Agri-tech: Adding value to the food chain

Agri-Tech East

Executive summary

We now have a perfect storm where there is a clearly articulated market need for innovation within the agri-food industry and an appetite for change.

By 2030 the UK will need the equivalent of 7 million more hectares of land to support our growing population. It is estimated that with 'smart use' of land and technology we could release more benefit from existing land resources.

Agri-Tech East is positioning the east of England, the crucible of the agricultural revolution, as a leading region in identifying what 'smart use' means in the real world.

Innovation is needed, not only in the way we develop new varieties of crops that can perform well under adverse environments, but also in the way these crops are grown, harvested and processed.

For farmers and growers 'total factor productivity' is the key consideration and a sound evidence base is required for the uptake of new approaches and disruptive technologies.

This report looks at the requirements for new technology by all stages of the value chain and identifies different models for supporting innovation in the industry. It provides an evaluation of the current situation and proposes ways forward.

Agri-Tech East is already making a significant impact on the agri-food industry through its pragmatic approach and this report aims to support the next phase – fast-tracking innovation from lab to field.

Dr Belinda Clarke
Director of Agri-Tech East

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Foreword: The market opportunity

Agri-tech represents a huge market opportunity that can be summarised in three big statements:

1. There is an increasing demand for food
2. Changes in legislation mean that UK agriculture is now competing on a world stage and needs to improve its productivity
3. The "Grand Challenges" of climate change, disease and health mean that we are looking for new agricultural solutions that will build greater resilience into our crops and higher nutritional value into foods

We also have the will at all levels to revitalise the sector.

The government recognised within its 2013 Agri-Strategy that there is a need for new technologies to revolutionise agriculture and food production and it has supported the strategy with new sources of funding. This has opened the door for a new approach to innovation.

A key element of this is to create a multi-disciplinary ecosystem of individuals and organisations with different perspectives and shared goals.

Within the pharmaceutical and high-tech sectors we have seen how "open innovation" can work: companies collaborating with each other and the academic sector to define the requirements and generate new solutions.

This is where Agri-Tech East fits in. It is growing across the East of England a cluster of people with mutual interests and creating a platform where players at all stages of the food chain can articulate their needs. This openness allows entrepreneurs from other sectors to bring new ideas into the sector and will also help to fast-track innovation into agriculture and horticulture.

Agri-Tech East catalysed interest in the UK's first Agri-Tech Week, which included four events, each with a different focus.

Agri-Tech East's own conference, "REAP – Realising our Economic and Agricultural Potential", concentrated on increasing understanding between the key players. We brought together:

- growers within the Producers' Panel to articulate their needs
- academics to participate in a discussion about the need for evidence-based research
- food manufacturers to explain what they require from producers, including describing new models of interaction that can share risk
- a panel of entrepreneurs to describe the new technologies they are bringing to the industry.

Some of this discussion has been captured in this report.

If we are to meet the growing need for cost-effective, sustainable food production in a changing climate, it is imperative that we embrace new innovations. I am delighted that Agri-Tech East has set itself the challenge of facilitating this process.

Julius Joel

Managing Director of Greens of Soham
and Chair of Agri-Tech East's Stakeholder Group

Perspectives: Producers articulate their needs

To better understand the needs of producers we asked three of the region's leading farmers and growers to present their views.

Dr Ed Moorhouse

Group Technical Director of G's Fresh

G's is a family run business established in 1952 and has a turnover of £40m. It employs 5,000 people and has farms in the UK, Czech Republic, Poland and Senegal. Vegetables are grown by small specialist growers that need specialist equipment so when an innovation is introduced it immediately has a global market.

To improve profitability every single input must work harder, but increasing efficiency in production of the "ultimate fast moving consumer good" is a major challenge.

Dr Ed Moorhouse set out his priorities for research.

Top research priorities:

1. Improved mushroom production – this is a very sensitive crop; innovation would put a better product on the market.
2. Mechanisation of salad cropping – for example lettuce is currently picked by hand 24/7, and the picker has seconds to decide whether to cut or reject. It is a very labour intensive crop with high wastage. In some crops such as celery we are overcoming the problem of timing by bringing the processor into the field.
3. Better soil management – we have to work the soil 24/7 and this trashes the soil structure.
4. Water management – precision application of water would improve efficiency and crop performance. There is a need for soil mapping to evaluate moisture levels and elicit a response when levels fall.

Richard Hirst

Chairman of Anglian Pea Growers

The pea industry produces 135,000 tonnes a year and the industry hasn't changed since Birds Eye introduced fast processing on a Norfolk farm in the 1970s. Innovation and investment is required if we are to keep this crop within the rotation, according to Richard Hirst.

Key priorities:

1. Chemical alternatives – the chemicals we use are under threat, and there is a lack of precision application for peas as a non-standard tramline is used.
2. Improved sampling – there is a requirement for a better form of tenderometer. We have lost the idea of taste and need an infield organoleptic test to ensure that an AA grade crop has an AA grade taste.
3. Improved cultivation – peas are grown on a field typically one in eight years and are harvested by a 25 tonne pea harvester that does not fit the tramlines created to stop soil impaction. Thus harvesting peas can undo 8-10 years of work building up the soil structure. What are the alternatives?
4. Improved harvesting – the thrashing mechanism of the harvester means that 10-15% of every harvest is lost in the field. Improving efficiency would instantly increase yields.
5. Energy efficiency in processing – lack of investment means that the UK lags behind Holland and Belgium in energy efficiency of processing. It is currently 9-10 kW/tonne in the UK – double that of the EU. Inefficiency adds cost to production and means that opportunities for factories and jobs are being lost to the east of Europe.

Tony Bambridge

Managing Director of B&C Farming

Farmers are not slow to adopt innovation. If there is a strong evidence-base of economic benefit then they are open to new ideas. But there seems to be a missing link that identifies the science and sees how it works in the field. There is a real need for an experimental husbandry farm, or network of farms, where you could see in practice the benefits of new technology and do comparative studies of different cultivation approaches.

We also need to look at the way that agricultural research is funded. It is based on 3-4 year discrete projects that tackle a very specific topic with the aim of producing a paper. There is a need for longer-term multi-disciplinary research that looks at emerging science with economic potential and evaluates how it could be used in the field.

For example we need a greater knowledge of the soil.

Organic matter is essential for retaining moisture, nutrients and structure of the soil but the amount of humus in the soil has steadily decreased since the Second World War. This is accelerating with the increasing use of waste vegetation being used for biofuel.

Top research priorities:

1. Microbes – how important are microbes and what is their role in the soil? Are we losing beneficial microbes? Would there be benefit in a probiotic for soils?
2. Soil structure – good soil structure is vital to ensure aeration and drainage. But we often have to work the soil after adverse weather. Is there a way to increase the 'shock absorbance' of the soil? Would more humus help? What impact do the tyres and tracks of vehicles have?
3. Control of potato cyst nematode – in some fields 80% of soil is infested with potato cyst nematode. We are losing the chemicals needed to control this problem so what are the alternatives?
4. Slug control – slugs are on the increase and the species are changing and getting bigger. The chemicals used for controlling slugs are being removed so what are the alternative control strategies?

Comment

Pamela Forbes

Regional Communications Director at NFU

There is a need for more "good science" to inform government policy, particularly within initiatives such as the Water Framework Directive which would impact farmers.

There is also a need for independent applied research that can provide an economic cost benefit analysis for introducing new technologies and approaches at a farm level.

Perspectives:
Food processing and manufacture

Food is the ultimate fast-moving consumer good, and meeting the needs of consumers 24/7 with a seasonal product creates challenges.

Ian Noble, Senior Director of PepsiCo and member of the UK Agri-Tech Leadership Council

It is often overlooked that food production is the biggest industry sector in the UK and has a £72bn turnover; it is also a major employer. Pepsico for example is more than just a beverage company – its interests in the food industry also include well-known brands such as Quakers and Walkers, so sustainability in this sector is of utmost importance.

A major challenge facing food manufacturers is a disconnect between the consumer and the origins of the food that they eat.

There is an unwillingness to pay more for quality. This is seen by research into attitudes in the supermarket. When offering a consumer a product made with palm oil or a superior tasting product made with butter, there is little appreciation of how the product was grown and made, just the recognition that one costs 99p and the other £1.50.

There have been changes in attitudes; for example the campaign by celebrity chefs to promote free-range eggs means that it is now impossible to buy "battery farm" eggs, but more needs to be done.

In the crisp industry this means there is little understanding by the consumer of what it takes to produce a bag of crisps and the science and development that has gone into every last detail; such as the angstrom-thick inner lining of the bag which retains the freshness and flavour.

Sustainable food production is vital in order to ensure that wholesome and nutritious foods can be produced now and in the future.

Preparing great food and beverage products starts with the best ingredients. Ensuring these remain available needs advances in storage technologies to preserve the quality of these ingredients all year round.

Over recent years, Pepsico has been focussed on sustainability and given that much of its production process happens in the field it has been supporting developments such as Cool Farm Tools and iCrop which provide information about inputs such as water usage.

One of the biggest challenges has been that although it is a 24/7 business, potatoes can only be harvested when they are ready. This means that the company is particularly interested in varieties with good taste, high nutritional value and good storage properties, and in technologies that will enhance storage.

In addition to this there is a need to ensure that raw materials are grown in a sustainable manner. This can be achieved by discovering new advanced agronomics, and investing in technological innovation that encourages sustainability in the supply chain.

The role of evidence based research

Bill Clark

Commercial and Technology Director of NIAB

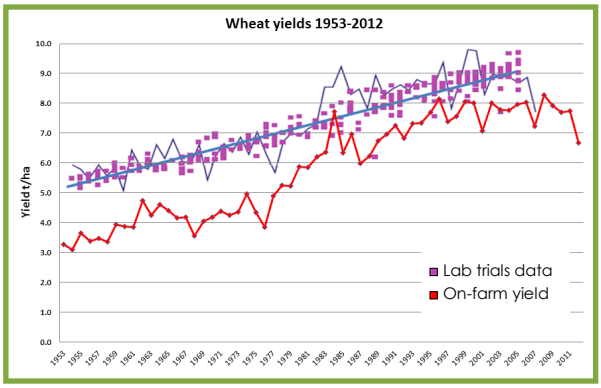
Yields of wheat under laboratory conditions have increased year on year over the last 50 years, whereas yields on-farm have plateaued for the last 20 years. The reasons for the discrepancy between on-farm and lab yields are complicated and not fully understood.

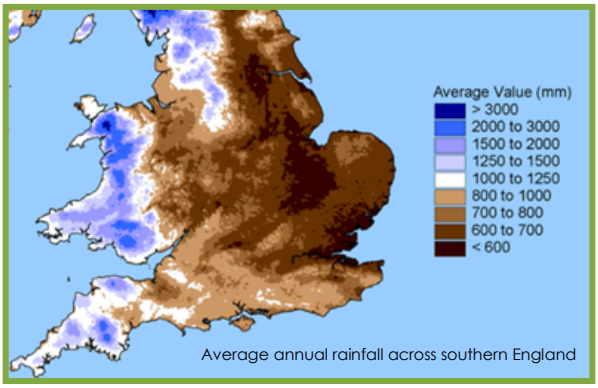
Availability of resources and on-farm conditions impact performance. For example: a wheat yielding 10 tonnes a hectare requires 500mm of water a year. However, a wheat yielding 20 tonnes needs 1,000mm of water a year. This is greater than the annual rainfall in East Anglia.

This demonstrates that although advanced research is increasing the knowledge-base there is a need for more work to translate this science into practical solutions in the field.

The supply chain is also convoluted, with many parties between the academic and the end user, so there is a role for players at all levels within the supply chain to define the parameters and targets for research to achieve results within shorter time goals. The pipeline is not broken, just fragile.

The issue for scientists is that farmers often want the solutions to last year's problems and require a rapid response. Farmers also require an integrated solution that fits within the farming system and that is economically sustainable. To obtain this type of cost-benefit analysis needs greater involvement of the end-user and improved levels of feedback.





Diagrams courtesy of NIAB

Research models: Case study 1 – Applied research supports growers

Dr Lydia Smith

Head of NIAB Innovation Farm

Where there has been an industry need for a rapid response, NIAB has been able to provide a solution. For example, it was able to develop a new variety of oilseed rape with a higher nutritional content to overcome the impact of the removal of a key chemical. The recent Hasse Fen Collaboration between NIAB and G's is a good model of how growers can gain benefit from applied research.

Research models:
Case study 2 – Collaborative research by farmers within a water catchment

Hutchinsons is an agronomy consultancy service that supports 8,000 farms in the UK. Jeremy Macklin worked for many years in France where, he explains, that as farmers work in cooperatives they are accustomed to working together and sharing data. This makes it feasible to have wide scale on-farm trials.

Jeremy Macklin
Director of Technology and Innovation for Hutchinsons

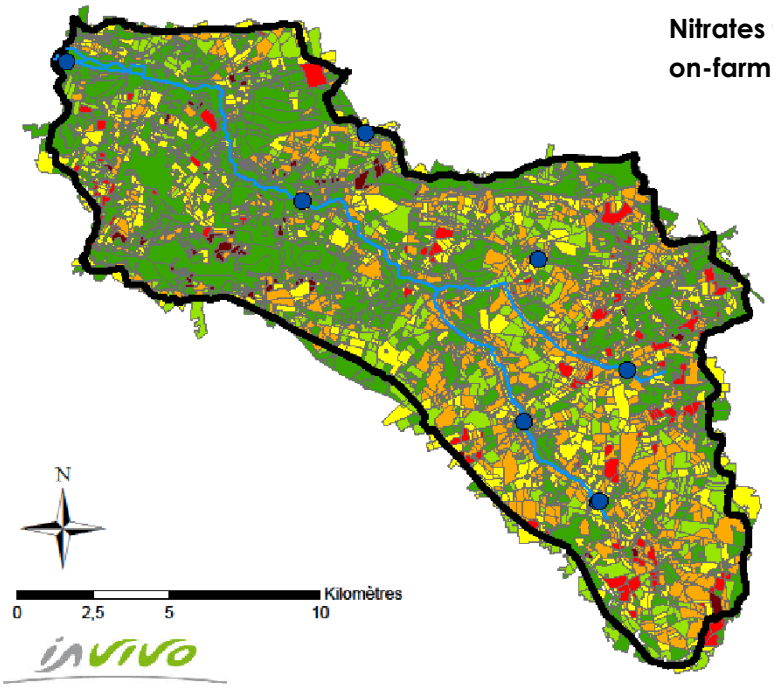
French farmers were met with a challenge in 2007 when, following the election of Nicolas Sarkozy, the French government accelerated the implementation of the EU Sustainable Use of Pesticides directive, to satisfy electoral pledges made to the Green party. This included a commitment to reduce pesticide usage by 50%, if possible, before 2018.

To address this challenge, four leading agricultural organisations – INRA, Arvalis, Cetiom and InVivo – established a demonstration trial using representative farms from different regions of France to see how it would be possible to reduce environmental impact while retaining good economic performance.

The studies were looking at three indicators: volumes of inputs; environmental impact and economic performance.

The studies focussed on water pollution, measuring both pesticides and nitrates, which provide an indication of wasted inputs of agrochemicals and fertilisers; on gas emissions from the field and production processes; and two indicators of biodiversity, pollinators and butterflies.

InVivo also deployed a food availability model for honey bees, which analyses the different nectar and pollen sources based on analysis of the flora in a 2km area around the hive.



Nitrates found in water at l'Orvanne, Dormelles: on-farm trial covering water catchment

- Catchments

Amount of nitrates

- less that 35 mg/l
- 35–50 mg/l
- 50–75 mg/l
- 75–100 mg/l
- 100–125 mg/l
- more than 125 mg/l

Diagram courtesy of Hutchinsons

The benefit of the French cooperative system meant that it was possible to study an entire water catchment. In all there were four networks of 43 farms, representing 1,700 hectares of winter wheat.

The study showed that the fields with the lowest levels of pesticide pollution in water had gross margins up 6% vs the average; those with the lowest levels of nitrate pollution in water were at the same levels of gross margin, and those with the lowest greenhouse gas emissions gave an 18% uplift in gross margin vs the average.

This demonstrates that it is possible to achieve lower environmental impacts and retain performance.

Importantly, the use of the models would also allow predictive recommendations for the farmers to further reduce any environmental pollution of agronomic practices. For example, advice on crop use on particular fields or use of intermediate crops.

Bee threat

A further study provided useful insights into beekeeping. Beekeepers are concerned about the use of neonicotinoids, systemic pesticides which have been connected to the decline in bee populations.

A local beekeeper was particularly vocal about the impact of this pesticide use on his bees. Bees travel up to 2km from the hive to find food, so the study looked at availability of nectar within a 2km circumference. It revealed that there was insufficient food available for the hive during the spring so recommended feeding the bees to supplement their foraging. This provided evidence that the impact on bees is multifactorial.

Lessons for the UK

Hutchinsons is now working to modify the French models so that they are validated for use in the UK. This activity has received support from Innovate UK. In parallel with this the company is training its agronomists to implement the models.

The advantage that this type of study has in France is that 75% of farms are already working in cooperatives. The nearest equivalent in the UK is the National Farmers Union Yield Enhancement Network which allows farmers to benchmark their results against other farms.

There is also a different approach to data collection and sharing. Data in France is shared if data from the individual farms is not identifiable.

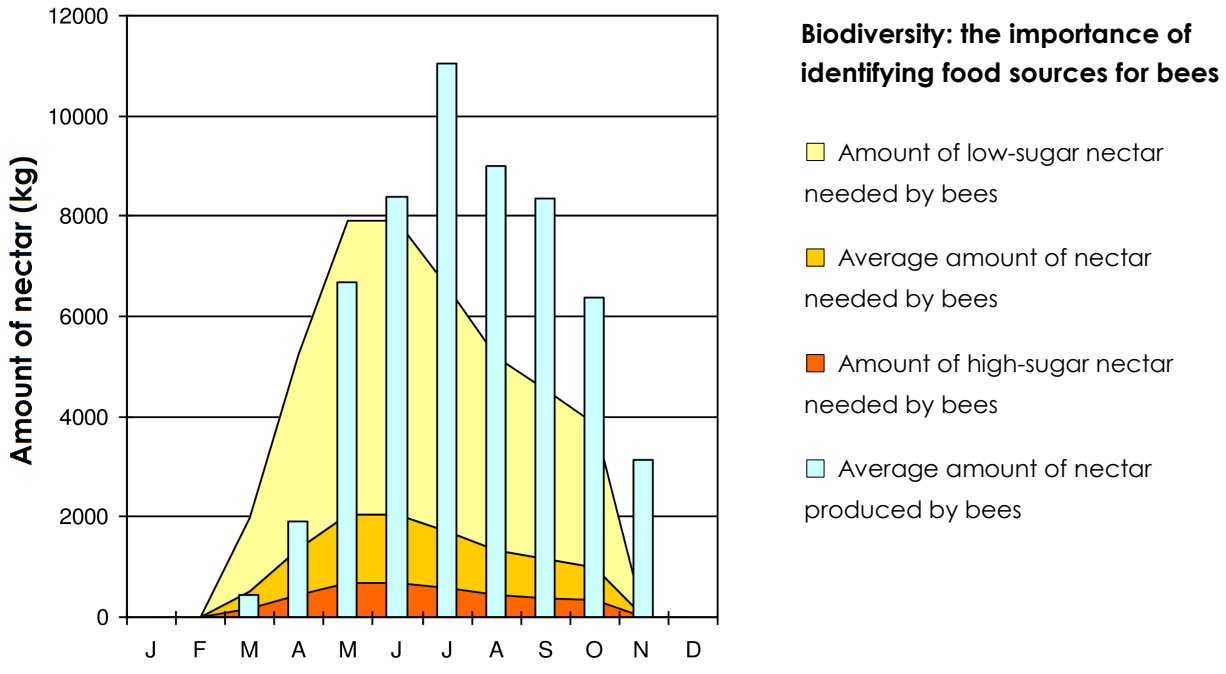


Diagram courtesy of Hutchinsons

Research models:
Case study 3 – Industry-led research

Greater involvement of all policies in the value chain can improve resilience, explains Richard Burkinshaw of Kellogg's.

Richard Burkinshaw

European Environmental Strategy Manager at Kellogg's

Kellogg's sources locally and the two UK factories use 100% British wheat. Traditionally Kellogg's only worked with the millers, but now it is keen to connect with all stages of production, including the farmers.

This is partly driven by the desire to build resilience in the supply chain and partly by increasing interest from consumers about quality and where and how their food is produced.

Consumer demand is interesting as there is a disconnect with what they say and what they buy. According to research by Manchester University consumers purchase on the basis of quality, taste and price. Although consumers say they are concerned about sustainability they won't pay extra for this.

To get closer to the farmers, Kellogg's has established a group of 16 volunteer farms with a combined 30,000 hectares. Feedback from these farmers suggest that they most want help in a number of areas.

Research priorities:

1. Soil and soil biology
2. Blackgrass management and control
3. Management of microtoxins that reduce the quality of the premium grades of wheat
4. Common Agricultural Policy greening legislation

There is a need to translate research into practical advice and demonstrate the business-case through improved efficiency. Improving resource efficiency will in time help us to meet the targets for carbon reduction but reducing climate change will not be the driver for farmers.

For example there is much debate over use of cover crops. But a farmer must be confident of the benefits before investing the time and cost in taking this option. Kellogg's believes that the best way to communicate best practice is to get the farmer to tell the story. Learning from another's experience and being sure it is 'roughly the right advice' is sufficient.

Kellogg's is working with NIAB and is also part of Game and Wildlife Conservation Trust's Allerton Project farm at Loddington in Leicestershire, where they are trialling alternative cultivation techniques. For example by using beetle banks to reduce pests they have not needed to spray aphids for 22 years.

Agri-tech is at the centre of Kellogg's' strategy, which is investing to increase innovation through the whole value chain. 99% of Kellogg's products are grown, not made, so current developments are aligned to the founder's core values of growing healthy, nutritious food in a more sustainable way.

Healthy nutritious food

In 1906 William Kellogg was looking for an alternative to egg and ham for breakfast and had been experimenting with a corn mush. This wasn't very palatable so he abandoned the project. When he looked at it again the mush had dried in the sun and become crispy and more tasty – the corn flake was born. The grain was grown on his brother's farm and is now an international operation delivering 10 billion portions of cereal a year. 200 bowls of cereal are produced by a hectare of wheat.

Creating an entrepreneurial culture

The industry needs new ideas and approaches. Encouraging growers to invest in research and development will fast-track innovation.

William Kendall

Entrepreneur

There is an opportunity to introduce a greater entrepreneurial spirit into farming. For too long it has depended on subsidies and has lost touch with its customers, both within the value chain and the consumer.

Good management of productive land now holds the solution to the two most important issues facing mankind – feeding nine billion people, and cleaning up the millions of tonnes of surplus greenhouse gasses in the atmosphere.

A different mindset is required to achieve change. Unlike small start-up companies, which will spend a high proportion of their turnover on R&D to get ahead, a farmer doing well will buy more land and continue to do exactly the same practices on that.

We need to encourage new thinking into the industry and show the big farmers and growers that investment in other areas can add value to their operations and create new types of business.

There are now incentives for new players to provide new approaches and technologies. This includes a number of tax incentives and a growing culture of entrepreneurialism in the UK. Cambridge in particular has been one of the leading areas for new businesses and innovative enterprise.

Also, our tolerance to failure has increased which is vital for a vibrant entrepreneurial culture. Greater improvements could be made if more notice was taken of when things don't go so well, and learning from the experience.

For example New Covent Garden Food was a success in the UK but failed when it was taken to the USA. Just because something seems like a good idea does not guarantee that it will be successful. However this should be the springboard for better business concepts.

The Wheatsheaf Group, which is part of Grosvenor Estates, is not buying up land, but is instead more interested in the latest technologies, which will make the land and seas more productive.

This includes looking at investment in food security, especially new ways to generate protein. There are also opportunities to extract more value from waste through biotechnology. One example is a company that uses potatoes and generates a huge supply of potato peelings; this creates an opportunity for a raw material for another application.

At present, much of new innovation that the Wheatsheaf Group sees comes from outside the EU. This is disappointing for investors and entrepreneurs, particularly considering the amazing resources that are available in the east of England.

Agri-tech requires good ideas from all parties and there is an urgent need to encourage a new way of thinking in a sector which, for far too long, has assumed that somebody else is doing all the clever stuff.

A life in food

William Kendall loves new business. Enterprise is hugely important in his life, changing the world in tiny little slices with well-chosen business ideas.

Brought up on a farm in Bedfordshire, his passion for natural products and quality ingredients has led William to grow two well-known brands: the chocolate company Green & Blacks and the fresh soup company New Covent Garden Food Co – which went from a loss-making concern with £2m sales to an iconic brand turning over in excess of £20m under William's guidance. He's now going for a third success with up-and-coming drinks brand Cawston Press.

Recommendations and priorities

A number of common themes are emerging from discussions, these include:

Industry driven varietal development

New varieties are important but increased yield is only one element of this. Resilience during poor weather conditions and to disease is also vital to de-risk the industry. All parts of the food chain from grower to end-user need to have involvement in the adoption of new varieties. There is a role for testing on-farm and with millers etc. and feeding this information back to breeders. Quality and taste are also important and there is a need for new ways of measuring this in the field.

New strategies for improving resistance to disease

There is concern across the industry about the removal of chemicals. New approaches are required to improve and replenish the armoury, not just with new chemicals but also cultivation techniques. There is a role for 'model farms' to provide cost-benefit analysis of the strategies to enable informed decisions. In addition, there is a need to 'unlock the science' and explore existing knowledge that may yield new solutions when viewed from a fresh perspective.

Collaboration along the whole chain

Sharing of risk and open innovation where players from different parts of the value chain collaborate on projects would fast-track innovation and ensure it is directed at real industry need.

Implementation of precision agriculture to reduce inputs

Applied research and farm trials are needed to create a sound cost-benefit analysis for new technology. There is a risk that new technologies will not be farm-centric and that a lack of standards will mean incompatibility between devices. Entrepreneurs developing these technologies need a greater knowledge of what information is useful to producers and others in the value chain.

Improved knowledge of soil biology in a way that is deployable on the farm

Soil biology and ways of maintaining soil performance when it is worked 24/7 was highlighted as a key opportunity for improving productivity. The perception is that improving the vitality of the soil would increase its resilience and crop performance.

Better use of research and its translation into the field

There is a perception that existing investment in science could be better deployed. Knowledge-mining of scientific papers might yield results in the short-term, as fresh opportunities are being provided by new technologies that have been developed since the research was done.

L-R: Ian Noble, Julius Joel, Jeremy Macklin, Belinda Clarke, Richard Burkinshaw

Response from Agri-Tech East

Dr Belinda Clarke

Director of Agri-Tech East

Agri-Tech East's role is to catalyse innovation within the agri-food industry by creating a cluster of individuals and organisations with the right combinations of skills and experiences to seize the opportunities that are presented.

Here are some of the initiatives we are facilitating:

1. **Special Interest Groups**

   We have set up Special Interest Groups in the areas highlighted as being of greatest value:

   - Soil
   - Water for Agriculture
   - Remote Sensing and Monitoring
   - Big Data
   - Field Phenotyping

   The co-chairs for each SIG have different perspectives to ensure a multi-disciplinary approach. Already these SIGs are creating connections that are leading to collaborative projects and offers of field trials. Identifying a network of farmers prepared to trial new technologies is creating an opportunity to develop a real world test bed. This will provide the types of cost-benefit analysis that is being sought by farmers.

   The opportunity to meet the end-users is also invaluable for entrepreneurs coming from other backgrounds and industries, allowing technologies to be 'ground truthed' and new opportunities to be explored.

The first Remote Sensing and Monitoring SIG

2. **Translation of research into the field**

   The Pollinator meetings are an opportunity for researchers to meet producers and other players in the value chain and to improve understanding. There are opportunities for new models for research directed more closely by the needs of the users. This requires the needs to be clearly articulated and proposals for support and funding to be written by those with expertise in this area.

   There are new sources of funding available for this applied research and Agri-Tech East is signposting existing finance and facilitating the development of consortia to pitch for it.

3. **Encouragement of new approaches and technologies**

   By creating opportunities for non-traditional players to learn about the industry Agri-Tech East is encouraging new thinking. It has launched GROW, the first national agri-tech business plan competition, to provide support for new business ideas and concepts, and this is supported by Angels, mentors and potential investors.

4. **International perspectives**

   Agri-tech is an international market, with many of the producer groups having interests overseas, and the research centres are world-leading.

   Agri-Tech East works at the highest levels of government including UKTI to ensure that innovation in the east of England is well represented. This includes speaker opportunities on an international stage and support for delegations.

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