to, research, development and innovation.

EXECUTIVE SUMMARY

This pilot project has been designed in collaboration the UK Department for Business, Innovation & Skills (BIS) to explore new approaches to enhance the effectiveness of smart specialisation in UK regions. The main outcome of the investigation has been the development of an 'industrial-innovation system' approach, which allows a better alignment between *distinctive* regional capabilities and promising areas for specialisation and regional value capture.

The suggested approach has been designed to address common issues that have limited the effectiveness of recent regional innovation efforts internationally, including:

- the selection of priorities that are too generic, do not appropriately take into consideration existing regional assets, and/or are simply replicated from elsewhere.
- an excessive focus on basic R&D that is not sufficiently business driven.
- the lack of sound analysis of the industrial and economic structures of the region.

The approach involves the following critical activities that help overcome these weaknesses and support more effective smart specialisation:

- characterisation of the activities, actors and institutions in the region contributing to value creation through innovation (beyond just R&D) but also to value capture through business activities (beyond just end users).
- evidence gathering and analysis on the basis innovation dynamics defined by modern industry and technology structures rather than on traditional boundaries defined by industrial classifications.
- practical exercises which offer a systematic way to structure the 'entrepreneurial discovery process' for identifying what regional capabilities are *distinctive* and *competitive*, and what potential areas of specialisation are *promising* and *feasible*.

As a result, the industrial-innovation system approach suggested has the following advantages:

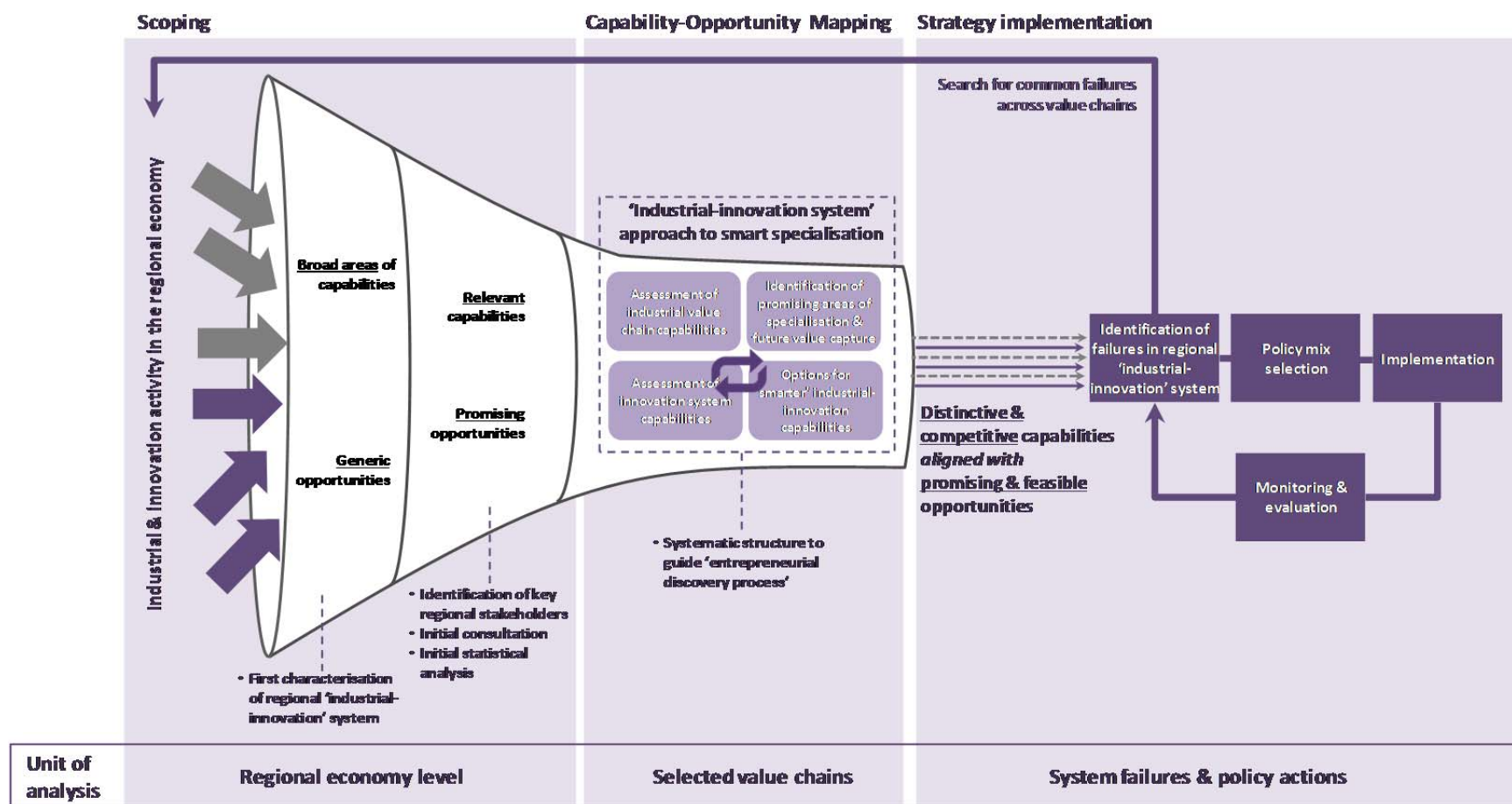
- a simple structure that allows rapid application, effective communication with relevant stakeholders, and quick updating;
- the ability, through application across various sectors, to focus on critical system failures rather than on 'picking winners';
- the potential to point to areas where there a genuine role for the government and to inform the choice of an appropriate policy mix ;

A case study focused on Agri-Tech East, a leading agr-tech cluster located in the East of England, proved the value of the suggested approach, in particular, because:

- it guided a clear identification of what makes the cluster distinctive;
- it helped visualise how different organisations and stakeholders fit and complement each other rather than viewing the activities in competition with each other.
- it recognised the role of technology-led firms that are critical to the industry but are often not accounted for in the sector statistics.
- it highlighted the critical role of intermediaries in the translation of knowledge from the science and research base into industry.
- it guided the identification of promising opportunities for specialisation and future value capture for which the region is particularly well placed to pursue, from smart irrigation systems and automated harvesting to integrated crop modelling and the production of crops with specific nutrition improvements.

While a particular case study in the agri-tech industry has been selected in this pilot project, the process and principles developed here have the potential to be deployed across different regions and sectors.

In conjunction with other projects commissioned by BIS, it is intended that the ideas developed during this investigation can help reveal opportunities for maximising the impact and efficiency of public funding, in particular EU instruments for research, development and innovation.



An 'industrial innovation system' approach to smart specialisation

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1. INTRODUCTION

As countries around the world step up efforts to address challenges related to high-wage job generation, productivity growth and technological innovation, there is a growing need to ensure that policy actions are as effective and efficient as possible. Particularly in the current context of significant budget constraints across many nations and regions it has become increasingly relevant to ensure ‘value for money’ in public investments. In response to this need, ‘smart specialisation’ aims to promote more strategic approaches to regional innovation and economic growth.

Smart specialisation is a conceptual and policy approach that aims to build competitive advantage by concentrating resources on “those activities that are likely to effectively transform the existing economic structures through R&D and innovation”¹. This approach calls for strategies that identify a limited number of priorities based on the recognition of the region’s distinctive industry structures and knowledge bases². It also emphasises the need to ensure that activities are fully integrated in local value chains and promotes the use of enabling technologies that can transfer and add value between related sectors³. Smart specialisation has been presented as an alternative to reduce the dispersion of resources and the duplication and fragmentation of efforts aimed at promoting regional innovation⁴.

In practice, however, smart specialisation remains an elusive target. Regional innovation strategies have historically selected priorities that are too generic or that do not appropriately take into consideration existing regional economic and innovation structures⁵. Regions struggle to clearly identify and articulate what makes them really distinctive and often resort to replicating the priorities selected by others, without necessarily having the capabilities to support them⁶. There has also been excessive focus on basic R&D that is not sufficiently business driven⁷.

This pilot project has been designed in collaboration with the UK Department for Business, Innovation & Skills (BIS) with the purpose of addressing some of the analytical weaknesses outline above. It does so by applying concepts, tools and frameworks from relevant academic literature and international policy practice to suggest an ‘industrial-innovation system’ approach to smart specialisation. A case study on the agri-tech industry is presented to illustrate the suggested approach and test emerging concepts.

Challenges to developing effective smart specialisation strategies

Section 2 of this report starts by discussing some of the major conceptual and analytical challenges faced by regions in pursuing smart specialisation. It is argued that conducting the analyses required to effectively underpin smart specialisation is not a trivial task. Regions and clusters host diverse actors across the industrial and innovation communities, who often lack visibility about each other’s needs and capabilities. Statistical data at a useful level of granularity are not always available⁸. Practice-oriented analysis frameworks are in short supply. As a result, even experienced and long-established policy makers and advisory bodies have found great difficulties in developing and implementing coherent smart specialisation strategies⁹.

An ‘industrial-innovation’ approach for smart specialisation

¹ Foray D. (2015). *Smart specialisation. Opportunities & challenges for regional innovation policy*. Routledge. London & New York.

² Foray, D., Goddard, J., Goenaga-Beldarrain, X., Landabaso, X., McCann, P., Morgan, K., Nauwelaers, C., Ortega-Argiles, R. (2012). Guide to Research and Innovation Strategies for Smart Specialisation (RIS 3). JRC-IPTS. European Commission.

³ BIS (2015). *Smart Specialisation in England*. Submission to the European Commission. Department for Business, Innovation & Skills.

⁴ OECD (2013). *Innovation-driven Growth in Regions: The Role of Smart Specialisation*. OECD.

⁵ European Commission (2015). *Perspectives for Research and Innovation Strategies for Smart Specialisation (RIS3) in the wider context of the Europe 2020 Growth Strategy*. Report by the Expert Group established to assess the contribution of “Research and Innovation Strategies for Smart Specialisation” (RIS3) to the Europe 2020 Growth Strategy.

⁶ Foray et. al., 2012

⁷ Foray et. al., 2012.

⁸ European Commission, 2015.

⁹ European Commission, 2015.

Section 2 then presents an ‘industrial-innovation system’ approach to support smart specialisation strategies. This approach brings together value chain and innovation system concepts to support a better identification of *distinctive* regional industrial and innovation capabilities, and a better alignment between these capabilities and promising areas for future specialisation.

There is value in using a value chain structure for smart specialisation analyses. Value chain analyses allow going beyond traditional boundaries of sectors and technologies to better characterise where the centres of gravity in regional industrial activity reside. The value chain structure emphasises the fact that activities in the region are part of wider industrial system where other ‘links’ in the chain – activities, regions and countries – are relevant to understanding the unique position of the region. Finally, it allows thinking about distinctive complementarities of capabilities among different stakeholders with seemingly different industrial interests and technical competencies.

A systematic review of innovation system capabilities can also support smart specialisation. Explicitly distinguishing between *knowledge generation*, *knowledge diffusion* and *knowledge absorption* capabilities builds into the analyses the recognition that innovation is more than just R&D. This distinction allows a more careful characterisation of actors, mechanisms and institutions (and their linkages) in the regional innovation system. The importance of intermediaries supporting the translation of research and know-how into the productive activities of local firms is particularly emphasised if the region is to capture value from innovation.

Put together, the value chain and innovation system structures form the basis of an ‘industrial-innovation system’ approach that can be used to guide more detailed smart specialisation analyses. In particular, the approach offers a highly effective way to characterise industrial and innovation capabilities at more granular level than commonly found in practice. The simplicity of the approach allows a rapid characterisation of activities, actors, institutional infrastructure and linkages supporting regional innovation, competitiveness and value capture. The result is an analytical tool with the potential to be deployed across sectors and regions to guide the alignment between current capabilities and identified future opportunity areas.

Testing the approach: the case of Agri-Tech East

Section 3 tests the suggested approach in the case of the Agri-Tech East cluster. This cluster is located in the East of England region, which is home to much of the UK’s most productive and profitable agricultural land. Members of Agri-Tech East include some of the major research centres in the agri-tech field in the UK. In order to ensure a thorough review at the level of disaggregation required, it was decided that the focus of this investigation should be limited to crops. In this instance, livestock has not been included in the analysis. The case study has involved the analysis of regional, national and international statistical and documental evidence. Thanks to the support of the Agri-Tech East management, access has been gained to the regional business and innovation communities through interviews, site visits and a ‘smart specialisation workshop’.

The approach suggested has been effective at guiding smart specialisation analyses of the cluster. It was found that what makes the East of England distinctive is a unique mix of industrial and innovation capabilities underpinned by (a) *an integrated value chain that is a national leader in a number of horticultural and arable crops, encompassing both small and large producers that are technological aware, have strong links to international markets, and boast significant capacity to invest*; (b) *research and technological capabilities in both engineering and plant sciences with the potential to address important multidisciplinary agricultural innovation challenges*; and (c) *a critical mass of intermediary institutions, technology-led firms and individuals, that situates firms in the region ‘one step away only from new knowledge’, facilitating the deployment of innovations and the capture of value locally.*

Stakeholders recognise, however, that the region also faces important challenges. Because the cluster hosts a wide variety of activities, the main drivers, challenges, and priorities among all actors are not necessarily shared nor aligned. In particular, there was recognition that opportunities exist to better align research agendas with business opportunities and to increase the speed in which research outputs are deployed in industry. Knowledge exchange mechanisms are seen as having a critical role to play in this respect. The East of England already boasts a range of agronomists, consultants, and other intermediary institutions active in the agri-tech industry. The community recognises that the establishment of Agri-Tech East as a business-focused cluster organisation has strengthened connections among actors and provided certainty on how stakeholders from diverse communities can come together in a productive way. It is recognised, however, that further work needs to be done. In particular, an assessment is required to understand which existing knowledge exchange functions might need to be further strengthened or scaled up, and which new functions might need to be developed.

It is hoped that the approaches presented in this report will help regions develop ‘smarter’ smart specialisation strategies. It is also hoped that, in conjunction with other projects commissioned by BIS, ideas developed in this project can help reveal opportunities for maximising the impact and efficiency of public funding, in particular EU instruments for research, development and innovation.

2. AN 'INDUSTRIAL-INNOVATION SYSTEM' APPROACH FOR SMART SPECIALISATION

This section outlines a practice-oriented approach to support smart specialisation strategy development. It reviews analytical weaknesses identified in recent regional innovation initiatives across Europe and reviews common data limitations. An 'industrial innovation approach' with the potential to support 'smarter' smart specialisation strategy design is developed. Guidance on how the proposed approach may be applied by policy analysts to identify smart specialisation priorities is offered.

KEY POINTS OF THIS SECTION

- Recent regional innovation efforts across Europe have suffered from important analytical weaknesses. In particular, smart specialisation priorities have been too generic and not appropriately connected to distinctive regional capabilities. Excessive focus has been given to R&D which is not sufficiently business driven and little attention has been given to the translation of knowledge into industry.
- An 'industrial-innovation system' approach with the potential to address some of these analytical weaknesses is suggested.
- The approach suggested adopts a value chain structure to better characterise *distinctive* regional industrial strengths. An innovation systems perspective allows a more detailed representation of actors, mechanisms and institutions supporting the translation of knowledge and the appropriation of value through innovation.
- Bringing these structures together, the suggested approach allows a more detailed characterisation of regional industrial and innovation capabilities and a clearer alignment between these capabilities and promising future value capture opportunities.
- The result is a simple yet highly structured analytical tool with the potential to be deployed across sectors and regions.

2.1 Introduction

Smart specialisation calls for strategies that identify a limited number of priorities based on the recognition of the region's industry structures and knowledge bases. Yet smart specialisation can only be 'smart' if regions are able to identify and clearly articulate what makes them *distinctive* at a useful level of detail and in a way that is recognised by the local and external actors. It can only be 'specialised' if this distinctiveness is used as the basis to identify, against the backdrop of international competition, promising opportunity areas around which efforts are concentrated. Regional innovation efforts, however, have not always been so smart (**Box1**).

Recent assessments have concluded that regional innovation initiatives often suffer from important analytical weaknesses. In particular, regions have often been unable to clearly articulate what they are good at, with priorities being too generic, not appropriately connected to regional economic and innovation structures, or simply replicated from elsewhere¹⁰. Little attention has been given to the translation of knowledge into industry and there seems to be a "general lack of more advanced intelligence gathering methods and strategy processes"¹¹.

Addressing the analytical tasks involved in smart specialisation is not a trivial task. Policy analysts face the need to deal with increasingly complex industrial activities that cut across sector and technology boundaries. Internationally comparable statistics at useful levels of disaggregation are not always available and therefore producing intelligence from data represents a major challenge. While a number of contributions to date have provided valuable insights and high-level guidance, practice-oriented tools and frameworks presented in a way that is accessible to policy analysts in regional departments and agencies are in short supply.

This project has aimed to make a contribution by offering a simple yet highly structured 'industrial-innovation system' analytical approach, grounded on the analysis of modern industries and technologies, to support smart specialisation. This approach brings together an overarching value chain structure with innovation system concepts. This approach offer practical guidance not only on the gathering and analysis of statistical data but also on the 'entrepreneurial discovery process' to generate evidence from local stakeholders.

Box 1. When 'smart specialisation' is not so smart...

Recent assessments carried out by the European Commission reveal that regional innovation efforts over the last few years have often suffered a number of shortcomings, including:

- Attempts to create 'miracle growth' in headline industries such as semiconductor or biotechnology, which perpetuate "patterns of market dominance with leaders and followers".
- 'Copy-pasting' from best performing regions without consideration of the local context.
- Excessive public involvement in R&D which is not sufficiently business driven.
- Failure to consider the industrial and economic structure of the region.
- Lack of a sound analysis of the region's assets.
- Lack of trans-regional and international perspectives, i.e. the regional innovation and economic system is often considered in isolation.
- A 'picking winner's syndrome'.

Source: Adapted from Foray, et. al. (2012). Guide to Research and Innovation Strategies for Smart Specialisation (RIS 3). JRC-IPTS. European Commission

In the following sections, basic considerations around smart specialisation evidence needs are first discussed. The suggested 'industrial-innovation system' approach is then presented and guidance on how this approach might be used to support regional smart specialisation evidence gathering and decision making is offered.

¹⁰ Foray et. al., 2012).

¹¹ European Commission, 2015.

Smart specialisation evidence needs: basic considerations

It is useful to review a number of basic considerations related to the evidence needs for smart specialisation before moving on to the following sections:

- *Smart specialisation priorities are not about choosing sectors.* Smart specialisation calls for the identification of a limited number of priorities to allow regions to take advantage of scale, scope and knowledge spillovers. This is not to say, however, that regions would need to specialise in a limited set of chosen industries. Instead, smart specialisation is about identifying activities and priority actions with the most potential to unlock future business opportunities and promising areas of future specialisation, based on the recognition of the region's *distinctive* strengths.
- *Smart specialisation requires knowledge from the industrial and innovation communities.* Smart specialisation choices need to be underpinned by insights into what the region is presently good at, as well as potential future sources of business and value capture. These are not questions that can be fully answered by simply analysing historical data trends. A dynamic process that allows incorporating insights from the industrial and innovation communities of the region – what has been called the ‘entrepreneurial process of discovery’ – is therefore crucial to inform smart specialisation strategies.
- *Strengths need to be defined in relation to others.* Because smart specialisation is about distinctiveness, regional areas of competitive strength need to be understood in relation to appropriate comparators. This could include comparisons among economic activities within the same region, regions within the same country or regions in other countries – and/or a combination of all these. Benchmarking analyses in the context of smart specialisation should also help uncover options for practical cooperation between regions.
- *Evidence needs are not limited about promising opportunities for new firms and new industries.* It is important to keep in mind that value in industrial systems is not only created by new firms and industries. Existing firms in the region can also drive new competitive advantage and increased value capture by exploiting innovations to upgrade current productive processes and pursue new business opportunities. This recognition is actually implied in the very concept of smart specialisation, which emphasises the need to build on current strengths and take advantage of local assets. The ‘entrepreneurial discovery’ should therefore be focused on innovation opportunities in both new and existing activities. While this point might seem redundant, it is often overlooked.

2.2 Towards ‘smarter’ smart specialisation: An ‘industrial innovation system’ approach

With these basic considerations in mind, and based on the theoretical research and practical work carried out during this project, an ‘industrial innovation system’ framework to support smart specialisation has been developed. This approach is based on an overarching value chain structure and the distinction of innovation system capabilities. The result is an analytical framework that can be used to guide smart specialisation analyses and structure evidence gathering as part of the ‘entrepreneurial discovery process’.

Four building blocks organised according to basic strategic questions form the basis of the proposed ‘industrial innovation system’ approach for smart specialisation:

Building blocks	Strategic questions
1. Regional value chain strengths and areas of competitive advantage	<i>Where are we?</i>
2. Regional innovation system capabilities	
3. Promising areas of specialisation and future value capture	<i>Where can we be?</i>
4. Gaps in the regional industrial-innovation system	<i>How can we get there?</i>

A visual representation of the relationship between the four building blocks is shown in **Figure 1**. A full understanding of the current situation of the region requires characterising both industrial and innovation capabilities across the value chain. The variety of industrial activities in the region and the different potential configurations of the innovation system provide scope for distinctiveness (where are we?). Articulating this distinctiveness appropriately can support the identification of future potential business and technological opportunities across the whole value chain (where can we be?). What is then required is to assess how big the capability gaps are in order to understand whether the region can feasibly pursue those opportunities. Should it choose to, the region would then need to identify what ‘failures’ in the industrial-innovation system are behind the capability gaps and thus need to be tackled in order to pursue the identified opportunities (how can we get there?).

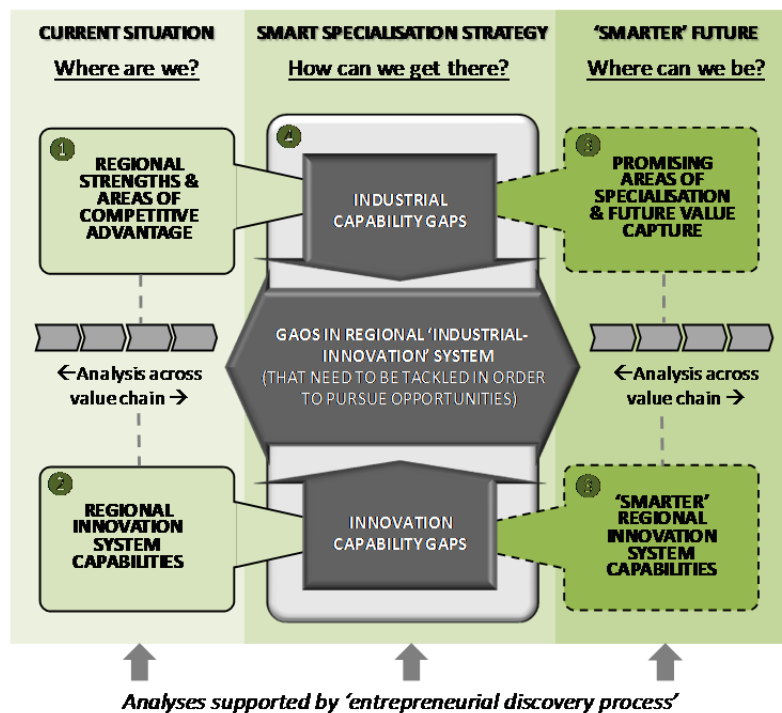


Figure 1. An ‘industrial innovation system’ approach for smart specialisation

In what follows, the underpinning concepts of the approach, the value chain framework and the innovation system concept, are first discussed. Thereafter, each of the building blocks of the framework is examined.

Special attention is paid to practical steps on how the analytical framework might support smart specialisation initiatives and how it might be deployed across regions and sectors.

The value of the value chain perspective

The value chain framework is a flexible and simple framework intensively used in business and operations management¹² that can be adopted to overcome some of the limitations of official statistics to better characterise the diversity of activities within modern industrial activity.

Because of the way they are collected, statistics based on traditional industry boundaries have important limitations. Official industrial classification systems group industries according to the types of goods or services they produce, or the processes through which these goods and services are produced. However, due to globalisation, advances in technology and global competition the way goods and services are designed, produced and sold is changing. The activities of firms in modern industries increasingly cut across sectors and technologies as traditionally defined, and the boundaries between production and services are blurring. Conventional economic indicators are not flexible enough to reflect the nature of many modern economic activities. As software and services become ever more integrated into products, for example, a number of 'unmeasurable sectors' such as embedded software and the 'app economy' are simply not monitored¹³. As a result, traditional industry boundaries might 'hide' specific high value activities where a region has distinctive competitive advantage. Strategies can therefore not be 'smart' enough if they solely rely on statistical analyses (**Box 2**).

Box 2. Not so smart: the problems with official statistics

Official statistics may not accurately reflect economic activity in certain sectors for a number of reasons, including:

- Sectors evolve over time (e.g. due to technological progress) and official statistics are generally slow to keep pace
- Sectors may emerge around new technologies which cut across and underpin many different industries (e.g. advanced materials)
- Industry may not recognise sectors as currently defined by SIC codes, thus firms may not always correctly self-report which sectors they are active in
- Business models of firms may have changed in response to trends such as globalisation (e.g. merger of manufacturing and services activities)
- New industries are emerging within established sectors of the economy which are not captured by the SIC codes (e.g. cyber-security)

Source: Adapted from BIS (2012). Industrial Strategy: UK Sector analysis

Thanks to its holistic perspective and focus on processes of value addition and dynamic linkages between diverse economic actors, the value chain framework provides a useful structure for smart specialisation analyses. A value chain structure can help address issues arising from the disconnect between what official statistics measure and the way in which modern economic activities are organised. Depending on the type of industry and the focus of the analysis, some value chain representations might be more appropriate than others. For illustration purposes, a generic simplified value chain is shown in **Figure 2**.

¹² Porter, M. (1998). *The Competitive Advantage: Creating and Sustaining Superior Performance*, 2nd ed. Free Press. New York.

¹³ NAE (2015). *Making Value for America: Embracing the Future of Manufacturing, Technology, and Work*. Committee on Foundational Best Practices for Making Value for America.

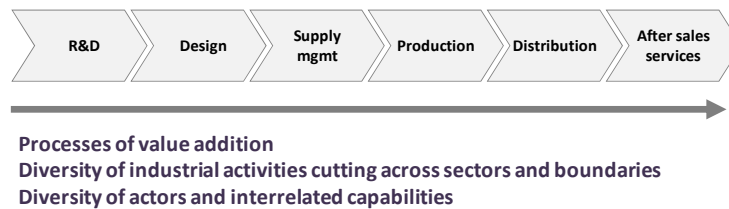


Figure 2. A simplified value chain

A systematic analysis of innovation system capabilities

A *system of innovation* encompasses “all important economic, social, political, organizational, institutional or other factors that influence the development, diffusions and use of innovations”¹⁴. A *regional innovation system*, meanwhile, is typically understood to be “a set of interacting private and public interests, formal institutions, and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use, and dissemination of knowledge”¹⁵.

The definitions above emphasise that, contrary to what is commonly assumed, innovation is not just R&D. A region’s innovation capabilities are not only defined by the amount of research that regional actors carry out but also the capabilities of regional actors to transfer new knowledge into productive process in order to achieve competitive advantage and increased value capture. At the most basic level, three types of interrelated innovation system capabilities can be distinguished:

- *capabilities to create new knowledge (including research in universities, public and semi-public research centres, and private firms)*
- *capabilities to diffuse knowledge (including intermediary institutions, advanced business services, extension services, and industrial training in emerging technologies)*
- *capabilities to absorb knowledge (including firm in-house design and engineering, development, and application customisation).*

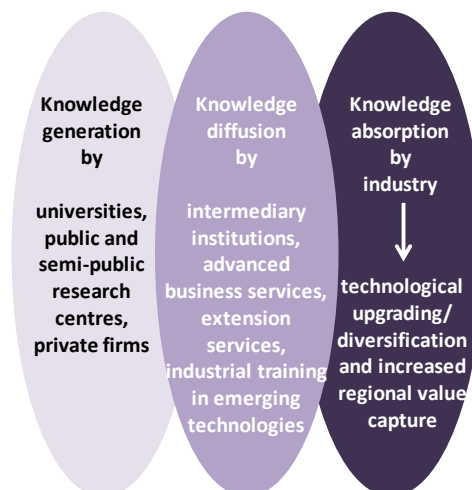


Figure 3. A systemic view of the regional innovation system

This distinction is important to emphasise that, in addition to the region’s capability to create new knowledge through R&D, equally important for innovation and value capture are the region’s ability to diffuse new knowledge, and to ‘absorb’ new knowledge and apply it to pursue in productive processes. It is also a simple

¹⁴ Edquist, C. (2005): Systems of Innovation. Perspectives and Challenges. In: Fagerberg, J., Mowery, D.C. and Nelson, R.R. (Eds.): The Oxford Handbook of Innovation. New York: Oxford University Press, 181–208.

¹⁵ Doloreux, D. and Parto, S. (2005): Regional innovation systems: Current discourse and unresolved issues. *Technology in Society*, 27, 133–153.

but highly effective way to structure the analysis of the contribution of independent players, policies and institutions to regional innovation.

The importance of knowledge diffusion intermediaries supporting the translation of research and know-how into the productive activities of local firms needs to be particularly emphasised if the region is to capture value from innovation. These intermediaries support the diffusion of knowledge by closing the gap between industry and research. Therefore, they play a key role in ensuring alignment between industry needs and solutions coming out of the research base.

An 'industrial-innovation' perspective

By bringing the value chain and innovation system structures together, the suggested approach allows a more detailed characterisation of regional industrial and innovation capabilities. This 'industrial-innovation system' perspective helps broaden the focus to include not only the activities, actors and institutions that interact to *generate, diffuse* and *apply* knowledge but also the processes of value addition along the industrial value chain.

As discussed in more detailed later in the report, by combining these analyses, a region's distinctive and competitive capabilities can be better aligned with promising and feasible market opportunities.

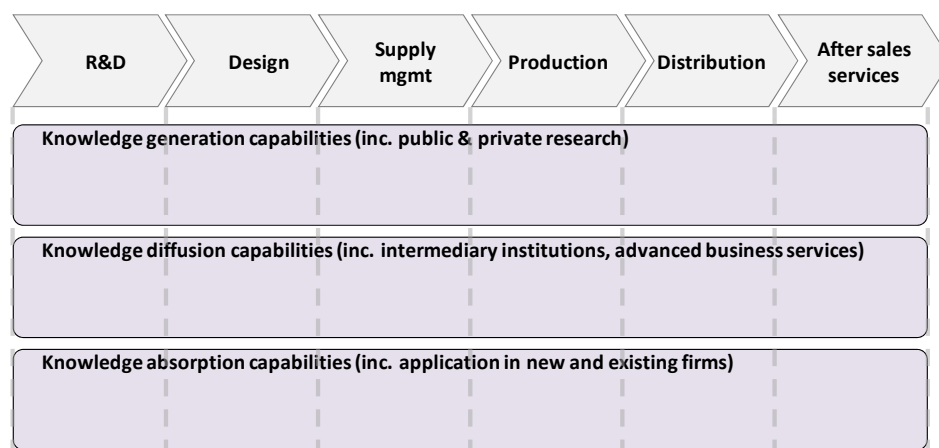


Figure 4. An 'industrial-innovation' perspective

2.2.1 Building Block 1: Regional value chain strengths and areas of competitive advantage

The analysis and characterisation of current industrial strengths and areas of competitive advantage is a foundational task for smart specialisation, partly addressing the question ‘*Where are we?*’

Depending on data availability, a number of measures can be used to map the contribution of different activities across the value chain to the regional economy and gain insights into those that enjoy competitive advantage in comparison to other regions within and outside the country. These include: value added, exports, FDI, jobs, capital investment, R&D expenditure, etc.; national and global market shares; and growth product classes (see **Appendix 1, Table 1**).

Assessing relative importance between value chain activities is not straightforward. Some activities might have high levels of revenue and value added but low employment contribution and vice versa. Some others might have a significant contribution to regional tax revenues. Such trade-offs need to be recognised as part of the evidence gathering process underpinning smart specialisation.

Indexes of revealed comparative advantage (RCA) have been developed as attempts to identify activities that are particularly competitive by comparing relative shares of industrial activities in regional and national economies. However, because of the data limitations discussed earlier, such indexes can only provide a partial picture of where regional industrial strengths lie.

Evidence needs from the entrepreneurial discovery process

Insights from the regional industrial and innovation communities are critical to gather information about the relative strengths of the region. Local actors can provide information about social and strategic factors that are hard to quantify, such as firms’ and employment long-term sustainability, technological spillover potential, and development of skills transferable to other sectors. Other important social considerations include opportunities for women and the youth, skill development, and environmental efficiency.

Local stakeholders are the key source of information to address not only the question ‘*Where are we?*’ but also ‘*in relation to whom?*’ Critically, they are better positioned to identify specific subsectors and activities across the value chain in which the region is a national and/or global leader, but that might fall outside the radar of available statistics. Complementary questions for identifying regional value chain strengths and areas of competitive advantage as part of the entrepreneurial discovery process are presented in **Appendix 1, Table 1**.

2.2.2 Building Block 2: Current regional innovation capabilities

A *system of innovation* encompasses “all important economic, social, political, organizational, institutional or other factors that influence the development, diffusions and use of innovations”¹⁶. A *regional innovation system*, meanwhile, is typically understood to be “a set of interacting private and public interests, formal institutions, and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use, and dissemination of knowledge”¹⁷.

The definitions above emphasise that, contrary to what is commonly assumed, innovation goes beyond R&D. A region’s innovation capabilities are not only defined by the amount of research that regional actors carry out but also the capabilities of regional actors to transfer new knowledge into productive process in order to achieve competitive advantage and increased value capture. At the most basic level, three types of interrelated innovation system capabilities can be distinguished:

- *capabilities to create new knowledge* – including research in universities, public and semi-public research centres, and private firms.

¹⁶ Edquist, C. (2005): Systems of Innovation. Perspectives and Challenges. In: Fagerberg, J., Mowery, D.C. and Nelson, R.R. (Eds.): The Oxford Handbook of Innovation. New York: Oxford University Press, 181–208.

¹⁷ Doloreux, D. and Parto, S. (2005): Regional innovation systems: Current discourse and unresolved issues. *Technology in Society*, 27, 133–153.

- *capabilities to diffuse knowledge* – including the activities of intermediary institutions, business and extension services, industrial training and collaborative research.
- *capabilities to absorb knowledge* – including firm in-house design and engineering, development, and application customisation.

Capabilities to generate knowledge

A number of actors and institutions might support the knowledge generation capabilities of the region. These include: universities, public research centres, contract research organisations and private firms. Care must be taken in identifying relevant research actors, as they might define their areas of specialisation according to specific technologies rather than sectors and therefore their relevance to the industry of interest might be overlooked. An important consideration is the variations in maturity levels of the research conducted in the regional research base. A popular measurement system used to assess this is the Technology Readiness Level (TRL) scale. While the TRL scale has some limitations, it can serve as an indication of how soon the research conducted in the region can be ready to find its way into industry applications.

Appendix 1, Table 2 provides examples of indicators to characterise knowledge creation capabilities, including: data on papers and patents published by regional actors, research grant data, and analysis of personnel engaged in R&D. Data from multiple agencies as well as regional institutions might be required, as those indicators might not be readily available from single national sources. Questions that need to be addressed during the entrepreneurial discovery process to properly characterise regional capabilities to generate knowledge are also presented.

Capabilities to diffuse knowledge

Competitiveness in modern industries increasingly relies on the rapid adoption of science and engineering developments in industry. Many companies, however, do not have the capabilities to actively seek out for new knowledge in order to apply it into their processes to upgrade and/or diversify and gain competitive advantage.

Regional institutions and mechanisms to engage firms and make them full participants of the national innovations system are therefore a crucial element in the regional innovation landscape. Typical knowledge diffusion mechanisms include patenting and licensing, contract research, industry training, and consulting. Institutions playing a knowledge diffusion function might include: public and private applied research centres, cluster management organisations, ‘innovation broker’ institutions, and even individuals. It is important to consider that while some actors might actively seek to share the knowledge with other regional partners, some others might prefer to keep the know-how within their organisations due to strategic considerations.

Appendix 1, Table 2 provides examples of indicators available to characterise knowledge diffusion capabilities, including levels of contract and collaborative research activity and presence of contract research organisations, technology & innovation centres, and university licensing offices. Questions that need to be addressed during the entrepreneurial discovery process to properly characterise regional capabilities to diffuse knowledge are also presented.

Capabilities to absorb knowledge

The ability of firms to identify and make use of new knowledge – their “absorptive capacity”¹⁸ – is another defining element of a region’s innovation capabilities. Indeed, a region’s innovative performance is defined by its ability to nurture new technology-based firms but also, critically, by the ability of existing firms to quickly absorb and apply new knowledge to upgrade, diversify and gain competitive advantage. Regions can capture value from innovation not only through the creation of new products and services based on new advanced

¹⁸ Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1).

technologies, but also by using advances in technology to improve the way in which current products and services are created.

Applying new knowledge in existing process represents a major challenge to many firms. In particular, SMEs tend to have weak internal capabilities and lack the required expertise and resources to actively engage in innovation. SMEs are often unaware of the potential of new technologies and given their limited time and resources, tend to have a 'fear to innovate'.

Efforts to improve firms' knowledge absorption capabilities as part of regional innovation strategies have so far been limited. There is a relatively strong focus on supporting the creation and development of new knowledge and technologies but "a relatively weak focus on improving the absorptive capacity and the take up of existing knowledge and technologies."¹⁹ Factors inhibiting the absorptive capacity of firms in the region are primary examples of innovation system 'failures'.

Appendix 1, Table 2 provides examples of indicators to characterise knowledge absorption capabilities, including patenting and licensing activity, and frequency of new product introduction. Questions that need to be addressed during the entrepreneurial discovery process to properly characterise regional capabilities to absorb knowledge are also presented.

2.2.3 Building Block 3: Promising areas of specialisation and future value capture

Revealing promising areas of specialisation and future value capture is, by definition, a subjective task. The difficulty lies not only in uncovering promising business and technological opportunities but also in identifying which of these opportunities might be relevant to the region given its unique capabilities.

A great deal of uncertainty is involved and thus local entrepreneurial actors need to play a leading role. Using their first-hand understanding of local market conditions and innovation dynamics, they are able to assess the potential and feasibility of identified opportunities.

It is important to emphasise that value in industrial systems is not only created by new firms and industries. Existing firms in the region can also drive new competitive advantage and increased value capture by exploiting innovations to upgrade current productive processes and pursue new business opportunities. Value can also be captured from 'smarter' innovation system configurations that address technological challenges and offer new innovative solutions.

Appendix 1, Table 3 offers examples of indicators to identify promising areas of specialisation and future value capture, which include high-growth products and markets, and industry growth forecasts. Useful insights can be gained from sources such as foresight studies as well as market and industry analyses but these need to be complemented with questions to be addressed during the entrepreneurial discovery process.

2.2.4 Building Block 4: Gaps in the regional industrial-innovation system

Once potential opportunity areas have been identified, it is necessary to assess what gaps in the industrial-innovation system might need to be overcome in order for the region to be able to pursue those particular opportunities. These (industrial and innovation) capability gaps refer to the difference between the *where we are* and the *where we can be*. They might relate to an insufficient generation of knowledge but also to the region's inability to use the knowledge already available in order to support better, more productive industrial activities.

¹⁹ European Commission, 2015.

Examples of industrial-innovation gaps might include:

- Limited presence of critical value chain activities and support functions
- Weak or missing linkages between innovation stakeholders
- Insufficient scale/scope of innovation capabilities (knowledge generation, transfer, absorption)
- Lack of institutions & actors in the innovation system

Important information to assess gaps in the regional industrial-innovation system can be obtained from benchmarking analyses. Regions can usefully compare against appropriate competitors to assess their capabilities across the areas outlined in building blocks 1 and 2. Of particular importance is the benchmark of intermediary mechanisms used in different regions to link actors in the innovation system and support the diffusion of innovations among the industrial community. It is important to emphasise that the approach suggested is an iterative one. Through application across various regional value chains, it is possible to identify cross-cutting gaps (that is, gaps that are common across different value chains) and relate them to potential innovation system failures. Such failures, in turn, can highlight areas where policy intervention is most pressing²⁰.

Finally, it is important to recognise that regions do not necessarily need to develop all the capabilities required to pursue identified opportunities. New or stronger linkages with other regions might provide the necessary capabilities in a more efficient way. An outward-looking perspective is therefore essential to achieving smart specialisation. **Appendix 1, Table 4** offers examples of indicators and questions to identify gaps in the industrial innovation system.

²⁰ For a more detailed discussion between the relationship between innovation system failures and policy interventions see Arnold et al. (2014). The Case for Public Support of Innovation – At the sector, technology and challenge area levels. Report to the Department for Business, Innovation & Skills (BIS).

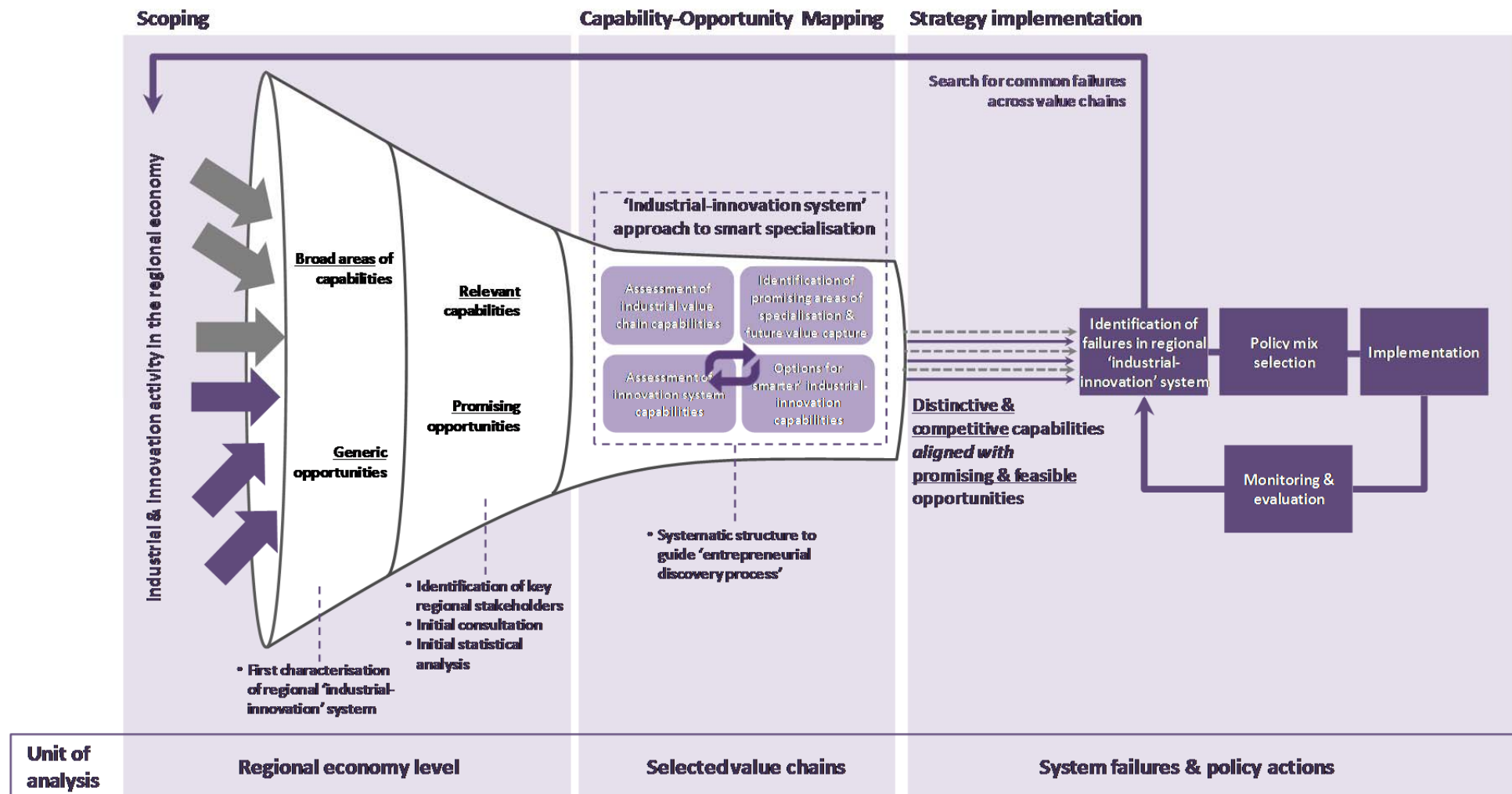


Figure 5. 'industrial innovation system' approach to smart specialisation

3. CASE STUDY: THE AGRI-TECH INDUSTRY IN THE EAST OF ENGLAND

This section illustrates the analytical approach suggested in Section 2 using the agri-tech industry in the East of England as a case study. It reviews different statistical analyses and stresses their limitations, highlighting the need to engage in more qualitative analysis as an additional source of evidence. To this regard, insights gained from expert interviews and a purposely designed ‘smart specialisation workshop’ convening key representatives from the East of England agri-tech sector are presented. The section concludes by highlighting the value in adopting an industrial-innovation system perspective to structure and guide smart specialisation analyses of clusters and regions.

KEY POINTS OF THIS SECTION

- Carrying out a case study has illustrated and validated in a real context the utility of the suggested industrial-innovation system approach. More particularly, it has been highly effective to reveal the distinctiveness of the agri-tech cluster and identify those competitive capabilities which are aligned with promising and feasible opportunities.
- With a value chain whose technological requirements are very different depending on the activity concerned, and a variety of actors, mechanisms and institutions which interact in the regional innovation system, the agri-tech industry has proved to be an interesting case to explore.
- The review of statistical analysis has shown that if it can help identify the main areas of industrial activity and innovation capabilities of the region, these analyses do not offer the level of disaggregation required to analyse the agri-tech industry specifically.
- To remedy the limited insights gained from quantitative analysis about what makes the agri-tech cluster distinctive, qualitative data has had to be collected through expert interviews and a smart specialisation workshop.

3.1 Rationale and boundaries of the case study

For testing and validation purposes, a case study has been conducted in this report to explore the ways in which the suggested analytical approach can be used to support smart specialisation strategies in the UK. A number of distinctive features together with practical considerations have made the agri-tech industry in the East of England a case study of particular relevance and interest.

Distinctive features of the agri-tech sector

It is estimated that the entire agri-food supply chain contribute £96 billion to the UK's economy.²¹ The agri-tech industry offers an interesting example of a science and technology sector which can have an enabling impact at every stage of the value chain, from input supply, to collecting, processing and final retailing. Further, agri-tech presents specific challenges as it is still not well defined in traditional industrial classifications and presents blurry boundaries. As a multidisciplinary sector, involving a huge variety of core and cross-cutting technologies, agri-tech has received increased interest from a number of countries²². Governments have become more and more concerned with identifying and supporting those technologies likely to improve the efficiency, safety, quality and sustainability of agricultural production, raising specific issues around capability-based challenges and exploitation of market opportunities that a smart specialisation approach can help identify and align.

Agri-tech cluster in the East of England

The East of England agri-tech cluster selected for the case study is located in the East of England region, which is home to much of the UK's most productive and profitable agricultural land. The region also hosts some of the major research institutes and university departments which in some areas are at the forefront of research related to agricultural innovation not only at the national but also at the global level. The region has also a large number of progressive farmers, growers, agri-businesses and retailers. Last but not least, it boasts a range of agronomists, consultants and organisations involved in knowledge transfer.

From a practical perspective, the existence of a partnership between the Centre for Science, Technology and Innovation Policy (CSTI) and Agri-Tech East has facilitated privileged access to relevant databases, industrial stakeholders and agricultural experts. Agri-Tech East is an independent and membership-based cluster organisation which provides a networking platform to farmers, growers, researchers, technologists and entrepreneurs in order to "create a global innovation hub in agri-tech"²³. Its role was instrumental in ensuring that a relevant mix of stakeholders participated in the Smart Specialisation workshop held by CSTI.

Geographical and industry boundaries of the case study

In order to scope out the case study, analysis of regional, national and international statistical and documental evidence together with expert interviews have been conducted²⁴. Not only geographical but also industrial boundaries have been informed as a result, allowing for a refined unit of analysis.

The case study focuses on the core area served by the Agri-Tech East cluster, which includes the New Anglia Local Enterprise Partnership and the Greater Cambridge Greater Peterborough Enterprise Partnership.

²¹ Department for Environment, Food and Rural Affairs (2015a) *Agri-food sector contribution to the national economy. United Kingdom*.

²² Government of Canada (2013) Policy insight - Agricultural and natural manufacturing technology; Teagasc (2016) Technology Foresight – Final Report

²³ See <http://www.agritech-east.co.uk/>

²⁴ See appendix for the questionnaire, list of experts and main findings from the interviews.

However, information is also provided for the East of England region as to situate the Agri-Tech East cluster in the wider regional context. The boundaries of the East of England region can vary depending on the source consulted. According to the Nomenclature of Territorial Units for Statistics (NUTS) classification, the East of England includes:

- East Anglia: Norwich and East Norfolk; North and West Norfolk; Breckland and South Norfolk; Peterborough; Suffolk and Cambridgeshire.
- Bedfordshire and Hertfordshire: Luton; Bedford; Central Bedfordshire and Hertfordshire.
- Essex: Heart of Essex; Essex Thames Gateway; Essex Haven Gateway; West Essex; Southend-on-Sea; Thurrock.

In analyses made according to local enterprise partnership (LEP) boundaries, some studies have limited the East of England to the Greater Cambridge & Greater Peterborough, Hertfordshire and New Anglia LEPs. However, parts of South East LEP and the South East Midlands LEP may also be considered as being part of the region.

In order to ensure a thorough review at the level of disaggregation required, it was decided that the focus of this investigation should be limited to the crops segment of the agri-tech industry. Livestock has not been included in the analysis in this instance.

3.2 Sources of evidence

The case study has involved the analysis of regional, national and international statistical and documental evidence. In complement to analytical evidence, needed qualitative insights have been gained through expert interviews, a smart specialisation workshop and site visits²⁵.

The expert interviews were conducted in the initial phase of the project. They have allowed to get a sense of the key players involved, of the current and future challenges the cluster is facing, and of its distinctive features and competitive advantages (see appendix X). They have been very useful in scanning and scoping the boundaries of the case study.

The one day workshop on smart specialisation has permitted to address some of the gaps identified in the review of analytical sources of evidence, and more particularly the discrepancies in the boundaries of region and sector, the incomplete analysis levels, the confusing aggregation of data and limitations of SIC codes.

Methodology-wise, the workshop was based on an interactive bottom-up process bringing together varied members from the agri-tech community with the aim to help inform the development of strategies and activities of local and national government agencies. As part of the entrepreneurial discovery process (EPD), the workshop helped pool expertise from participants and supported the exploration of the distinctive industrial, research and innovation strengths of the agri-tech industry in the East of England. It also brought a different and complementary level of analysis.

The workshop was structured around a number of interactive exercises designed to permit the identification of the areas of comparative advantages, the market opportunities and challenges to overcome to realise them, and the industrial, research and innovation strengths to build on in order to exploit these market opportunities.

3.3 Testing the “industrial innovation system” approach

²⁵ The Agri-Tech East management has been key in facilitating access to the regional business and innovation communities to organise the interviews, site visits and a ‘smart specialisation workshop’ has been

Following the analysis outlined in Section 2, an “industrial innovation system” approach has been adopted to structure the exploration of the East of England agri-tech cluster. This exploration has been conducted against the tasks shown in Figure 6 and has aimed to reveal those categories and types of evidence of particular interest to inform a smart specialisation strategy.

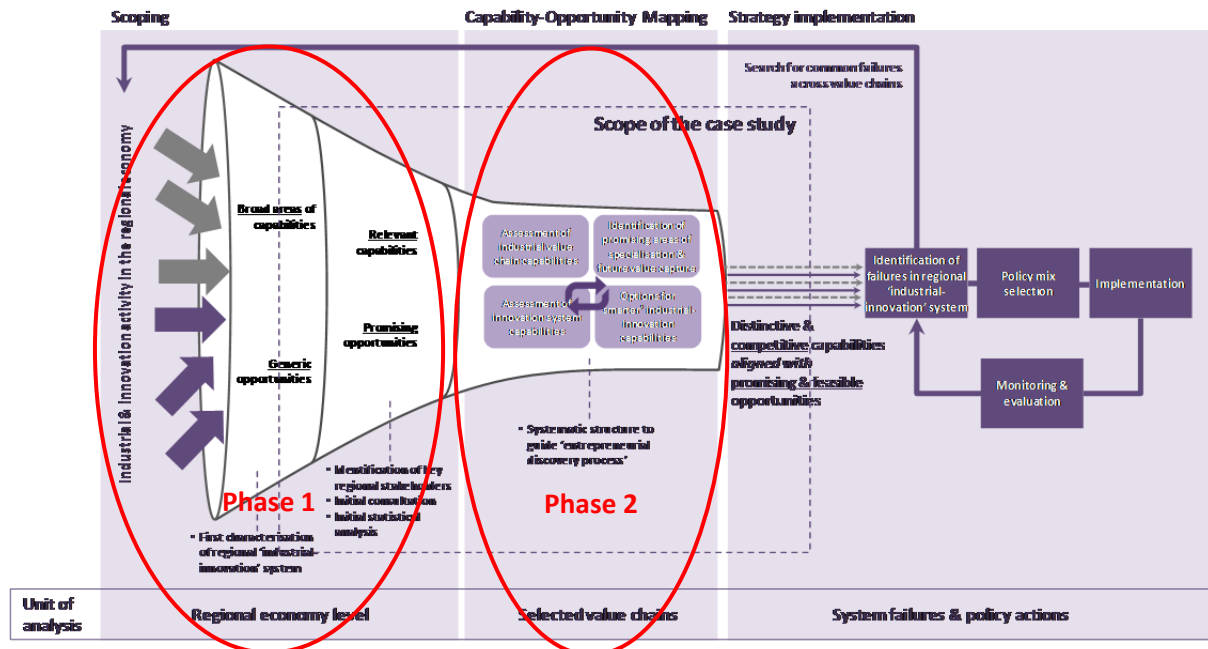


Fig.6: Categories of evidence for an “industrial innovation system” approach to smart specialisation

3.3.1 Phase 1: First characterisation of the industrial-innovation system

Agri-tech value chain overview

To conduct smart specialisation analyses, it is important to gain clarity on the whole range and types of stakeholders involved. The holistic view embraced by a value chain perspective supports thinking about interrelated capabilities in a structured and dynamic way. Combined with an emphasis on value added process, it helps not only to reveal the diversity of stakeholders, with seemingly different industrial interests and technical competencies, but also to highlight the linkages between them.

For the purpose of this report, the generic value chain structure has been revisited and customised to account for those added value stages of particular relevance in the agri-tech sector. Harvesting, storage, processing and packaging have therefore been included. A distinction has also been made between the pre-farm gate and post-farm gate stages²⁶. In this perspective, production, harvesting and supporting activities, like the provision of seeds, fertilisers, etc. but also the sale of equipment and machines, and consultancy services from agronomists, would belong to the pre-farm gate; whereas dimensions around processing, packaging, retailing and relating logistics issues would occur at the post-farm stage.

²⁶ Hethel Innovation (2012) High Value Manufacturing and advanced Engineering – AgriTech Sector – Sector Development Report

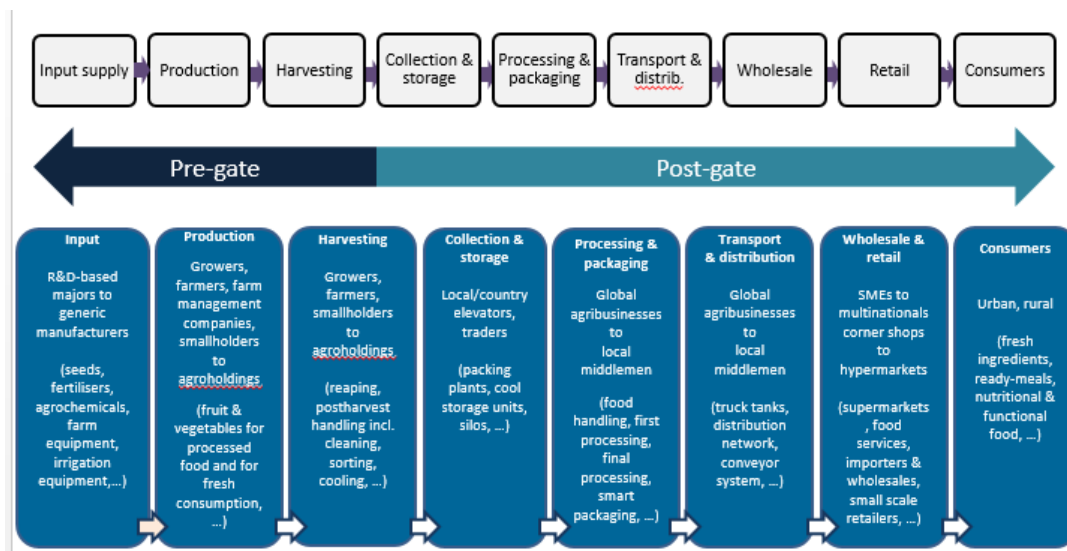


Fig. 8: Detailed value chain structure for the agri-tech sector

Innovation system overview

A systematic review of innovation system capabilities can also support smart specialisation. An explicit distinction between knowledge generation, knowledge diffusion and knowledge absorption capabilities builds into the analyses the recognition that innovation is more than just R&D. This distinction allows a more careful characterisation of actors, mechanisms and institutions (and their linkages) in the regional innovation system.

The importance of intermediaries supporting the translation of research and know-how into the productive activities of local firms is particularly emphasised if the region is to be capture value from innovation.

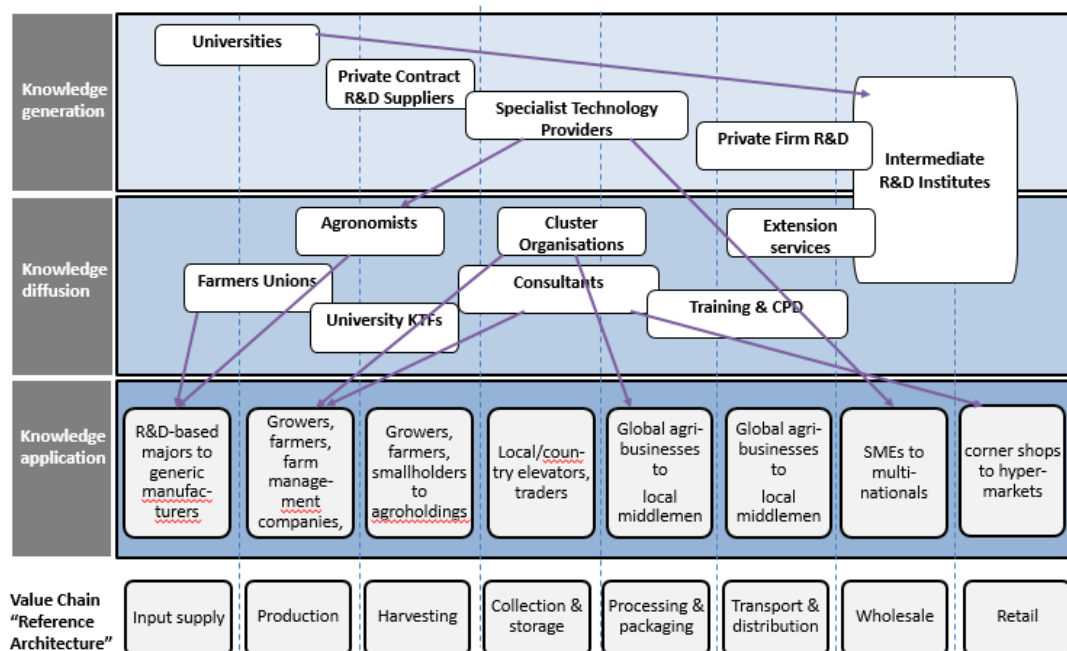


Figure 9: Overview of the innovation regional system for agri-tech

3.3.2 Phase 2: Capability-opportunity mapping

Building Block 1: Regional value chain strengths and areas of competitive advantage

The question which is raised here is “Where are we?” Gaining a clear view of current industrial strengths and areas of competitive advantage represents a prerequisite in any smart specialisation strategy development.

Key value chain strengths and areas of competitive advantage identified in the different sources of evidence

- Second highest ‘agriculture, forestry and fishing’ value added in the UK.
- Third highest ‘basic pharmaceutical products and preparations’ value added in the UK.
- East of England ranking first among the English regions in the production of wheat, barley, sugar beet, fresh vegetables and potatoes (including seeds).
- Highest farming productivity by capital consumption and by land in England.
- Concentration of technology-led companies
- Integrated value chain
- Technological solutions developed in the region in plant breeding, precision agriculture, systems engineering and supply chain management

The comprehensive nature of the agri-tech value chain in the East of England was stressed as an asset with a participant highlighting: “Except for dairy, the Agritech supply chain can be done entirely in the East of England”

Insights from the smart specialisation workshop

Being asked to reflect and share their knowledge on the industrial value chain capabilities of the region, participants were prompted to identify those distinctive characteristics which confer particular competitive advantages to the East of England in comparison to other regions. These key capabilities are:

- Processing, manufacturing
- Base for major service providers and down-stream processors
- Large agri-businesses operating on national & international scale with high innovation demand
- Industrial scale capability
- Complete chain (from growing, processing & packing)

It was found that the East of England in general, and Agri-Teach East cluster in particular, boasts an integrated value chain that is a national leader in a number of horticultural and arable crops. This value chain encompasses both small and large producers that are technological aware, have strong links to international markets and significant capacity to invest.

The region also hosts a significant concentration of technology led companies that provide inputs to the agritech sector (e.g. seeds, livestock, feed, machinery etc.). Many national trade bodies are also present in the region. These technology led companies are at the heart of the cluster and which makes the region distinctive.

Insights from the expert interviews

A number of areas of competitive advantages were stressed by the experts interviewed in this project. They include:

- Water management
- Soil management
- Engineering and robotics
- ICT
- Big data, Data modelling
- Pest control

- Remote sensing
- Crop genomics, crop breeding, plant performance, crop disease & health
- Pre-breeding research, genetics and molecular biology
- Applied plant science (sustainable intensification agenda)
- Epidemiology
- Spray application
- Environmental studies

Complemented by a literature review on key agricultural trends and drivers, the findings from the interviews served as a basis to populate a framework combining a value chain structure with key areas where the agri-tech industry of the East of England possesses distinctive and comparative advantages (figure 10).

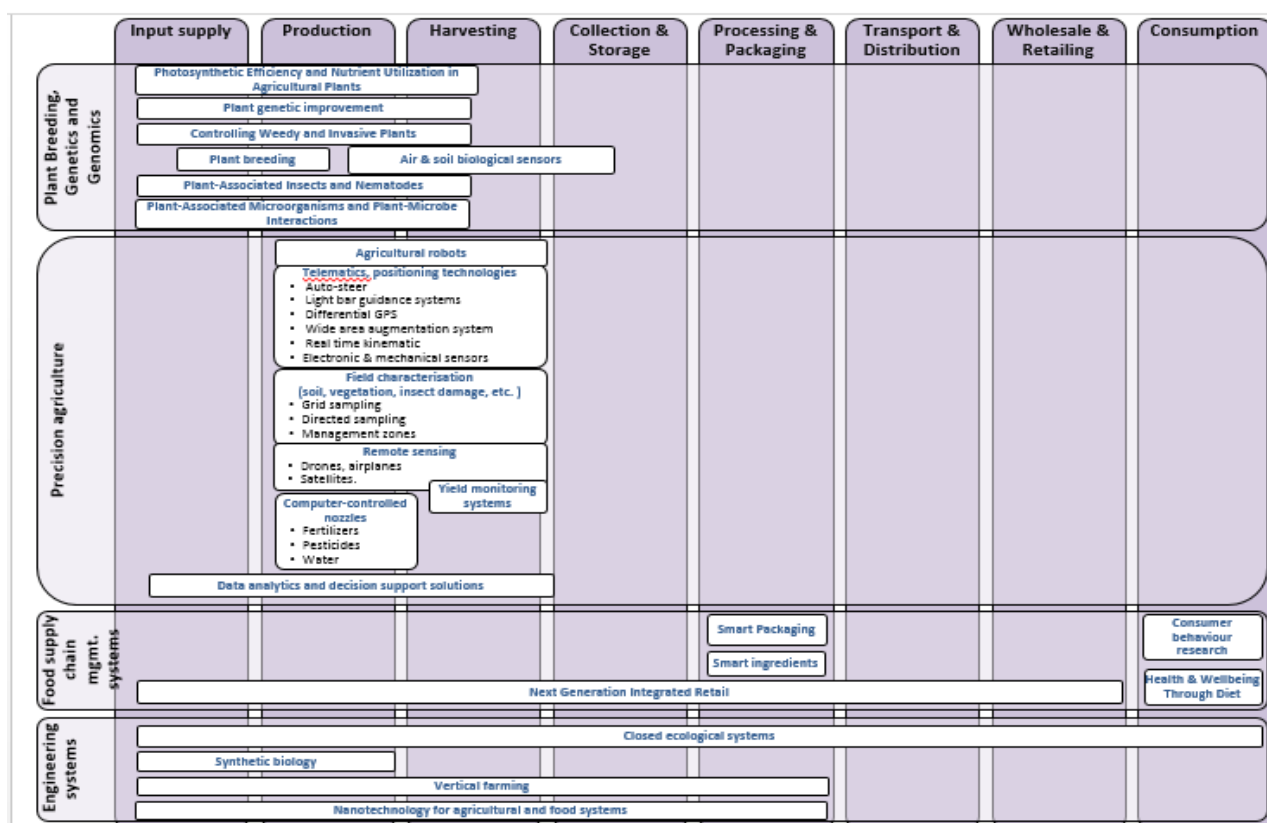


Figure 9: Overview of key technological solutions

Insights from documental evidence and previous report

The analysis of a number of reports combined with online research were used to get a sense of the spread of companies across the agritech value chain in the East of England region. The value chain diagram as populated in figure 8 was used and amended with examples of companies for each stage of the chain (figure 10)

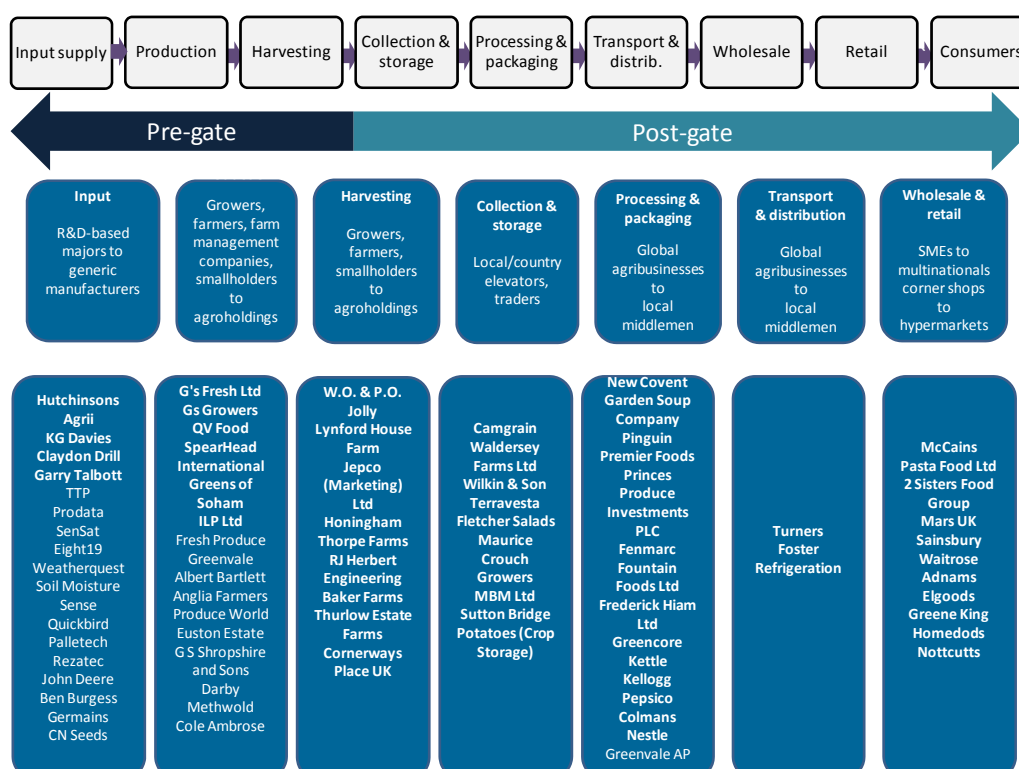


Figure 10. Example of companies in the Agri-Tech East value chain

Insights from statistical evidence

Table 4. Overview of industrial strengths in the East of England

East of England	
Industrial capabilities	- Third largest region in England in terms of private sector employment and turnover. - Fifth largest region in terms of number of private sector businesses. - The main sectors according to their value added in the region are: manufacturing (13.0%); real estate activities (12.8%); wholesale and retail trade, repair of motor vehicles (12.7%); construction (8.2%) and human health and social work activities (6.7%). - Second highest 'agriculture, forestry and fishing' value added in the UK. - Third highest 'basic pharmaceutical products and preparations' value added in the UK. - Within the manufacturing industry, the economic sectors with the highest contributions to the gross value added in the region are: food products, beverages and tobacco (13.1%); basic pharmaceutical products and preparations (10.7%); transport equipment (9.2%); basic metals and metal products (8.7%) and machinery and equipment (8.6%). - The main commodities exported in the region are machinery and transport (31.5%), mineral fuels (20.9%) and chemicals (16.5%). From these, mineral fuels show the highest contribution (14.2%) to the UK total exports.

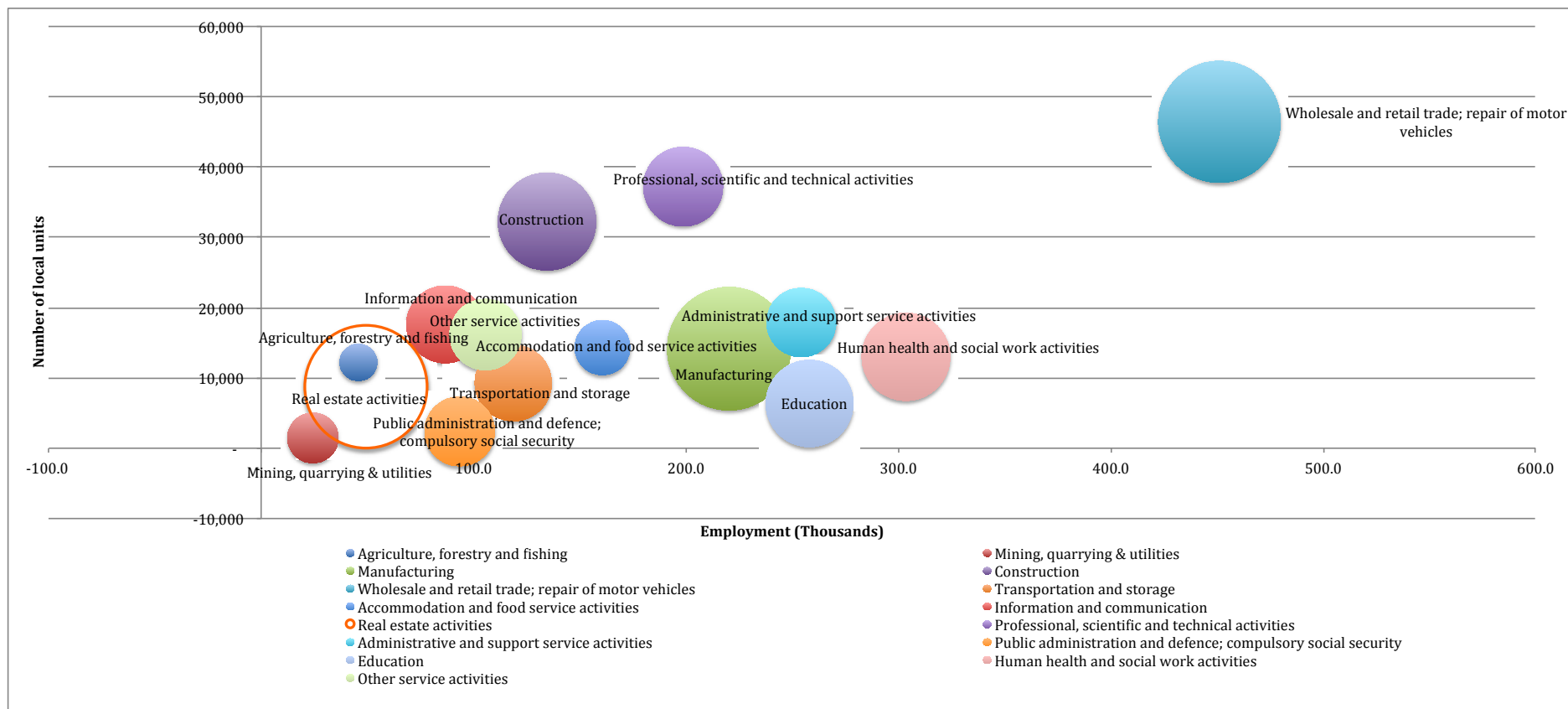
Source: BIS (2015) *Business population estimates for the UK and regions 2015*. Sheffield, UK: Department for Business Innovation and Skills. HM Revenue & Customs (2014) *UK Regional Trade Statistics*. ONS (2015). *Regional Gross Value Added (Production approach), 1998 to 2013*. Office for National Statistics (2014) *Annual estimates of employees from the Business Register and Employment Survey (BRES) 2013*.

According to their contribution to the value added of the region, the main economic sectors in the East of England are: manufacturing (13.0%); real state activities (12.8%); wholesale and retail trade, repair of motor vehicles (12.7%); construction (8.2%) and human health and social work activities (6.7%). This region also outstands in different sectors by its contribution to the UK value added: agriculture, forestry and fishing (highest value added); basic pharmaceutical products and preparations; machinery and equipment (second highest); manufacturing; computer, electronic and optical products; electrical

equipment and construction (third highest).²⁷ Moreover, the sectors with the highest employment figures in the region are: wholesale and retail trade, repair of motor vehicles (17.6%); human health and social work activities (11.8%); education (10%); administrative and support service activities (9.9%); and manufacturing (8.6%).²⁸

²⁷ ONS (2015). *Regional Gross Value Added (Production approach), 1998 to 2013*.

²⁸ Office for National Statistics (2014) *Annual estimates of employees from the Business Register and Employment Survey (BRES) 2013*.

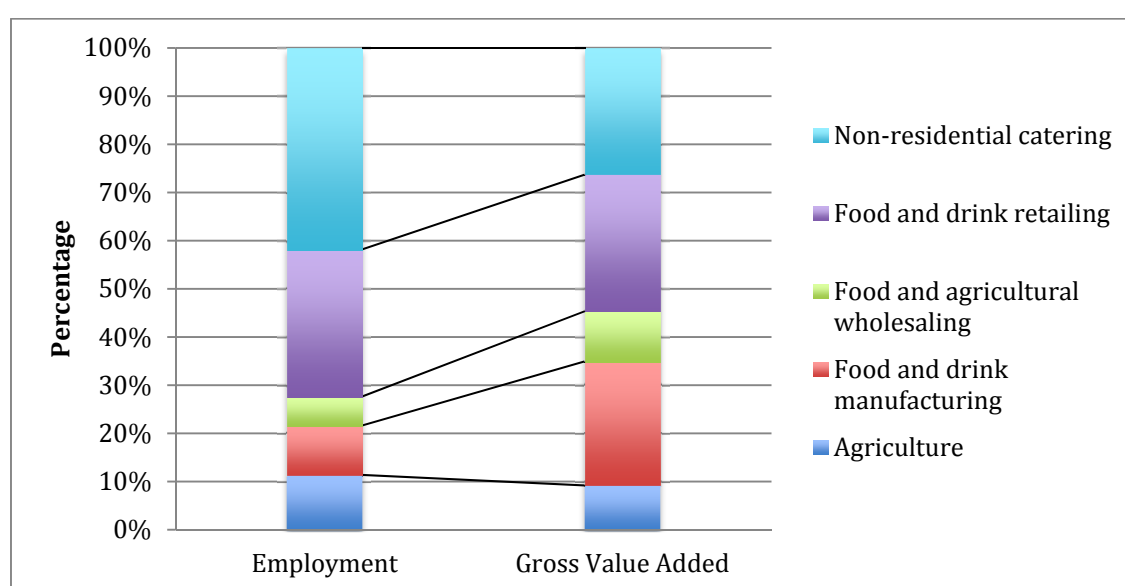


¹ Gross value added is represented by the size of the bubbles.

Source: Office for National Statistics (2015) *Regional Gross Value Added (Production approach), 1998 to 2013*. Reference tables. Office for National Statistics (2014) *Annual estimates of employees from the Business Register and Employment Survey (BRES) 2013*. Office for National Statistics (2013) *UK Business: Activity, size and location, 2013*. Dataset

Figure 11. Number of local units, employment and gross value added in East of England, 2013¹

The agri-food sector contributes with 6.7% of the gross value added in the United Kingdom, 13.4% of the total workforce employment and 5.5% of the national exports. Within the food chain, food retailing and non-food non-residential catering concentrate more than half of the gross value added and almost three quarters of the employment.²⁹ This sector (food, feed and drink) shows a trade deficit. In 2013 its imports summed up to 40,270.6 million pounds, while the exports summed up to 18,888.7 million pounds.³⁰ The main crop products imported were wheat, grapes, bananas, raw beet/cane sugar and tomatoes; while the major exports were barley, wheat, nuts, raw beet/cane sugar and rice. In the case of wheat and raw beet/cane sugar that are among the main exported and imported crops, both present a deficit balance. In 2013, 53.7% of the internal food consumption depended on production within the United Kingdom. Nonetheless, the food production to supply ratio was 60.3% for all food and 72.9 for indigenous type food.³¹ These levels reflect a decrease of around 20% in comparison with the highest levels recorded since the 1950s.³² The main origin of food imports is the European Union, covering the 28.0% of the British food demand.³³



Source: Department for Environment, Food and Rural Affairs (2015) *Agri-food sector contribution to the national economy. United Kingdom*.

Figure 12. Distribution of gross value added and employment within the food value chain in the United Kingdom, 2013

The East of England contributes with 22.4% of the UK crop production, 14.2% of the input supply, 10.8% of food wholesale value added, 9.4% of the value added of manufacturing of food and drinks and 8.7% of the livestock output.³⁴ In 2013, agriculture contributed with 1.03% of the total value added generated by economic activities in the East of England.³⁵ During that year, agriculture employed 1.35% of the workforce. The people employed in agriculture in the region represent 7.7% of the UK total, while 22.4% of the employment in input supply activities is concentrated in the region. In 2013, the hectares farmed

²⁹ Department for Environment, Food and Rural Affairs, DEFRA (2015) *Agri-food sector contribution to the national economy. United Kingdom*.

³⁰ DEFRA (2014). UK trade in Food, Feed and Drink. DEFRA Overseas Trade Data System (MOTS).

³¹ The gap between the food production to supply ratio and the percentage of consumption covered by British production is due to the produce exported.

³² DEFRA (2015). *UK food production to supply ratio*.

³³ DEFRA (2015) *Agri-food sector contribution to the national economy. Op. cit.*

³⁴ DEFRA (2015) *June Survey of Agriculture and Horticulture*.

³⁵ DEFRA (2015) *Agriculture in the English regions 2014 – 2nd estimate*.

were 1.4 million. The main crops were wheat (31%) and other cereals (13%), permanent grass (13%) and oilseed rape (12%).³⁶ In terms of their contribution to the national production, the main crops grown in the region are: sugar beet (66.7%), wheat (27%), potatoes (24.4%), oilseed rape (22.2%) and fresh vegetables (23.8%).³⁷ The East of England rank first among the English regions in the production of wheat, barley, sugar beet, fresh vegetables and potatoes (including seeds) (Table 6).

Table 5. Local units, production / value added and employment in the agri-food chain of the East of England, 2013

Value chain	Local units		Production / Value added		Employment	
	Value	Percentage of the UK total	Value (£ million current prices)	Percentage of the UK total	Jobs	Percentage of the UK total
Input supply (intermediate consumption)	250	13.8%	2,339.2	14.2%	5,600	22.4%
Crop production	7,565	22.3%	2,112.7	22.4%	32,900	7.7%
Animal production	4,400	4.9%	1,243.6	8.7%		
Food and drinks manufacturing	810	8.6%	2,526.0	9.4%	33,800	9.1%
Food wholesale	1,320	11.7%	1,150.0	10.8%	26,600	12.0%

Source: Collison, M. (2014). *The Farming & Food Chain in the Agri-Tech East area*. ONS (2015c). *UK Business Counts - Local units*. ONS (2015b). *Regional Gross Value Added (Production Approach)*. Reference tables. Department for Environment, Food and Rural Affairs (2015b). *June Survey of Agriculture and Horticulture*.

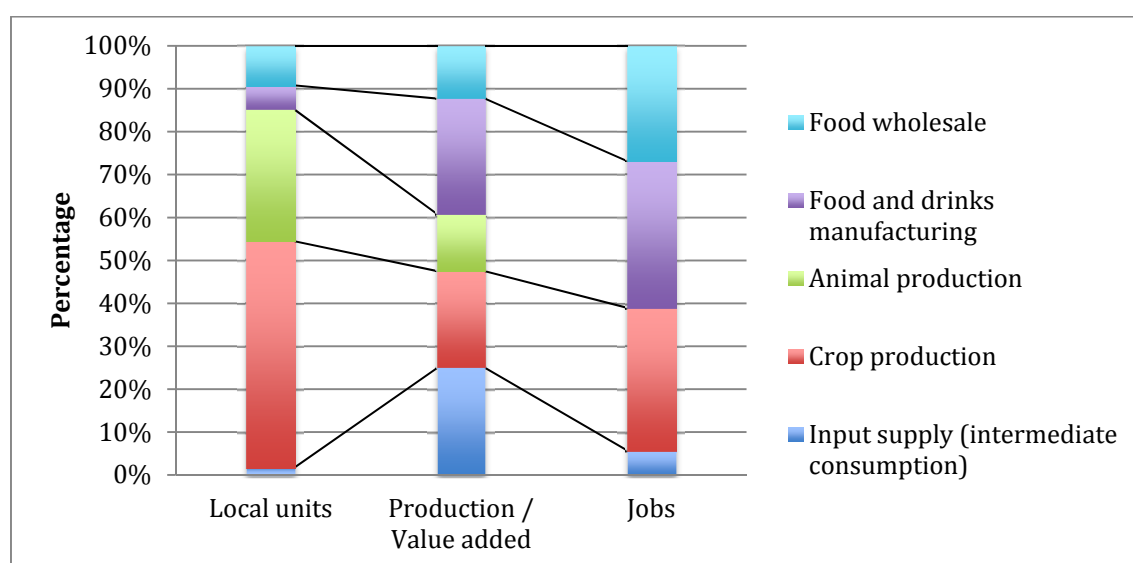
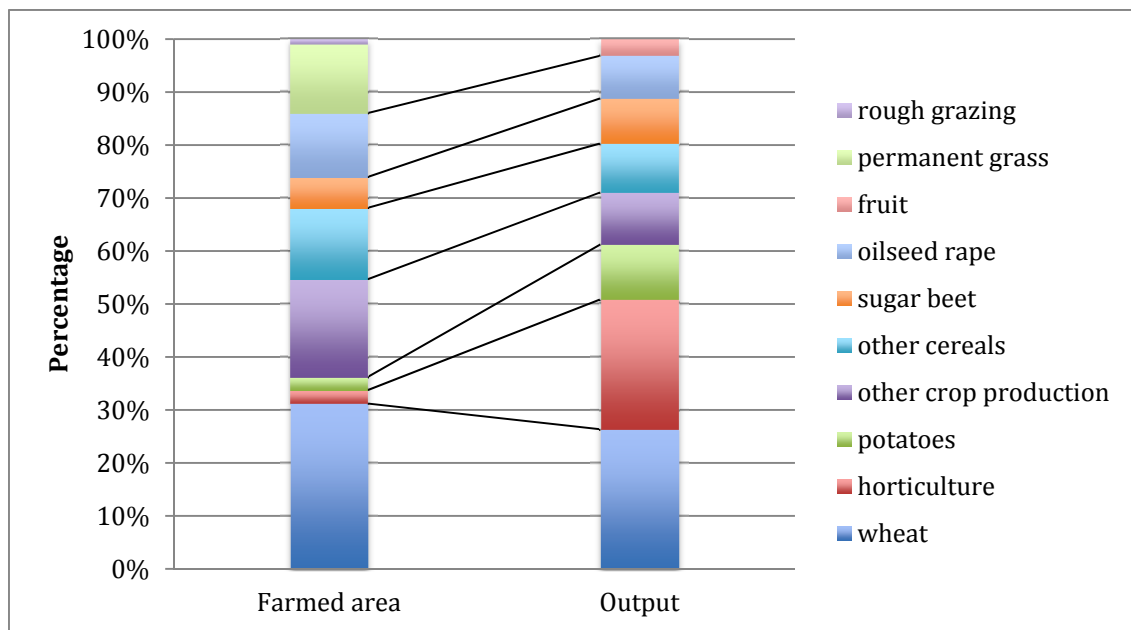


Figure 13. Jobs, production/value added and local units in the agri-food chain of the East of England, 2013

Source: Collison, M. (2014). *The Farming & Food Chain in the Agri-Tech East area*. ONS (2015c). *UK Business Counts - Local units*. ONS (2015b). *Regional Gross Value Added (Production Approach)*. Reference tables. Department for Environment, Food and Rural Affairs (2015b). *June Survey of Agriculture and Horticulture*.

³⁶ Ibid.

³⁷ DEFRA (2015) *June Survey of Agriculture and Horticulture*.



Source: Department for Environment, Food and Rural Affairs (2015b). *June Survey of Agriculture and Horticulture*.

Figure 14. Distribution of farmed area and output by main crops in the East of England, 2013

Table 6. Distribution of crop output in the East of England, 2013
(£ million current prices)

Output at market prices	UK		East of England	
	Output at market prices	Output at market prices	Percentage of the UK total	Ranking among the English regions
1. Cereals	3 371	752	22.3%	1
wheat	2 070	557	26.9%	1
barley	1 135	183	16.1%	1
2. Industrial crops	1 183	364	30.8%	1
oilseed rape	768	170	22.2%	2
protein crops	123	6	5.0%	7
sugar beet	270	180	66.5%	1
3. Forage plants	217	10	4.6%	7
4. Vegetables and horticultural products	2 530	519	20.5%	1
fresh vegetables	1 340	324	24.2%	1
plants and flowers	1 191	194	16.3%	2
5. Potatoes (including seeds)	947	219	23.1%	1
6. Fruit	602	65	10.9%	4
7. Output of other crop products including seeds	581	183	31.6%	1
Total crop output	9 431	2113	22.4%	1

Source: Department for Environment, Food and Rural Affairs (2015b). *June Survey of Agriculture and Horticulture*.

Table 7. Overview of agri-tech strengths in the East of England

Agri-tech in the East of England	
Agri-tech value chain capabilities	• Highest farming productivity by capital consumption and by land. • Greater Cambridge & Greater Peterborough LEP shows comparative advantage in the agri-tech industrial sector according to economic analyses commissioned by BIS. • 22.4% of the UK crop production, 8.7% of the livestock output and 9.4% of the value added of manufacturing of food and drinks. • In terms of their contribution to the national production, the main crops grown in the region are: sugar beet (66.7%), wheat (27%), potatoes (24.4%), oilseed rape (22.2%) and fresh vegetables (23.8%). • While the focus of this study is on crops, it is worth noting that the region is national leader in pigs and poultry production. • First among the English regions in the production of wheat, barley, sugar beet, fresh vegetables and potatoes (including seeds).

Source: DEFRA (2015). *June Survey of Agriculture and Horticulture*. DEFRA (2015). *UK food production to supply ratio*.

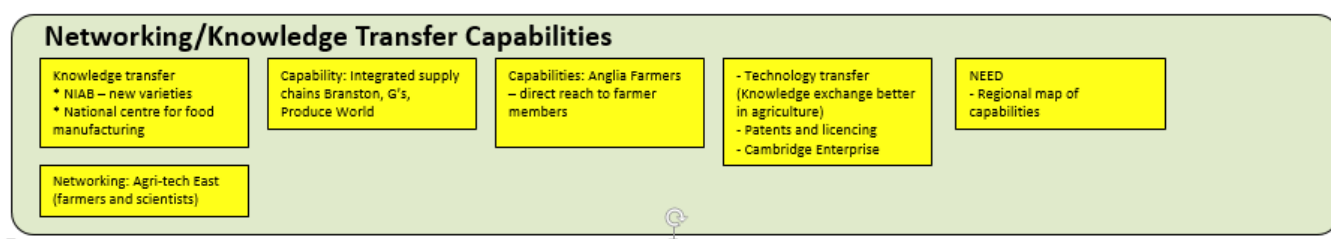
Building block 2: Regional innovation system capabilities

This block is about the capabilities to create, diffuse and apply new knowledge. This distinction between three types of knowledge builds into the analysis the recognition that innovation is more than just R&D. Of particular importance in this regard are intermediaries, i.e. those organisations and people which assist in knowledge transfer and support the translation of research and know-how into local farming practices and industrial activities. They are instrumental in ensuring that end users, the research and innovation base and the technology companies connect.

Key regional innovation system capabilities identified in the different sources of evidence

- Five of the eight national strategic sites supported by the Biotechnology and Biological Sciences Research Council (BBSRC) are located in the region.
- The Norwich Research Park has the most significant agrifood technology cluster in the UK.
- Highest budget of the total Innovate UK grants offered in Bioscience (23.1%); and the second highest in Sustainable Agri-Food Protection (12.9%).
- According to the impact per organisation (based upon citations) and the number of publications, some of the areas of research expertise are: Clinical Sciences; Life Sciences; Agri-science; Synthetic Biology and Health & Care.
- Instrumental role played by technology transfer organisations
- Importance of having a network platform to facilitate contacts between farmers and researchers

Insights from the smart specialisation workshop



In an expected way, organisations specialised in technology transfer and involved both in the dissemination of results and in the articulation of demands from end users were mentioned by the participants. Research institutes like John Innes Centre, NIAB, Rothamsted Research were identified as key actors along with universities. Initiatives like C.C.C were also stressed. The instrumental role played by Agri-Tech East in providing a platform to connect farmers and researchers was also stressed.

Insights from documental evidence

The East of England is one of the leading English regions in terms of resources and performance in research, development and innovation. It shows the second highest R&D expenditure in the UK, 5,242 million pounds in 2013.³⁸ R&D expenditure comprises four sectors (in descending order of size): business enterprise, higher education, government and private non-profit. Regarding the economic sectors, business R&D expenditure is concentrated in manufacturing. Within this sector, the activities with the highest R&D expenditure in the East of England are: chemicals, transport equipment and mechanical engineering.³⁹ Moreover, Greater Cambridge and Greater Peterborough rank in the first positions by the proportion of STEM jobs and research-based doctorate degrees awarded. This LEP is also the third with largest number of active patents.⁴⁰

Regarding knowledge diffusion, Greater Cambridge and Greater Peterborough LEP also leads the rankings by the amount of income generated by higher education institutions through business and community interactions. In addition to this, Hertfordshire ranks first in the category of regeneration and development programmes income, while South East Midlands ranks second in the category of continuing professional development income. The East of England also outstands in the application of knowledge, showing a high proportion of firms engaged in innovation activities. These percentages are in some cases even higher than the national average. In particular, Greater Cambridge and Greater Peterborough rank first in England according to the percentage of firms engaged in strategic and marketing innovation and second by their involvement in R&D activities; while South East Midlands ranks third according to the percentage of firms engaged in product or service innovation.⁴¹

The East of England outstands by its research capability in agri-food sciences. Five of the eight national strategic sites supported by the Biotechnology and Biological Sciences Research Council (BBSRC) are located in the region: Babraham Institute, John Innes Centre (JIC), Institute of Food Research (IFR),⁴² Rothamsted Research (RRes) and the Genome Analysis Centre (TGAC).⁴² Other research institutions placed in the region are: Centre for Environment, Fisheries and Aquaculture Science (CEFAS), National Soil Resources Institute (Cranfield University) and the British Beet Research Organisation (BBRO).⁴³

These are in addition to the universities and private research centres with expertise in this area:

- Universities: University of Cambridge and Institute for Manufacturing; Cranfield University; University of Hertfordshire (UoH); Royal Veterinary College (RVC) and University of East Anglia (UEA).
- Private research organisations/centres: ADAS, Colworth Park, Elm Farm Organic Research Centre - Wakelyns Agro-Forestry, National Institute of Agricultural Botany (NIAB) and The Sainsbury Laboratory (TSL).⁴⁴

Moreover, the Hertfordshire LEP hosts a Life Sciences Cluster of over 200 companies, while the Greater Cambridge and Greater Peterborough LEP hosts the BioScience Catalyst, an open innovation bioscience campus.⁴⁵

³⁸ Office for National Statistics (2015a). *UK Gross Domestic Expenditure on Research and Development, 2013*.

³⁹ Ibid.

⁴⁰ Evans, R., Meegan, R., Karecha, J. & Jones, G. (2015) *Mapping local comparative advantages in innovation. Framework and indicators*. London, UK: Department for Business, Innovation and Skills.

⁴¹ Roper, S., Love, J., Bonner, K. (2015) *Benchmarking Local Innovation. The innovation geography of the UK*. Enterprise Research Centre. Enterprise Europe Network.

⁴² Collison, M. (2014). *The Farming & Food Chain in the Agri-Tech East area*.

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ Evans, R., et al. (2015) *Op. cit.*

Table 8. Overview of regional innovation system capabilities

General innovation capabilities in the East of England	
Knowledge generation capabilities	• Second highest R&D expenditure in the UK (18% of UK total). • Second highest R&D expenditure performed by business (22% of UK total). • Half of the UK private non-for-profit expenditure on R&D is located in the East of England. • Greater Cambridge & Greater Peterborough is the LEP with the second highest percentage of science, research, engineering, technology and associated professions in total employment. • Greater Cambridge & Greater Peterborough LEP has the second highest publication output.
Knowledge transfer capabilities	• Greater Cambridge & Greater Peterborough LEP hosts the highest number of inventor population with patents 5 to 10 years old.
Knowledge absorption capabilities	• Second highest contribution to UK R&D employment in business (17.7%). • Hertfordshire has the second highest proportion of firms engaged in product and process innovation. • Greater Cambridge & Greater Peterborough LEP shows the second highest reported income per higher education institution. • Greater Cambridge and Greater Peterborough LEP shows the highest percentage of firms engaged in strategic and marketing innovation and second by their involvement in R&D activities.
Innovation capabilities to Agri-tech in the East of England	
Knowledge generation capabilities	• Five of the eight national strategic sites supported by the Biotechnology and Biological Sciences Research Council (BBSRC) are located in the region. • The Norwich Research Park has the most significant agrifood technology cluster in the UK. • According to the impact per organisation (based upon citations) and the number of publications, some of the areas of research expertise are: Clinical Sciences; Life Sciences; Agri-science; Synthetic Biology and Health & Care. • The region also leads nationally in soils and water research (Cranfield) and climate change (UEA). • ICT leadership in Cambridge sub region is also worth noting, as well as the Martlehsam Innovation cluster around BT's global R&D centre near Ipswich.
Knowledge transfer capabilities	• Highest budget of the total Innovate UK grants offered in Bioscience (23.1%); and the second highest in Sustainable Agri-Food Protection (12.9%). • 'Human necessities' is one of the main areas of patenting activity. • Agri-Tech East in its role as a business-focused cluster organisation has strengthened connections among actors and provided certainty on how stakeholders from diverse communities can come together in a productive way. • The region has launched initiatives such as Eastern Agri-Tech Growth Initiative, which supports product development, agriculture productivity, as well as research and development activities.
Knowledge absorption capabilities	• A number of firms in the cluster have established in-house research capabilities. • In particular large companies have developed engineering capabilities are able to customise technological solutions available in the market to cater for their specific needs.

Sources: Anyadike-Danes *et al.*, 2013; BIS, 2015; Collison, 2014; DEFRA, 2015, 2015b, 2015c, 2015d; ; Evans *et al.*, 2015; GCGP, 2016; HM Revenue & Customs, 2014; Innovate UK, 2016; ONS, 204, 2015a, 2015b.

Table 9. Research, development and innovation selected indicators in England and the East of England by LEP area

Indicator	England	Greater Cambridge & Greater Peterborough			Hertfordshire			New Anglia			South East			South East Midlands			East of England	
	Value	Value	%	Ranking	Value	%	Ranking	Value	%	Ranking	Value	%	Ranking	Value	%	Ranking	Value (Sum / average)	%
Knowledge generation																		
Business Enterprise R&D expenditure (£ millions), 2013	16,838	1,332	7.9	1	1,322	7.9	2	641	3.8	12	957	5.7	9	647	3.8	11	4,899	29.1
Percentage of science, research, engineering, technology and associated professions in the total employment, July 2013 - June 2014	7.2	11	-	3	8.6	-	9	5.9	-	29	6.1	-	24	7.3	-	16	7.8	-
Students graduating with first degrees with honours in HEIs by LEP area, 2013/14	308,127	6,228	2.0	19	4,087	1.3	22	3,587	1.2	26	14,105	4.6	5	11,186	3.6	8	39,193	12.7
STEM Research-based doctorate degrees awarded by LEP area, 2013/14	11,251	831	7.4	3	53	0.5	26	179	1.6	21	161	1.4	20	223	2.0	17	1,447	12.9
Count of active patents, 2012/13	15,000	1,837	12.2	3	10	0.1	27	36	0.2	25	72	0.5	23	164	1.1	14	2,119	14.1
Knowledge diffusion																		
Higher Education Business and Community Interaction income (3 year average in real terms values / £000s), 2010/11-2012/13	2,803,563	177,421	6.3	3	49,312	1.8	19	30,582	1.1	22	75,389	2.7	16	76,585	2.7	15	409,289	14.6
Contract research income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	967,439	29,465	3.0	9	4,734	0.5	25	4,785	0.5	24	16,441	1.7	17	15,159	1.6	18	70,584	7.3
Collaborative research income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	668,294	68,789	10.3	2	1,152	0.2	29	10,458	1.6	18	8,703	1.3	19	7,860	1.2	20	96,962	14.5
Continuing Professional Development income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	359,124	30,836	8.6	3	2,886	0.8	29	3,138	0.9	27	22,412	6.2	4	39,009	10.9	2	98,281	27.4
Consultancy income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	314,666	27,480	8.7	3	12,021	3.8	9	6,167	2.0	16	15,204	4.8	6	5,765	1.8	21	66,637	21.2
Regeneration and development programmes income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	129,615	2,290	1.8	18	23,990	18.5	1	4,716	3.6	12	3,456	2.7	16	731	0.6	26	35,183	27.1
Facilities and equipment related services income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	117,273	1,960	1.7	18	1,609	1.4	21	754	0.6	26	3,738	3.2	13	456	0.4	28	8,517	7.3
Intellectual property income in HEIs (3 year average in real terms values / £000s), 2010/11-2012/13	63,452	12,350	19.5	2	59	0.1	28	272	0.4	19	184	0.3	20	4,089	6.4	3	16,954	26.7
Knowledge application																		
Percentage of firms engaged in product or service innovation, 2010-2012	45	24	-	7	15	-	35	14	-	36	18	-	23	25	-	3	19.2	-
Percentage of firms engaged in process innovation, 2010-2012	10	15	-	4	10	-	28	11	-	24	9	-	32	14	-	9	11.8	-
Percentage of firms engaged in strategic and marketing innovation, 2010-2012	16	32	-	1	29	-	12	21	-	37	28	-	18	31	-	4	28.2	-
Percentage of firms undertaking R&D by local economic area, 2010-2012	15	26	-	2	16	-	9	12	-	13	15	-	27	19	-	11	17.6	-

Sources: BIS (2014) *First findings from the UK. Innovation survey 2013. Knowledge and Innovation Analysis*, London, UK: Department for Business, Innovation and Skills. Evans, R., Meegan, R., Karecha, J. & Jones, G. (2015) *Mapping local comparative advantages in innovation. Framework and indicators*. London, UK: Department for Business, Innovation and Skills. Roper, S., Love, J., Bonner, K. (2015) *Benchmarking Local Innovation. The innovation geography of the UK*. Enterprise Research Centre. Enterprise Europe Network.

Building block 3: Promising areas of specialisation and future value capture

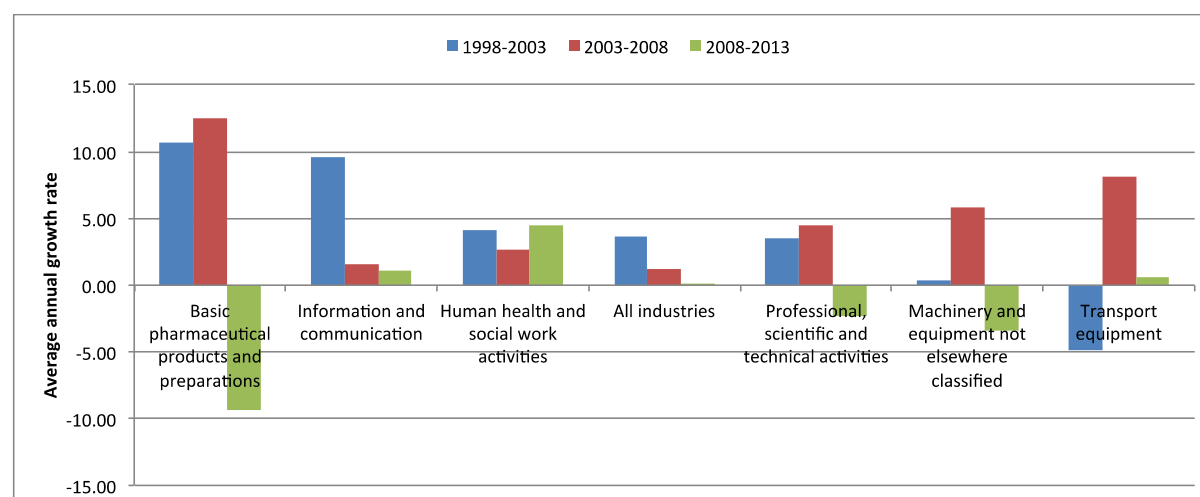
Identifying future opportunity areas of specialisation for a region or a country brings precious insights to guide smart specialisation strategy development. Foresight analyses are important sources of information but local stakeholders, for instance innovative farmers, can also play leading roles in discovering these areas by leveraging on their first-hand understanding of local needs and innovation dynamics. For a country, developing distinctive and competitive capabilities aligned with promising opportunities is likely to encourage future value capture.

Key promising areas of specialisation identified in the different sources of evidence

- Challenges faced by global agriculture as indicators of potential future market opportunities and areas of specialisation
- Value in exploring areas of specialisation through foresight studies and identification of seed care, crop protection, bio-pesticides and bio-stimulants, precision agriculture, pest management and digital farming as promising sectors for value capture
- East of England sectors showing a relative outstanding performance during the period 1998-2013 include: basic pharmaceutical products and preparations; information and communication; human health and social work activities; professional, scientific and technical activities; machinery and equipment; and transport equipment.

Insights from documental evidence

The economic downturn of 2008 has had effects across all the sectors, making it difficult to identify consistent growth trends. Nonetheless, there are some sectors that showed a relative outstanding performance during the period 1998-2013, such as: basic pharmaceutical products and preparations; information and communication; human health and social work activities; professional, scientific and technical activities; machinery and equipment; and transport equipment. These figures could shed light on the potential interactions between the agri-tech sector and other industries that have shown a better performance than the average.



Source: Office for National Statistics (2015) *Constrained Index of Real Gross Value Added (Production approach), 1998 to 2013*. Reference tables.

Figure 15. Economic sectors with highest growth rates in the East of England, 1998-2013 (2012=100)

Insights from documental evidence and existing report

The global context for agriculture is at an unprecedented crossroad. On one hand, the global demand for more and better quality food is increasing rapidly, mainly driven by a growing middle class but also by the need to ensure food security in less developed countries⁴⁶. On the other, resource shortage, depletion of soils and

⁴⁶ FAO (2012) *World agriculture towards 2030/2050 – 2012 Revision*, US National Academy of Engineering (2011) *The Bridge: Special Issue on Agriculture and Information Technology*.

changing weather patterns are all looming issues that are already constraining agricultural production all over the world⁴⁷.

New global approaches and local solutions are required to address these global challenges, giving indications about potential future market opportunities and areas of specialisation. Figure 11 outlines some of the major trends and challenges for global agriculture as well as potential technology solutions, highlighting how the increase of global agricultural productivity, the promotion of food safety and the enhancement of nutritional content – all while ensuring environmental and resource protection, could be tackled by the development of new technologies and the deployment of existing ones.

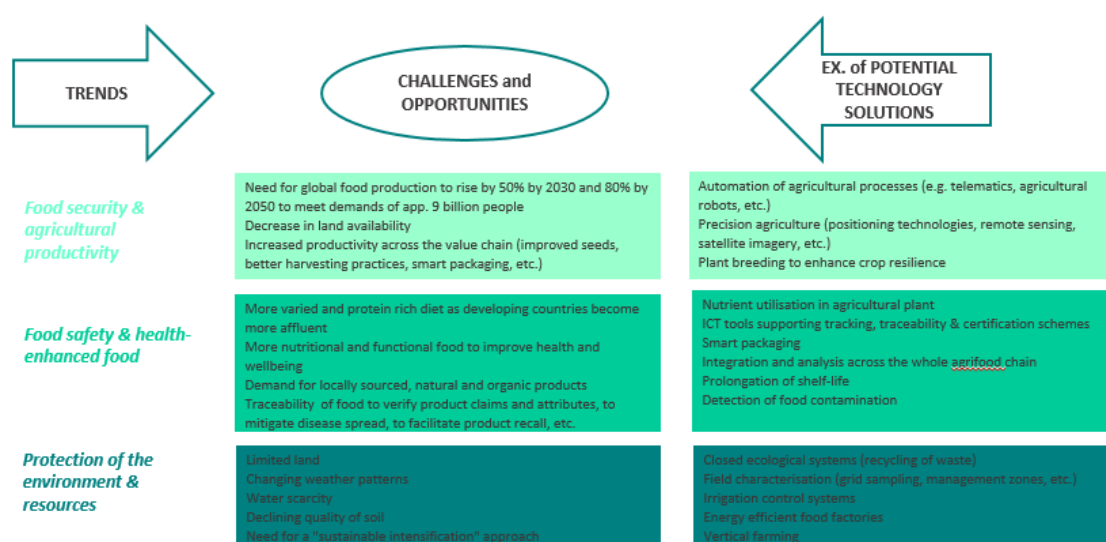


Figure 11: Major trends and challenges for global agriculture and potential technology solutions

Several foresight studies and market reports have looked into promising market opportunities for technology innovation⁴⁸. Scientific advances in genomics and biotechnology, informatics, satellite imagery and remote sensing, environmental and chemical sciences have already led to some value capture in sectors like seed care, crop protection, bio-pesticides and bio-stimulants, precision agriculture, pest management and digital farming.

Insights from the smart specialisation workshop

Participants were asked to discuss the main market opportunities that the East of England agri-tech cluster could pursue. They were prompted to consider the whole agri-tech value chain (i.e. pre- and post-farm gate), potential high-growth products / markets, and new and existing products for arable, horticulture and other crops in their responses.

The main workshop outputs are summarised in the table below.

⁴⁷ US National Academy of Engineering, *ibid.*, Government Office for Science (2011) Foresight: The Future of Food and Farming - Final Project Report, Commission on Sustainable Agriculture and Climate Change (2011) Achieving food security in the face of climate change - Summary for policy makers

⁴⁸ Government of Canada (2013) Policy insight - Agricultural and natural manufacturing technology; Teagasc (2016) Technology Foresight – Final Report; Shoham J. (2015) Disruptive technologies herald a 21st revolution in farming. Available at: <http://www.hardmanagribusiness.com/21st-century-revolution-in-farming/>

Table 10: Main market opportunities identified by workshop's participants

Value chain's stage	Main market opportunities
<i>Input supply</i>	Smart LED, smart irrigation systems & infrastructure, cost efficient fertilisers, variable spray applications, drones, big data analysis, data platform to support purchasing solutions, crop phenotyping (incl. above and below the ground), IP on new crop traits, rapid diagnostics for use in-field, biological control for horticulture, controlled environment and protected crops technologies,...
<i>Production</i>	Arable production (e.g. malting barley, ...), chemicals from biomass, modelling use of big data, horticultural efficiency, water optimisation, nutraceuticals and nutrition specific improvements, novel materials to enhance growth, urban farming, insect survey, crop management platforms, integrated crop management and data platform, plant-derived protein, remote sensing and precision farming, computer vision for crop identification and monitoring, willow varieties, ...
<i>Harvesting</i>	Robotics, water efficiency and quality, food waste reduction, bioinformatics and statistics (training and know-how), satellite and precision farming to create a big picture of supply chain,...
<i>Collection & storage</i>	Automation, real-time and just-in-time sensing in-field and in-storage, crop storage, content management systems and platform, controlled environment, assessment capability for specific end point food
<i>Processing & packaging</i>	Process engineering software and hardware, smart packaging, automation and use of RFID, treatment of waste by products (e.g. starch from potato skin), processing robotics (e.g. potato picking), ...
<i>Transport & distribution</i>	Horizontal collaborations between growers and packers with a better control of the demand side,
<i>Wholesale & retailing</i>	End-to-end product supply chain modelling, value-added products (e.g. potato innovation)
<i>Consumption & after sales</i>	Demand of healthy food, development of functional food through GM, data analysis, modelling and final food production, ...

On the basis of the list of market opportunities and in order to identify the priority opportunities for the region, participants were asked to vote against two criteria:

- The size of the opportunity (from small to large)
- The level of current capability (from low to high) to realise the opportunity

The following promising areas for future value capture were revealed at the end of this process:

Crop Modelling

- Big data
- Remote sensing
- Process automation
- Processing and packaging (esp. software, RFID)
- Food waste reduction solutions through supply chain
- Improved crop varieties
- GMOs
- Nutrition specific improvements
- Robotics (esp. harvesting)
- Controlled environment (esp. LEDs)
- Water management –Smart irrigation
- Value chain Modelling

Building block 4: Gaps in the regional industrial-innovation system

Taking forward future opportunity areas asks for an alignment between new and current capabilities and identified areas in order to capture value from innovation. The scanning and assessment of innovation system capabilities, together with considerations around level of readiness and needs for future deployment, are core tasks at this stage.

Insights from the smart specialisation workshop

The last part of the workshop was spent on exploring options to take forward the different market opportunities identified and voted on by the participants. Five business cases were developed to assess in more details both the current relevant capabilities and strengths, and the need for new or enhanced ones, to realise the opportunity and overcome potential challenges in its realisation (see business case templates below).

The five opportunities which were investigated are:

1. High-quality combinable crops for specific food and industrial end-uses
2. Fresh produce fortification for improved human nutrition
3. Crop modelling, remote sensing, inputs alignment and extension services
4. Process automation
5. Water management

Description of challenge / opportunity (including indication of size)	• LOW PRICES AT COMMODITY LEVEL – need to produce higher value product. • Consumer demand to make bulk carbohydrates “healthier” (even without noticing). • National food and nutritional security, linked to national health agenda. • Dependency on petrochemicals – sustainable reduced inputs.			
Why should the region pursue this?	• World-leaders in production of high quality cereals (on a unit area basis). • World-leading research base, including trait discovery. • Access to germplasm collections and ability to derive and capture value from			
What are the main agronomic / technical challenges?	• Restriction of key crop protection chemicals • <u>Water</u> (management, storage, recycling) • <u>Blackgrass</u> • Lack of understanding of the rotation and impact on soils (soil management) • Fuel/food challenge (eg supplying AD plant vs growing food)			
Local capabilities to address challenge / opportunity				
	Current relevant capabilities / strengths	New capabilities / strengths that will need to be developed	Key issues to be addressed	Key competitors, their initiatives & strengths
In the research & innovation base	JIC, NIAB, RRes, ADAS	• Not enough “research-y” plant breeders. • (robotics for) high-throughput phenotyping	• Further the understanding of what a healthier breed is	• USA • Scotland • Hutton
In local organisations / networks	• Farmer groups • ATE • Innovation Farm	• Learning from new disciplines (eg nanotechnology, space industry, ...)		
In the industrial value chain	• Unilever • Syngenta		(see fresh produce fortification)	• USA • Australia • Canada • Russia
Other				

Business Case 1:

High-quality combinable crops for specific food and industrial end-uses

In the case of high quality combinable crops for specific food and industrial end-uses, the low prices at commodity level were considered as leading to a need to produce higher value product. National food and nutritional security linked to national health agenda were considered as providing a supportive context. The

world leading position in production of high quality cereals of the East of England was acknowledged as a key asset, together with the world leading research base of the region. On the challenge side, the restriction of key crops protection chemicals and issues around water management and blackgrass were highlighted.

Description of challenge / opportunity (including indication of size)	- EDE (Inc Lincs) produces around ~40% of UK's (daily) fresh produce - Consumer demand for healthy product - High market value commanding higher prices - Import substitution (...↑ food security for UK) - Innovative fresh produce growers – tightly linked to retailers (Inc M&S, Ocado) - Industry led, hungry for innovation			
Why should the region pursue this?	- End-to-end capability to create and capture value/economic benefit - Non-glasshouse (field) - Very strong links with academia and growers and breeders - Highly innovative, research-active growers, hungry for new innov. & appetite for new things - Academics, institution capable of utilizing new genetic resources in veg germplasm - Strong/growing links between R&D organisations and retailers			
What are the main agronomic / technical challenges?	- Matching varietal delivery with required inputs (water, chemical, management) - Soils – link between soil inputs and nutritional quality/impact of product - Management of pests and diseases - Management of extremes of weather/climate change - Consumer perception/acceptance	} Applying big data predicting capabilities is a challenge		
Local capabilities to address challenge / opportunity				
	Current relevant capabilities / strengths	New capabilities / strengths that will need to be developed	Key issues to be addressed	Key competitors, their initiatives & strengths
In the research & innovation base	Genetics / genomics / plant sciences / quadrum	Hardware and product development for data value extraction	- Produce novel genetic lines - link between husbandry / management regime and nutritional quality of product	- UC Davis - Wageningen - Warwick
In local organisations / networks	- Farmer groups - ATE - Anglia Farmers - Innovation Farm	NO GAPSI!		
In the industrial value chain	- Unilever - Bayer / Syngenta - Elcoma	- Managing supply and demand - Interpretation of big data information leading to better decision making and input management	- Better supply chain management - No match for translational resource - Need better understanding of targets for bio-fortification	- Netherlands - Spain
Other			- Exclusion gap of subsidy funding to farmers (who would otherwise be excluded) - Loss of critical crop protection products in the EU could lead to low wage markets being able to grow in a more competitive way	

Business Case 2:

Fresh produce fortification for improved human nutrition

For fresh produce fortification for improved human nutrition, the research base strengths in areas like genetics, genomics and plant sciences were put forward. The strong links between academia, growers and breeders as well as the growing links between R&D organisations and retailers were also acknowledged as important assets. Key issues to address were identified in terms of better supply chain management, a better understanding of consumer perception and acceptance, and management of extremes of weather.

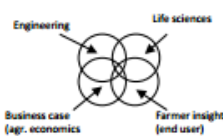
Description of challenge / opportunity (including indication of size)	Challenge: - Models variable by crops - Technology variable Opportunity: "Pulling it all together" - Technology configuration - Quick enough real time processing (1)			
Why should the region pursue this?	- EoE has all the components already linked together - Access to: workforce, diversity, pool of skills 2			
What are the main agronomic / technical challenges?	- Agronomic – providing the value to the end user "so what test" - Selling things to farmers - HMRC – allowing software to be treated as <u>capital</u> expenditure - Risks: BREXIT, UKIP			
Local capabilities to address challenge / opportunity				
	Current relevant capabilities / strengths	New capabilities / strengths that will need to be developed	Key issues to be addressed 3	Key competitors, their initiatives & strengths
In the research & innovation base	- Test beds / trials - Expertise	Integration of technologies	Application of image (MRI) technologies	- USA - World competitors - Wageningen / Netherlands
In local organisations / networks	Existing communication challenges	(K – E) – infrastructure to support right people interacting		
In the industrial value chain	Multinational routes to market	Cross-compatibility between <u>hardware kit</u>	ROI proving to farmers	
Other	Lots of existing gov support across sector	- Biodiversity & sustainability (e.g. slug pellets) - Social sciences angle		

Business Case 3:

Crop modelling, remote sensing, inputs alignment and extension services

For crop modelling, remote sensing, inputs alignment and extension services, there was a sense that the East of England region had all the necessary components linked together. Access to workforce and relevant pool of skills was also mentioned. Integration of technologies was recognised as a new capability to develop. The existence of government support across sector was seen as a current relevant strength.

Description of challenge / opportunity (including indication of size)	C: living wage C: ongoing increased productivity C: political uncertainty migrant labour O: export opportunities (urbanization, similar challenges around world) O: precision ag. £2billion global market			
Why should the region pursue this?				
What are the main agronomic / technical challenges?	• New business model • Variability (living system) • System capability • Systems integration • Legislation H&S			
Local capabilities to address challenge / opportunity				
	Current relevant capabilities / strengths	New capabilities / strengths that will need to be developed	Key issues to be addressed	Key competitors, their initiatives & strengths
In the research & innovation base	• Computer vision systems • Soft robotics – Cambridge, Lincoln	• Real-time data processing • ICT – Cambridge, Martlesham (Ipswich), Norwich • Research - Rothamsted	• Variability – breeding for harvest	• IBERS
In local organisations / networks			• Knowledge transfer and adoption	<u>Multi-disciplinary</u> Engineer Social economist Plant scientist End user
In the industrial value chain			• Short termism in value chain • Lack of network infrastructure on farms	Harper Adams etc Bath (vision0 Bristol (robotics) SRVC
Other			• Cost • Data ownership	

The region has the potential to capture an opportunity in:
Multi-disciplinary integrated process automation for multiple applications
The region is particularly well-positioned because:
Commercial base , including end-users (SMEs, large, global) as well as multidisciplinary academic base (eng., life sciences) Capacity to invest 
Key issues to be addressed:
- Compatibility / standards / legislation - Short termism in VC - Engagement with end users

Business Case 4: Process automation

In the case of process automation, living wage, ongoing increased productivity were depicted as main challenges while export opportunities were put forward. The needs for new business model, system capability and systems integration were identified as key technical challenges. New capabilities around real-time data processing were also discussed.

Description of challenge / opportunity (including indication of size)	High-value crops need water supplies for business to operate economically			
Why should the region pursue this?	- Crops in EoE including potatoes and vegetables already water efficient 50% of irrigation in the UK happens in the EoE			
What are the main agronomic / technical challenges?	- Genetics have a part to play - Efficient use of water, including use of sensors - Understanding local Infrastructure needs for specific crops, including storage - Managing water in a more integrated manner / larger geographies - Real-time decision tools at point of use			
Local capabilities to address challenge / opportunity				
	Current relevant capabilities / strengths	New capabilities / strengths that will need to be developed	Key issues to be addressed	Key competitors, their initiatives & strengths
In the research & innovation base	- Research Institutions - Delta T (water balance), Blomation (soil management)	Less water waste in Irrigation systems In-field sensors & communication technologies Smart Irrigation Complex Irrigation systems – both engineering and plant sciences	Balance of water efficiency and product quality Balance of supply from water utilities (housing, farming needs)	Netherlands (Twente)
In local organisations / networks		- Crandfield - UEA - Anglia Water - Lincolnshire LEP, Anglia LEP conducting projects in this area		
In the industrial value chain	40% Irrigation businesses located in EoE			Netherlands California Israel

Business Case 5:
Water management

Water supplies are a key issue for high-value crops. Some technological solutions supportive of smart irrigation are already being explored and developed, they include in-field sensors, communication technologies and soil management systems. Water-related issues are a global concern and massive export markets. The agenda is currently led by the Netherlands, the US (California) and Israel. In the East of England, a number of networks exist already (Cranfield irrigation organisation, UEA), with Greater Lincolnshire LEP and New Anglia LEP also focussing on water.

4. DISCUSSION

The case study conducted helped prove the value of the ‘industrial-innovation’ approach outlined in Section 2. The case study has focused on specific sector (agri-tech), and a representative community within a selected value chain (primarily arable and horticultural crops). Access to this community was possible thanks to the support of Agri-Tech East, a major agri-tech cluster organisation in the East of England.

While the analysis of the whole East of England region was beyond of the scope of this project, the Agri-Tech East community offers a useful test case including as it does a rich variety of agri-tech actor types. These include: end users (farmers and food companies), some of the most important research centres in Europe, technology-led input suppliers (e.g. seeds, agrochemical products, machinery, etc.), intermediate institutions and specialised service providers (agronomist, consultants, etc.), as well as a number of national trade bodies (see Appendix 2).

The case study helped prove the value of the suggested approach, in particular, because:

- it guided a clear identification of what makes the cluster distinctive, including areas of particular strength
- it helped visualise how different organisations and stakeholders fit and complement each other rather than viewing the activities in competition with each other.
- It helped overcome some of the limitations related to data availability
- it recognised the role of technology-led firms that are critical to the industry but are often not accounted for in the sector statistics.
- it allow a clear recognition of the role of intermediaries in the translation of knowledge from the science and research base into industry.
- it guided the identification of promising opportunities for specialisation and future value capture for which the region is particularly well placed to pursue.

As shown in Appendix 3, the feedback from key participants of the workshop highlighted the advantages of the approach adopted for the purposes of smart specialisation.

5. CONCLUSIONS: MAKING SMART SPECIALISATION SMARTER

This pilot project has been designed in collaboration the UK Department for Business, Innovation & Skills (BIS) to support smart specialisation in UK regions. The main outcome of the investigation has been the development of an ‘industrial-innovation system’ approach which allows a better alignment between *distinctive* regional capabilities and promising areas for future specialisation. The approach addresses common analytical weaknesses and data limitations hindering recent regional innovation efforts. In particular, it defines a novel framework that allows a more detailed characterisation of a region’s industrial and innovation capabilities, thus enabling a clearer articulation of what makes a region distinctive. As such, the ‘industrial-innovation system’ approach has the potential to underpin ‘smarter’ smart specialisation.

The ‘industrial-innovation system’ approach focuses not only on the activities, actors and institutions that interact to *generate*, *diffuse* and *apply* knowledge but also pays close attention to the processes value addition along the industrial value chain. By combining these analyses, a region’s distinctive and competitive capabilities can be better aligned with promising and feasible market opportunities.

Our approach has been designed to address common issues that have limited the effectiveness of recent regional innovation efforts internationally, including:

- the selection of priorities that are too generic, that do not appropriately take into consideration existing regional economic and innovation structure, and/or that are simply replicated from elsewhere.
- an excessive focus on basic R&D that is not sufficiently business driven.
- attempts to create 'miracle growth' in headline industries such as semiconductor or biotechnology.
- lack of sound analysis of the industrial and economic structures of the region.

These issues observed in practice can be, in turn, related to a number of weaknesses in the analytical frameworks and the evidence base commonly used as the basis for smart specialisation. These include:

- the lack of sub-sectoral regional data to reveal the structure and areas of specialisation of the regional economy at a useful level of disaggregation to reveal distinctiveness.
- the use of composite statistical indicators that provide high-level benchmark of regions' economies but fail to provide information about competitiveness in specific industrial activities.
- the difficulties to identify cross-sectoral and emerging capabilities and opportunities from reliable statistical analysis.
- the lack of taxonomies based in technological and industrial know-how to match areas of industrial specialisation with areas of research and innovation specialisation.

The suggested ‘industrial-innovation system’ approach addresses some of these analytical and evidence limitations by combining value chain and innovation system structures. The result is a structure that offers practical guidance on the gathering and analysis of data but also on questions that need to be addressed as part of the ‘entrepreneurial discovery process’.

The approach suggested involves the following critical activities:

- characterisation of the activities, actors and institutions contributing to the generation of value through innovation and to the capture of value through business activities
- evidence gathering and analysis on the basis of particular industry and technology characteristics observed in practice rather than on traditional statistical boundaries defined in theory
- an entrepreneurial discovery process that focuses on the identification of innovation system failures constraining the region from pursuing promising areas of specialisation and future value capture opportunities.

The value of the value chain framework resides in its ability to:

- more precisely identify where the industrial centres of gravity in the region reside.
- structure the analysis of complementarities among capabilities of different types of stakeholders in the region with seemingly different industrial interests and technical competencies.
- locate regional activities as part of wider industrial system in which other 'links' in the chain – industrial activities, regions and countries – are relevant to understanding the region's unique position.

A systematic review of regional innovation system capabilities is simple but highly effective way to:

- emphasise that innovation is not just about R&D
- recognise that regional competitiveness and value capture require capabilities to diffuse new knowledge, and to 'absorb' new knowledge in productive processes.
- characterise the contribution of independent players, policies and institutions to regional innovation, as well as the linkages between them.
- Recognise the critical role played by knowledge diffusion intermediaries supporting the translation of research and know-how into the productive activities of local firms needs, thereby closing the gap between industry and research.

A case study was conducted to demonstrate the advantages of the approach suggested. This case study has been limited to a specific sector (agri-tech), and a representative community within a selected value chain (primarily arable and horticultural crops) in the East of England. Access to this community was possible thanks to the support of Agri-Tech East, a major agri-tech cluster organisation in the region.

The case study helped prove the value of the suggested approach, particularly in that:

- it guided a clear identification of what makes the cluster distinctive, including areas of particular strength
- it helped visualise how different organisations and stakeholders fit and compliment each other rather than viewing the activities in competition with each other.
- it helped overcome some of the limitations related to data availability
- it recognised the role of technology-led firms that are critical to the industry but are often not accounted for in the sector statistics.
- it allow a clear recognition of the role of intermediaries in the translation of knowledge from the science and research base into industry.
- it guided the identification of promising opportunities for specialisation and future value capture for which the region is particularly well placed to pursue.

While a particular case study in the agri-tech industry has been selected in this pilot project, the process and principles developed here have the potential to be deployed across different regions and sectors. It is hoped that the approaches presented in this report will help regions develop 'smarter' smart specialisation strategies. It is also hoped that, in conjunction with other projects commissioned by BIS, ideas developed in this report can help reveal opportunities for maximising the impact and efficiency of public funding, in particular EU instruments for research, development and innovation.

APPENDIX 1: Example sources of evidence for smart specialisation strategies

Table 1. Example sources of evidence to assess value chain strengths and areas of competitive advantage

Example indicators	Example sources of data	Complementary questions for entrepreneurial discovery process
• Distribution of value added, exports, FDI, jobs, capital investment, R&D expenditure across industrial activities in the region • National and global market share of activities across in the value chain • High growth product classes • Benchmark indexes (e.g. revealed comparative advantage indexes)	• Official statistics (e.g. ONS) • Government white papers • Industry & market studies • Company reports • Surveys, interviews, workshops • Academic studies	• <i>What activities across the value chain make a significant contribution to the regional economy (financial, social, strategic value)?</i> • <i>In which value chain activities is the region a national and/or global leader?</i> • <i>Which competitor regions have similar specialisations in the value chain?</i> • <i>Which regions participate upstream and downstream the region's value chain?</i>

Table 2. Example sources of evidence to assess regional innovation capabilities

	Example indicators	Example sources of data	Complementary questions for entrepreneurial discovery process
Knowledge generation capabilities	• Areas of research specialisation of firms • Areas of research specialisation in higher education institutions & public research centres • Level of maturity of research in the region • Number of scientific publications and impact factors • Proportion of personnel involved in research	• National and regional innovation scoreboards • Official surveys and reports by national government agencies (e.g. BIS) • Grant data analysis from funding agency databases (e.g. Innovate UK, Research Councils) • Bibliometric analyses • Company reports & websites • Science, engineering and technology (SET) statistics & higher education Statistics	• <i>In which research areas is the region a global or national leader?</i> • <i>Where are the most relevant areas of multidisciplinary?</i> • <i>How mature is the research carried out in the region across the value chain (e.g. TRL level)?</i> • <i>Where are the main areas of current and planned research investments?</i>
Knowledge transfer capabilities	• Levels of contract and collaborative research activity • Presence of contract research organisations, technology & innovation centres, and university licensing offices • Presence of technology consultants • Presence of cluster management organisations	• National and regional innovation scoreboards • Official surveys and reports by national government agencies (e.g. BIS) • Bibliometric analyses • Company reports & websites	• <i>What are the main channels used by regional SMEs to receive information about new technologies?</i> • <i>What types of networking mechanisms exist to connect firms with the research base?</i> • <i>Who do the small producers trust for advice on technology?</i> • <i>Are there organisations and individuals particularly effective at driving connections in the regional community?</i> • <i>Which regions are particularly successful in translating research into new businesses in the value chain analysed?</i>
Knowledge absorption capabilities	• Patenting and licensing activity • Entrepreneurial activity in terms of, for example, spinouts and start-ups • Proportion of firms introducing new products and services and frequency • Proportion of personnel involved in engineering, design and development	• National and regional innovation scoreboards • Venture capital reports • Company reports & websites	• <i>Which type of research conducted in the region is most likely to be applied in industry?</i> • <i>How used are the companies in the region to introducing new technologies into their processes?</i> • <i>How common is for companies in the region to have their own development/engineering/design departments?</i> • <i>Are firms aware of relevant standards?</i>

Table 3. Example sources of evidence to assess promising areas of specialisation and future value capture

Example indicators	Example sources of data	Complementary questions for entrepreneurial discovery process
• High-growth products and markets • Industry growth forecasts	• Foresight studies • Official national statistics • Industry & market studies • Consultancy reports • Surveys, interviews, workshops	• <i>Considering the region's distinctive value chain strengths and innovation capabilities, what are the main areas of opportunity?</i> • <i>Is there a strong business case for the region to pursue identified opportunities?</i> • <i>Which companies are likely to benefit? How likely are these new activities to be carried out in the region?</i>

Table 4. Example sources of evidence to identify gaps in the regional industrial-innovation system

Example indicators	Example sources of data	Complementary questions for entrepreneurial discovery process
• Number and size of intermediary actors and mechanisms	• Benchmark analyses • Consultancy reports • Surveys, interviews, workshops	• <i>How well connected are the regional industrial and innovation actors?</i> • <i>What else can be done to facilitate linkages between regional industrial and innovation actors? What do other regions do?</i> • <i>What new (industrial and innovation) capabilities are required to address identified opportunities?</i> • <i>What new research projects are required?</i>

APPENDIX 2: List of smart specialisation workshop participants

Belinda Clarke

Agri-tech East

Martin Collison

Collison and Associates Limited

Dean Cook

Lead Technologist - Agriculture and Food
Innovate UK

Laure Dodin

IfM Education and Consultancy Services
University of Cambridge

Chris Dunkley

CEO
Rothamsted Centre for Research and Enterprise

Mariana Fazenda

Department of Plant Sciences
University of Cambridge

Charles Featherston

Research Associate, Centre for Science,
Technology & Innovation Policy
University of Cambridge

David Flanders

CEO
Agrimetrics

Helen Francis

Research Manager and Knowledge Transfer
Facilitator
University of Cambridge Department of
Engineering

Carlos López-Gómez

Head of Knowledge Exchange, Policy Links, Centre
for Science, Technology & Innovation Policy
University of Cambridge

Martin Lutman

Agri-Tech Programme Manager
Greater Cambridge Greater Peterborough
Enterprise Partnership (LEP)

Peter McDonald

General Manager Agrochemicals
Anglia Farmers

Rob Merrall

President-elect
IAgrE

Ed Moorhouse

Group Technical Director
G's Fresh

Kate Parsley

Research Facilitator, Bioscience Impact Team
University of Cambridge

Tony Peloe

Distributor Manager
Delta -T Devices

Tamsin Sayer

School of Biological Sciences Translational
Research Manager
University of Cambridge

Liliya Serazetdinova

Knowledge Transfer Manager for Plants and Crops
Knowledge Transfer Network

Sachin Shende

Co-Founder and CEO
KisanHub

Paolo Siciliano

PA Consulting Group

Robert Smith

Russell Smith Farms

Lydia Smith

Head Innovation Farm
NIAB

Richard Turner

National Centre for Food Manufacturing,
University of Lincoln

APPENDIX 3: Feedback from smart specialisation workshop participants

"The structured methodology of the event provided a valuable focus to discussions. As a result, the output from the day felt that it had really captured the essence of the regions strength in agri-tech."

Dean Cook, Lead Technologist - Agriculture and Food, Innovate UK

"The workshop was of great benefit to the agri-tech community. There was a good spread of people from across the industry, from scientist through to farmer, and consequently there was a good broad spectrum of input. I think one of the greatest challenges for the sector is actually getting the science applied into practice - and I think engaging and exposing farmers to the science and technology and the people who are behind it is really important."

Representative of major family-owned agricultural firm

"The workshop provided a valuable insight into the challenges that farmers are facing in our area and the output will play a key role in helping the academic and industrial communities prioritise areas for research and investment. This will support the critical role played by Agri-Tech East in developing innovative solutions for farmers and creating new business opportunities, both of which will be critical in maximising the potential of this area."

Representative of major transnational agricultural firm

"Claiming you are World class in everything will not be believed and therefore in an emerging sector like agritech it is vital that we collectively agree where our real strengths lie. The workshop successfully brought together a wide cross section of partners to identify the USP of the AgriTech East region and this will strengthen our ability to attract companies and investment to the area, as well as helping us to develop bids for national and EU funding."

Consultant and representative of family-owned firm

"The workshop was useful as it enabled to meet and exchange thoughts with the key regional academics, industry, and economic development representatives about specific strength of the East of England in the agritech sector, and how different organisations and stakeholders could fit and compliment together. It was helpful to do it in this way, rather than view the activities in competition with each other, which happens quite often. For research organisations, it is invaluable, as smart specialisation could help them to focus research efforts on an area which would make a difference economically, and will make them more successful in winning external funding, a very critical mission for research organisations. For businesses, it is invaluable to know how they can work with each other pre-competitively, and where to go of a specific academic expertise. In summary, the workshop on 7th March was very collaborative and constructive.

As a follow up activity it would be good to receive a summary of key regional opportunities and then to gather again to discuss a few very specific ones, and develop a regional action plan for achieving higher impact."

Manager, Knowledge Transfer Network



 **POLICY LINKS**
linking policy principles and practice

Institute for Manufacturing
17 Charles Babbage Road
Cambridge, CB3 0FS, UK