REAP CONFERENCE 2020:
From micro- scape to landscape –
Innovating at the frontier
INTRODUCTION: Innovating at the frontier

John Barrett, Director of Sentry Ltd and Chair of the Agri-TechE Stakeholder Group

The REAP 2020 conference brought together innovative thinkers from different disciplines to look at agricultural production from the perspective of a system that is an integral part of the natural environment.

A new era of decision support tools is making it possible to understand the complexity of food production for the first time and to begin to see how the system can be improved at every level to provide both incremental improvements and disruptive change.

Speakers discussed emerging agri-tech, the learning points gained from technologies already deployed on-farm, and the requirements for managing this complexity to move us closer towards a future that is productive, profitable and sustainable.

This report aims to provide a flavour of the discussions from REAP 2020 and to capture some of the excitement of the Agri-TechE innovation ecosystem.

Virtual experience: REAP was hosted virtually for the first time in 2020, using an interactive platform to provide scheduled video content, livestreamed presentations, group discussions and AI-enabled brokerage to link guests for discussions.
When the concept of ‘One Agriculture’ was presented at REAP 2019, the idea was to stimulate thinking about the dynamic between the natural and cultivated environment as an integrated system, with nutrients cycling between the different functions, and where change in one aspect creates an effect on other elements in the system.

Often the focus is on a particular crop, herd or specific field, but only by seeing production as part of the land management strategy for the whole farm, and within the context of the commercial constraints for the sector, can disruptive change occur.

As our understanding grows of the interactions between components of such a system, so does the need for technologies and tools to help interpret this into actions.

Over recent years we have seen the unintended environmental consequences of practices that were seen as transformative and beneficial when they were first introduced.

The future challenge is in identifying where interventions in the system will provide maximum benefit, and also to reduce risk for farmers when making a transition to a more sustainable approach. It can be hard for non-farmers to appreciate the amount of risk, innovation and financial commitment that is happening on-farm and the challenges faced from climate change and differing societal views on the consumption of food and use of land.

And of the many, many daily decisions to be made on-farm, ‘are my practices the best for my farm?’ is a major one.

REAP 2020 showed how much has already been achieved – the data is becoming available to provide this type of decision support, and so are the tools – but also how far there is still to go if we are to move the industry towards a more sustainable future.

*From micro-scape to landscape*

Agri-tech innovation is enabling a greater understanding of the interdependence between variables on every level – from the microbes in the soil to global weather patterns.
GROWING A REVOLUTION: Regenerative agriculture has potential to restore soil health

Chaired by Susannah Bolton, Knowledge Exchange Director, AHDB

David Montgomery, MacArthur Fellow and Professor of Geomorphology at the University of Washington, has travelled the world observing soil degradation and interviewing farmers who are restoring soil health.

Soil degradation is happening at an unprecedented rate; not just erosion, but also loss of organic matter fed on by the microbes that drive the nutrient cycle – the stuff of life itself.

The microbiome has parallels to the microbes in the human gut. Microbes make nutrients such as phosphorus more available to the plants and create growth-promoting hormones that are taken up by the plant roots. In return the plants create an exudate of carbohydrates, proteins and fats through their roots, which feeds the rhizosphere.

Restoring this living community is key to converting degraded earth into fertile soil.

Among farmers who have successfully made the transition to regenerative agriculture there are three common practices:

- **Minimum tillage** – reducing soil disturbance helps the microbial community to flourish.
- **Ground cover** – ensuring that there is vegetation at all times locks the nutrients into the soil and protects the surface from being eroded.
- **Diverse crop rotation** – variety provides a rich microbial mix and avoids over-extraction of nutrition from the soil.

Farmers practicing regenerative agriculture require fewer fertilisers and pesticides and gain up to 60% higher profits than conventional farmers on similar land.

The move to regenerative agriculture will take several years and it is important where you start in the rotation, for example legumes are a good crop to begin with. The change can be measured by analysing the carbon content but it is also visual, with the soil becoming deeper in colour, and the worms will come back.

Although education is important, one of the most important factors is the lived experience of farmers: looking over the gate and seeing the benefits is most likely to encourage a neighbour to adopt the same practices.

Image supplied by David Montgomery
Accurate prediction and forecasting have the potential to radically improve productivity, removing the guesswork and reducing waste in the value chain. Three technologists from **Outfield** (precision fruit farming), **Arable Labs** (decision agriculture) and **Breedr** (precision livestock production), together with their farmer collaborators, discuss the introduction of technology, the benefits achieved and the learning points.

**AUTOMATION AND PRECISION IN THE ORCHARD**

Automating time consuming manual tasks is a key objective in fruit and vegetable production, but decision support tools can bring other benefits.

Outfield is an orchard management platform that provides growers with yield estimates for fruit based on drone imagery. Growers are set up with their own low cost, off-the-shelf drone systems, and Outfield supports them to autonomously capture pictures of the orchard.

There can be a three-fold difference between fruit production on neighbouring trees in an orchard of 5,000 trees.

For Tom the technology needs a clear return on investment. “We take huge pride in what we do. It is a highly competitive industry and a major challenge is labour. Technology that can help with automation will take us forward.

“You've got to be clear up front – it is a time/reward exercise. You need to work out if the benefit of the product justifies the time input. What really excites me is not the drone, but the level of data processing and information it provides.”

The Outfield system counts the fruit but it can also assess the quality, size and colour. “I can see potential in the future to use information from Outfield to treat each tree separately,” says Tom, “selectively spraying when there is a need.”

achulmesons.co.uk  outfield.xyz
PREDICTION AND TIMING IN THE VINEYARD

Timing of operations can increase the effectiveness of plant protection products and reduce waste.

Arable, based in California, has developed a portable weather station, Arable Mark 2, which provides localised weather and plant health status in real time via a mobile phone. Adam Wolf, Chief Scientist at Arable, presented with his client Will Drayton, Director of Technical Viticulture and Research Winemaking at Treasury Wine Estates (Australia).

Keith Norman asked: “How did you know Will was the right partner to develop the technology?”

Adam says: “Will saw potential for the Arable system to support more precise in-field decisions by providing accurate frost prediction and precise forecasts for timing spraying and irrigation during the day. He was also interested in yield forecasts. He also made the point that he needs tools that his 3,000 employees are prepared to adopt.”

Will says: “The key thing is to focus. There are so many different possibilities with data collection systems but it is better to have one that works really well – it is like the difference between a Swiss Army knife and a single, sharp blade.

“The produce needs to be intuitive and useful as what I really need is reliable prediction of spray weather. Spraying too late or too early wastes money and reduces the efficiency of the spray. Knowing the exact hour to spray can have a major impact.”

Adam has been able to apply this input to other aspects of the product and is working with NIAB to develop a water model for timing application for potatoes – “when to pull back from water is key to the yield.” In the UK Arable has partnered with xarvio to combine its hyper-local crop and weather data with xarvio’s powerful crop production optimisation to support more precise in-field decisions.

tweglobal.com  arable.com
Digitising livestock production increases transparency in value chains.

For the last two years livestock farmer Doug Dear, Partner of AS & EA Dear & Son at Osgodby Grange near Selby, has been working with Ian Wheal, CEO of Breedr, an early-stage company that is developing a precision livestock app and online trading network.

Data about each animal is recorded within the app and used to predict a point of peak profit. Digitising livestock production enables the sharing of data across the value chain, which can be used to improve productivity and drive up profitability.

Doug runs a custom contract beef finishing business that supports around 28 customers at once from across the UK. The model is unusual, as the farmer retains ownership of the cattle. Doug has a good relationship with the processors and produces high quality meat to a variety of deadweight specifications.

Keith Norman asked: “Ian is a farmer in his own right – what did working with Doug achieve?”

Ian says: “The danger of being a technologist is that you can get excited about the potential and not keep checking it works for the farmer. It is only by working closely with farmers such as Doug that we have been able to develop an app that is easy to use and provides the tools they need for decision support.”

Doug explains: “Basically we needed a product that is simple, with about five or six things on the home screen with filters for breed, age, days on farm, and which ‘talks’ to the products we already have. It also needs to be reliable and fat finger friendly!

“Ian’s got a million ideas in his head but you need to get the basics working, such as needing the age of the cattle in months and days. For example, I can now look in Breedr and know I have a Belgium blue heifer that’s been on the farm 100 days and is putting on 1.4kg a day, so it’s ready to move on. It’s helpful being able to have that overview, or a quick reminder whenever I want it.

“Better prediction of the optimum weight is also more environmentally efficient. Younger cattle are more efficient at feed conversion, so if I can get cattle through the system more efficiently and off to the abattoir, that’s fewer days they are putting out emissions. The predictive weight is done by Breedr’s AI system, and the more you put in the better it gets; that’s the clever stuff.

“We started working with Breedr when it started, and have gradually moved forwards with the company, helping it to develop the product.

“I am thinking we are now where we want to be and it’s working well on the farm – just a tweak or two more and it’ll be bang on!”

breedr.co
THE FARMER-TECHNOLOGIST SESSION LEARNING POINTS

- Customer knowledge is vital - working closely with farmers will show how and where the technology adds value.
- Simplicity: do a few things well and build on this.
- Need an evidence-base that includes the business case for adoption of technology.
- Farmers value being able to extract knowledge from their own data.
- Manage expectations, don't overpromise.
- Farmers need support to transition to new systems - especially for livestock where a whole herd approach is required.
- Every farm is different, but a bespoke approach is not a sound business model. An alternative is to have a solution that can be customised by switching features on and off.

The farmer-tech session discussion panel:
Keith Norman, Keith Norman Consultancy;
Ian Wheal, Breedr; Doug Dear, AS & EA Dear & Son;
Tom Hulme, A.C. Hulme & Sons;
Adam Wolf, Arable; Jim McDougall, Outfield.
START-UP SHOWCASE: **The new generation**

**Chaired by Nicole Sadd, CEO of Rothamsted Enterprises**

*The REAP Start-Up Showcase is a much-anticipated highlight, having previously helped to launch many agri-tech innovations that address real world challenges.*

**PHEROSYN: Precision spraying**

In bad years the UK has lost one million tonnes of grain to midge pests, and the most effective treatment, Chlorpyrifos, was banned for use in 2016. To enable precision spraying for the orange wheat blossom midge (OWBM), start-up PheroSyn has developed a cost-effective smart monitoring system using the insect’s own communication channel: pheromones.

“Midges such as OWBM use pheromones to communicate and find a mate over long distances,” says Dan Bahia, co-founder and Business Manager at PheroSyn. “Our company aims to manufacture these natural high-value pheromones and then supply them into the agribusiness sector.”

The pheromone is loaded into a slow-release mechanism, housed in a prism of card with a sticky inner surface. By surrounding the crop with just a few of these traps, the grower can easily determine whether pest control is necessary and, if so, when will be the most effective time to make the application.

With increased temperatures being seen in the UK over the past decades, pest outbreaks are becoming increasingly unpredictable: “We’re looking to make pesticide use smarter in crop protection, for safer, greener and cost-effective insect pest management that is crucially also climate-friendly,” says Dan, who was previously part of the Smart Crop Protection team at Rothamsted Research.

[pherosyn.com](http://pherosyn.com)
BEESECURE: Improving the wellbeing of bees

By tapping into vibrations in the hive, agri-tech start-up BeeSecure is able to listen into conversations to ensure the bees are happy, healthy and performing well. **Roberto Pasi, co-founder of BeeSecure**, says the company can understand ten main topics and use this knowledge to quickly identify issues.

“There has been a massive loss of bees in recent years,” says Roberto. “No one really knows the reason for this and there has been little technology to support beekeepers.”

BeeSecure’s new product is changing the way bee services are rented on-farm. By providing a ‘high-performance pollination service’ well-kept bees are able to significantly boost yields of insect pollinated crops.

BeeSecure uses IoT devices such as sensors to monitor the temperature, humidity and sound.

“We have a little microphone that is able to translate vibration within the bee hive,” Roberto explains. “At the moment we can understand the ten most important topics, from ‘the Queen is dead’ to ‘there are not enough flowers nearby’ and this is sufficient to determine a problem with the hive and understand the size of the colony.

“Additionally, bees maintain a constant temperature of 35°C; if that suddenly changes that is a real alarm that something is wrong.”

Hive theft is an increasing problem for beekeepers so BeeSecure also contains a GPS tracker, which provides an alert if the hive is moved. Data from the hives can be viewed in real-time by the farmer and keeper via a secure app.

BeeSecure, based in Italy, supports thousands of beehives across mainland Europe. It is part of the EIT Food Accelerator Programme and has just started working with beekeeper associations and farmers in the UK.

**Beesecure’s co-founders:**
CEO Roberto Pasi and CTO Gabriele Garavini

**beesecure.app**
MANTLE LABS:
Risk assessment and crop monitoring

There was a big drop in the oilseed rape acreage in 2020: 28% less than initial government estimates. However, one start-up picked this up early and flagged the issue to its clients. That start-up was Mantle Labs, a leading remote sensing analytics company, which has developed a revolutionary AI algorithm called Helios for ‘seeing through clouds’, increasing the accuracy of satellite imagery for risk assessment and crop monitoring.

Jon Pierre, Chief Business Officer of Mantle Labs, was an agricultural commodities trader for ten years, and saw the potential to improve prediction of yield and management of risk using satellite data – but the issue was clouds in the imagery. He says: “We saw the opportunity to offer a world view of global agriculture with our Geobotanics crop monitoring platform, which mixes data from multiple satellites to provide a daily update with zero interference from clouds.”

One application is risk assessment, continues Jon: “Banks in India have to lend about 18% of their loan book to agriculture and farmers, but there are 100 million smaller farmers in India with no financial records. The team at Mantle Labs have used historical satellite data and AI to analyse land use and provide risk management tools which were previously unavailable.”

Mantle Labs is currently working across the entire agri-food value chain to improve forecasting and risk assessment.

Leading growers in the UK and overseas are using Geobotanics for precision agriculture to understand variability across the field and appropriately apply inputs – fertiliser, plant protection, water. This creates a field-level profitability analysis and would enable decision making about future strategy.

Other users of the platform, such as food retailers, crop input providers, banks and insurers, want a more macro view to understand trends and impacts, such as drought impact analysis and global crop performance monitoring. The platform also provides an index for credit risk and insurance pricing, underwriting to claim probability.

Retailers source produce worldwide, and use a dashboard to quickly see issues, such as drought or flooding and forecast production,” Jon says.

mantle-labs.com
WILLAND GROUP: Controlled environment livestock facility

An innovative inflatable livestock production facility that offers the optimum conditions for animal wellbeing and productivity was announced by Daniel Larn, Managing Director of Willand Group. The Willand Intelligent Livestock System (WIL System) can be installed and fitted-out within weeks and offers the potential for methane and carbon capture to enable the industry to meet its Net Zero targets profitably.

Daniel explains: “The demand for meat is increasing internationally but the Middle East and Africa are environmentally unsuitable for intensive production.

“Happy animals are the most productive and we saw the opportunity for ‘sensitive intensification’: a climate-controlled environment that would offer the animals space and protection from pests and harsh conditions.

“If we can scale production then the units would also be suitable for temperate countries, offering benefits from standardising conditions and reducing greenhouse gas emissions.”

The WIL System – which resembles the inflatable structures used for many years to provide undercover sports facilities – can be installed quickly on a green field site. Fresh air is drawn in to maintain the pressure and stale air extracted and scrubbed to remove water, carbon dioxide and methane.

Daniel has been consulting with meat processors that have networks of suppliers. They see the potential to mass produce the livestock facility to lower the cost for farmers and support standardisation of the meat product.

willandgroup.com
A plant-based alternative to micro plastics is being developed by agri-tech start-up Xampla. The company is currently making edible plastics but sees a bigger opportunity in creating biodegradable products from non-food crops and waste streams.

Simon Hombersley, founder of Xampla, says plant-based plastics are a significant opportunity for growers: “Major plastic manufacturers, such as BASF, and packagers, such as Unilever, have pledged to replace or reduce their use of fossil fuel feedstocks in single-use plastics, but the outstanding question remains: where is that alternative feedstock going to come from?”

Xampla’s first order for a microcapsule application has just been produced in its Cambridge facility.

Hombersley explains: “We are currently using pea protein powder to create nutritional microcapsules and we are interested in talking to farmers and the wider supply chain about sources of pea and other protein.”

“I see a dramatic improvement in the revenue available from legumes, peas that might be rejected for human consumption. We’re also transitioning towards extracting plant proteins from agricultural waste and by-products. We have a project underway with NIAB, looking at the routes for extracting usable protein from waste biomass and valorising that part of the chain.”

xampla.com
The drivers for diversification are intensifying but how do you weigh up all the options? The Land App is an easy-to-use digital mapping platform that enables land managers to benefit from new agri-environmental schemes, connect with Natural Capital investors and design integrated estate plans that support best practice.

Tim Hopkin, founder of The Land App, began the company in 2015 out of personal frustration when he struggled to save the family farm. “Our main objective with The Land App is to support the development of the natural capital market and the transition to agri-environmental schemes by enabling improved decision-making. The platform enables the land management sector to work collaboratively and transfer land data more effectively.”

The Land App supports land managers in designing integrated estate plans that support diversification.

The software platform enables users to pull in data such as boundaries, registry titles, Ordnance Survey data and Defra designations, and to build projects and schemes that support diversification by including farming and environmental activities, energy generation and alternative land uses. The platform is collaborative, allowing consultants and land managers to work together in real time to deduce the most effective use of the land assets.

The Land App now has 1.2 million hectares of farmland represented within the platform and has contracts with Strutt and Parker, Savills and the majority of the regional and local land agents.
ANTOBOT: Agri-robots twice the ‘brain’ power in a third of the size

Smaller, faster, cheaper and more durable intelligent mobile robots will be possible with Antobot Ltd technology, which offers twice the ‘brain’ power of commercially available mobile robots in a third of the size.

The robotics technology company has teams in Cambridge, UK and China, focused on the development of control hardware and software for intelligent mobile robots.

Howard Wu, founder of Antobot, explains: “Our first commercial product will be a highly compact four-wheel-drive scouting robot capable of counting fruits and determining fruit ripeness and size, whilst also mapping fruiting locations in three dimensions to allow picking at a later stage.

“Small ground-based machines are able to fit into narrow spaces between plants to map fruit location in detail, and being light also prevents soil compaction. But the challenge of building very small robots is the requirement for a smaller control unit.

“Our universal Robot Control Unit (uRCU®) achieves twice as much ‘brain’ power as the current market leading mobile robot company, despite being just one-third the size,” says Wu. “We also offer our uRCU to other robotics companies, to accelerate their robotics application development.”

The product is based on two core software packages: AntMove™, a GPS- and Lidar-based autonomous driving software, and AntVision™, a total fruit monitoring software built on intelligent computer vision guided by Deep Neural Network. AntVision can count fruits or determine fruit ripeness and size, whilst also mapping fruiting locations in three dimensions to allow automated fruit picking.

The company has designed a unique thermal management system, which has allowed Antobot to combine traditionally stand-alone sensors onto a single board. The company is also filing patents in functional safety mechanisms, to ensure a safer operation in the field.

antobot.co.uk
**EMERGING AGRI-TECH:**

**Come into the lab**

What do a tube of Deep Heat, a bar code, a Rubik’s cube and some PVA glue have in common? These – and other – everyday objects were used by leading scientists to highlight the inspiration behind, and application of, their work to farmers and growers, exploring the discovery science that is evolving for commercial use.

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**Soil glue: a microbial perspective**

*Tom Wilkes, University of Hertfordshire*

Microscopic fungi provide the glue that helps to improve soil aggregates; a better understanding of the role of glomulins, the soil glue, could provide insights into improving soil resilience and structure, as well as reduce soil erosion.

“In zero tillage systems, macroaggregates created by the glomulin glue are present in greater abundance which makes the soil nutrient ecosystem more stable, dramatically reducing wind and rain erosion.

“By comparison, conventional till may break up these macroaggregates which leads to a more powdery soil susceptible to erosion and loss of nutrient content.”

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**Balancing the conflicting demands on farmers and farming systems**

*Jonathan Storkey, Principal Research Scientist – Agroecology, at Rothamsted Research*

Jonathan is a plant ecologist working on agricultural systems that reconcile crop production with the provision of ecosystem services and the conservation of biodiversity. He describes the difficulty of balancing current economic profitability against ecosystem health and function as “like trying to solve a Rubik’s Cube by focussing on just one colour.

“Life used to be simple: farmers were paid to grow food. Now they are also expected to store carbon and deliver biodiversity all against the background of an ever-depleting armoury of chemical crop protection products. At Rothamsted we are investigating a systems-based approach that integrates technology with nature, and could provide a strategy going forward.”

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WheatsApp: An AI app for plant disease detection

*Megan Long, John Innes Centre*

Scoring plants for diseases such as rust is time-consuming and needs the eye of a trained pathologist. Megan is investigating how machine learning could be used to score images taken on a phone. This app would enable farmers to identify pathogens quickly in the field.

“The model was trained on 20,000 images of wheat leaves with one of four diseases, before being tested on a never-before seen set of images – the model was found to be able to identify these images with an accuracy of 97% and, in a head-to-head test, performed better than five professional human pathologists.”

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**A smelly approach to crop protection**

*Joe Roberts, Lecturer in Entomology and Integrated Pest Management, Harper Adams University*

Plants’ natural defence mechanisms could be used to kill pests such as peach-potato aphids that are resistant to pyrethroids. For example, orange oil is an aromatic that has been shown to interfere with the basic metabolic, biochemical and physiological functions of insects.

“Crop losses in the UK due to aphids have worsened, and existing chemicals used to control the pests are increasingly unavailable. Neem, a biopesticide grown in the UK, could provide a new mode of control against the pest.”

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**Strawberries, robots and supply chains**

*Simon Pearson, Director of Lincoln Institute for Agri-Food Technology (LIAT)*

Advances in machine vision and soft robotics – to enable the grasping of fruit – are bringing agri-robotics closer to a commercial reality. The COVID-19 crisis has accelerated the labour challenges for the agricultural industry and this has generated interest and a sense of urgency for new methods of automating agricultural processes.

“The strawberry, although it is a humble fruit, a delicious fruit, is actually one of the most significant challenges in agri-robotics, and we believe if we solve the strawberry problem we can unlock robotic opportunities across many crops in agriculture and horticulture in the UK and globally.”
Soils - dirt with life in it!

*Alex Dumbrell, School of Biological Sciences, University of Essex*

Soil only becomes functional when it has microbial life, and analysis of the microbiome could provide insights into which order should crops be rotated to get the best outcome. New forensic technologies such as DNA Barcoding offer unprecedented insights into the fungi and bacterial communities that have such a huge impact on crop growth and yield.

“We are working on the capacity to quickly analyse a soil sample and reconstruct the entire network of biodiversity within that soil, which would allow us to recommend which plants will grow well in the soil, and what ameliorations need to be made in order to allow other plants to grow optimally.”

### 60 more harvests?

*Daniel Evans, Cranfield Soil and Agrifood Institute*

Headlines suggest the world's topsoil could be gone in 60 years, but does the evidence support these claims? For the first time, a global study has assessed soil lifespans, revealing the urgency needed to combat soil thinning. While most soils are thinning, some soil conservation practices are bucking the trend, including: use of cover crops, cultivating across the slopes, terracing, grassland and minimum tillage.

Daniel explains: “The formation of topsoil is a long and slow process, at a rate of a few millimetres each century, but the erosion process can happen quickly.

“Worryingly, 16% of soils in the study have a lifespan of less than one century. However, practices such as conversion of cropland to forest or pasture can give a big boost to that topsoil. As a result of these practices, over half of the soils in the study were predicted to have lifespans of over 5,000 years.”
Air-seq: using DNA sequencing to provide early warning of airborne crop disease

Richard Leggett, Group Leader of the Technology Algorithms Group, Earlham Institute

Airborne crop diseases are responsible for devastating loss of yield and over-reliance on pesticides. Current detection regimes often rely on expert identification of the pathogen from plant damage.

“With collaborators, we have developed Air-seq, a new approach that seeks to identify pathogens through sequencing of biological material present in the air.

“We have the expectation that we can detect the presence of pathogens in the air before damage becomes visible on the crop, thereby providing a crucial early warning system and increasing the time available to react to the pathogen.

“The DNA is sampled and sequenced, allowing us to work out which organisms are present.

“We’ve shown that we’re able to track amounts of pathogen spores in the field over a three month period, and now we’re working hard on automation of the process.”

Sustainable solutions for global food security

Giles Oldroyd, Professor of Crop Science at Crop Science Centre

Giles studies the mechanisms by which plants form beneficial interactions with micro-organisms, both bacteria and fungi, that aid in the uptake of nutrients from the environment, including nitrogen and phosphorus.

A long-term aim of this research is to reduce agricultural reliance on inorganic fertilisers, and he currently heads an international programme funded by the Bill and Melinda Gates Foundation and the Foreign, Commonwealth and Development Office to engineer nitrogen-fixing cereals.

“We are entering a golden era of crop science – basic science has given us insights into how plants grow and defend themselves against disease and stress and we now have a tool box to improve these traits – the explosive next step in the journey will be to replace chemical inputs with biological solutions.”
A key element of REAP is the opportunity for discussion. The Sofa Session asked innovators from different perspectives – from soil microbiology to earth observation, from field level to policy overview – to help pull together the thinking from the day.

The discussion was wide-ranging, but a developing consensus identified that a systems approach is needed that would allow visibility of the complexity and tools for managing interactions across the scales. This would improve the performance of agriculture whilst reducing unintended environmental impacts.

**Julian: David, what do the farmers you have talked to see as the role for agri-tech in the transition to soil conservation agriculture?**

**David Montgomery:** The people I interviewed were very involved in precision agriculture. I got a tour of a Dakota farm that was like Star Wars – they were keeping track of tyre pressure over every metre of land, where every vehicle was going – so the integration of satellite and GIS plus precision agriculture was something that played into their practices. But on the other end of the spectrum, in Ghana, Kofi Boa’s technology was a machete – so I think the basic idea of conservation agriculture is agnostic to technology but there are huge opportunities for agri-tech to contribute.

**Julian:** **Stuart, conservation agriculture has its benefits, but do we need to go at a slower pace to convince farmers?**

**Stuart Hill:** You need to break it down to properly understand what is going on within the agricultural system. We’ve had yield maps for quite a long time but not really known what to do with them. Technologies from the mining industry are now being repurposed for agriculture and this enables remote monitoring of soil and soil parameters; giving us interesting data. So now we’re looking spatially across farms, across yield maps, understanding what’s going on across the farm and then delving down into the soil biology.

Improving soil biology enhances the chemical and physical properties of the soil, which goes back up the chain into outputs.

**Mike Green:** Low tech things like drainage can also be important – soils need to be active and drained – but some of these drainage systems are 20 to 100 years old and nobody on the farm knows where they are – so an innovation that allows you to find those drains would be useful.

Also, if you may have a great innovation that looks brilliant, but if its energy and resource hungry, is it sustainable?

**Jane Rickson:** Yes, we need the data to understand the trade-offs. If I’m using cover crops, what is the beneficial impact on my farmed crop? We have some way to go before we get meaningful consequences from one action, in one given year, based on all of the biological parameters that we’re measuring – AND to be able to use this to predict what will happen in the future.

**Julian:** **Agreed. Duncan, one thing is for certain, we only got our heads round global warming when the data was there.**

**Duncan Wingham:** Going back to the conference theme, molecules to landscape scale, and how to tie those together successfully: I’ve been trying to achieve that integration of scales at the research council by bringing together environmental science and biological science – and that is only becoming possible with data and tools to manage it.

However, the data has to be available – if you can’t see your farm data in the context of the drainage basin, or how that relates to other parts of the environment, then the value of that data is very much reduced.
David has been making the case of soil biodiversity very compellingly to us – but it’s all biodiversity. In the UK we have the ag bill and the env bill – both of these are going to challenge us to understand what biodiversity means in the national context. How we measure it, what data we use, and how we get that across the various scales. There is a huge agenda around data.

**Julian:** When it comes to the microbiome, you have to remember that anything done on a landscape system will have a microbiological impact and vice versa. So how do you manage that complexity?

**Stuart:** If we’re going down to that microbiome level, we have got to be able to measure things, but what are you going to measure? Biology, or organic matter? And what tech do we need and what format of the data can the agronomist and grower interact with? We are asking those questions and putting the information into farm maps to integrate the data across all the scales.

**Julian:** Why aren’t more farmers adopting min-till practises? Where is the limitation?

**Jane:** We have over 700 different types of soil in the UK alone – so it’s very difficult to get a one-size-fits-all approach that’s always going to work. Farmers are often at the margin, and the new approach might need investment and new kit, and that’s quite a leap of faith. It seems to me that we need a stronger evidence-base to build the confidence for farmers that if they go on this journey, when are they going to get that return on investment?

**Mike:** Society is excited about carbon. But carbon is a factor of a healthy soil. Healthy soils deliver reliable food. But no-till isn’t right for everybody; it’s a journey. We have to be prepared as an industry to help farmers.

**David:** I am convinced that to get the biggest benefit fastest, you go straight to the full system, but of course that doesn’t integrate the human dimension.

None of the people I interviewed adopted the new approach fully straight out of the gate – they adopted one practise at a time and each time they liked what it was doing to their soil and to their bottom line – and now they’d never go back. There may be experimentation required to figure out how to make it work in different parts of the UK.

Demonstration farms can foster the innovation that could lead to faster transitions with a lower risk profile. But they also could help to communicate to farmers what the risks are of converting to no till, which will help the perception of farmers toward the approach.

**Jane:** Agriculture is more than just food production – and looking at ELMS, things like carbon management is presumably a public good. Agriculture is wonderful in being able to do these multiple goods and services, producing food, sequestering carbon, preventing carbon loss through runoff erosion and emissions particularly in some of these min till systems. Agriculture should be valued for its ability to deliver on all of these different public services.

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**The Sofa Session panellists:**
Julian Little, Director of Julian Little Communications;
Stuart Hill, Head of Technology and Innovation at Hutchinsons;
David Montgomery, Professor of Geomorphology at the University of Washington;
Jane Rickson, Professor of Soil Erosion and Conservation at Cranfield University;
Sir Duncan Wingham, Executive Chair of the Natural Environment Research Council;
Mike Green, Agricultural Sustainability Manager at BASF.
THE AGRI-TECHE ECOSYSTEM

The Technology Hub included missions from the Netherlands and South Korea, together with companies and organisations profiling products and services able to support the commercialisation of technologies and to assist producers and service providers in reaching new geographies and market sectors.
Lightweight robotics provide an alternative to heavy equipment and can enable precision agriculture with reduced requirement for inorganic chemicals.

Wilma, the brains behind Small Robot Company’s team of agri-robots, was launched at REAP 2020.

Wilma provides ‘per plant intelligence’, using precise information gleaned by Tom, the scouting robot, on the health of the plant. If she identifies the plant as a weed then Dick – the world’s first non-chemical robotic weeder – is dispatched to zap it.

Ben Scott-Robinson, CEO and co-founder of Small Robot Company, explains that the robots are being trialled on three farms, and their success is creating tremendous excitement among farmers that have invested in the technology.

He says: “Wilma creates a per-plant crop map and is then AI-enabled to recognise disease and the nutrient status of the plant. This enables precision weeding by the farmbots and, in the future, application of water, nutrients or fungicide as appropriate – cutting chemical use and emissions.

“Wilma can direct Dick on the most effective course across the field. The robot then kills the weeds, such as blackgrass, using the Rootwave technology, which is electric so there is no problem with resistance,” explains Ben.

“In a post-glycophosphate world the ability to quickly kill pernicious weeds as they appear means that farmers don’t need to wait to drill and can take the opportunity to get crops started in the better weather in early autumn. Our lightweight farmbot Harry will also be equipped to precision drill without damaging the soil.”

smallrobotcompany.com
At the end of the day, the farmer delegates were invited to have a ‘virtual beer’ with David Montgomery. The discussion was wide-ranging but of particular interest was around how to assess the benefits of regenerative agriculture and to reward best practice.

Intuitively, improving soil health and increasing the bioavailability of nutrients to the plants should result in crops that are more resilient to adverse conditions and more nutritious and flavoursome. The farmers wanted to know if there was evidence for this that could support some type of ‘quality mark’.

The potential for gaining reward for carbon capture was also debated. The farmers were unsure how metrics could be introduced that would not penalise those who had already introduced good environmental practices and therefore had less potential for improvement.

These two issues will be part of an ongoing discussion; however, the farmers did identify a number of initiatives that would support the adoption of new technologies and best practice on the farm:

- Create mechanism for valuing soil health and stored carbon.
- Create evidence-base to evaluate the nutritional added value of best practice.
- Create opportunities for technologists to learn basics of agriculture without need for excessive input from farmers.
- Improve benchmarking to ensure reward also for those already applying best practice.
- Support for evaluation of technologies and access to trial sites.
- Change focus of industry to whole system approach, but look for implementation in stages.
- Support for farms transitioning to regenerative agriculture.
AFTERWORD: Systems interconnectedness

Belinda Clarke, Director of Agri-TechE

With challenges come new opportunities. And 2020 certainly brought both at different scales, ranging from widespread global economic impact, down to the level of us all as individuals.

The interconnectedness of so many systems – not least the ones which produce our food and manage the landscape – has been starkly demonstrated by the pandemic, and the need to manage this complexity was the inspiration for the theme of this conference.

This year, innovative use of communication technologies have overcome geographies and enabled new connections to be created between businesses and with the research community. Finalists in our GROW business plan competition were able to meet our commercial service provider members and build new relationships. And we took the “Innovation Hub“ (usually in a field at the Royal Norfolk Show) online to a wider audience.

We were particularly excited to announce at REAP a major new partnership with the Western Growers Association, based in California, two inward agri-tech missions from the USA and from the V4 countries (Poland, Hungary, Slovakia and the Czech Republic), and a new rapid-fire “Agri-Tech Express” programme.

These are all offering another dimension to our line-up of activities for 2021. Come and join us!