

REAP CONFERENCE 2022:

Making Sense of Agriculture

Agri-TechE

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INTRODUCTION: **Making Sense of Agriculture**

There are so many variables in agriculture, with profitability impacted by everything from the nutrients in the soil through to extreme weather events. Some factors are controllable, many are not, but informed decisions can mitigate risk – and the digital world is facilitating this.

This year's REAP Conference explored how the meeting of real and virtual worlds is creating a new generation of technologies that are 'making sense of agriculture' and can provide the intelligence needed to take the best action on-farm.

Advanced sensors and tools for modelling, forecasting and scenario planning – including digital twins – were all discussed.

Farmers, technologists, researchers and others with a passion for turning challenges into opportunities for the agri-food industry participated in this vibrant event. This report aims to capture some of the highlights.

Delegates were welcomed by **John Barrett**, of Sentry Ltd, chair of the Agri-TechE Stakeholder Board and a farmer himself. He opened the conference by saying innovative thinking was the best way to create value for the industry.

He gave an example of this, describing when Dutch farmers were told to cut dairy herds by a third to reduce greenhouse gas (GHG) emissions – a potential cost to the industry of £26bn – they came out fighting.



Faced by roadblocks and empty shelves - the government agreed to spend £25bn on research. The outcome was a novel way of removing GHG from urine, reducing the environmental impact of the dairy industry and creating a valuable solution.

John firmly believes that improving farm productivity and enhancing environmental quality are both achievable.

On John's own farm he has been involved in a collaboration with Bayer to increase nitrogen use efficiency and decrease loss through leaching.

Giving the example of different strategies on three different crops, he showed how, by using a chlorophyl meter to assess what the crop actually needed and by increasing organic matter, he was able to reduce the nitrogen input without impacting the profit from the crop.

He concluded that REAP is the best place to engage in discussions of how technologies are performing in the field and to gain an overview of the emerging agri-science.

He also made the point that it is vital that farmers and growers are in the room to shape the discussions and to ensure that 'actionable insights' are gained from sensors and data.

THE TRANSFORMATION OF AGRI-FOOD VALUE CHAINS

*The digitisation of agriculture is enabling changes that are making the agri-food value chain more predictive and less reactive, according to **Elizabeth Fastiggi** of Amazon Web Services (AWS), the keynote speaker at REAP.*

Elizabeth explained how networks of low-cost sensors are facilitating a digital revolution. To provide higher levels of automation, an accurate picture of what is happening out in the field is required. This needs multiple sensors but, until recently, the cost has been prohibitive.

However, the introduction of low-cost sensors and Cloud computing – which reduces the processing load for the sensors and the energy they require – has been transformational. The role of the sensor is now simply to collate data and transmit it when connectivity is available.

"The global trend of connecting low-cost sensors to the cloud to access real-time analysis is becoming a real game changer for decision support," Elizabeth says.

AWS provides the infrastructure to support cloud computing and offers a suite of services that provide a toolkit for application developers, from early-stage start-ups to enterprise businesses, to build better farming solutions.

She gives the example of how AWS supported Halter, a New Zealand-based developer of herd management tools.

The company had developed a smart collar for cows that could improve the work/life balance for dairy farmers by enabling remote management and monitoring, or even creating virtual fencing to improve the efficiency of grazing.

But it was struggling to reduce its energy requirements to make it viable.

Now, instead of trying to analyse the data in the field, the smart collar sends information to a remote processor located on the internet – the 'cloud'. Machine learning is then used to understand the implications of the data – the animal is lame; the calf has become lost – and to use this to create an instruction for smart equipment or to provide the farmer with an alert or decision support.

As a result of leveraging the cloud, the wearable device requires less computing power, can be charged by sunlight, and can be reprogrammed remotely as required.

The development of cloud computing has opened the door for new types of agri-tech services.

Of course, you do still need a connection to the internet – but with the new network of communication satellites this too is improving.

Elizabeth continues: "Our objective is to enable the entire industry to use data to deliver insights and improve outcomes.

"There is a collective recognition that no one organization can 'go it alone'. We must collaborate because the agri-food system is complex and interdependent.

"This makes me incredibly hopeful because I know we will get to much better outcomes – for people and the planet – through cooperation, and AWS is uniquely positioned to foster these cross-industry collaborations."



Elizabeth Fastiggi, Head of Worldwide Business Development for Agriculture at AWS

AGRI-QUESTION TIME: **Panel discussion facilitated by Anna Hill**

Anna Hill chaired a panel of experts: Matthew Smith of Scientific Technologies, Sarah Kendall of ADAS, and Marcelo Galdos of Rothamsted Research

Renowned farming journalist **Anna Hill**, presenter of BBC Farming Today**,** revealed that she had an identical twin, farming in rural Devon and so had a particular interest in the concept of digital twins in agriculture!



Creation of a virtual world *in silico* is ground-breaking, she observed. Taking risks in farming is difficult but use of a model, powered by data, to test a new idea, enables rapid, risk-free experimentation, enabling expensive, on-farm investments and decisions to be de-risked.

She put this question to the panellists:

COP27 brought home clearly the threat of global warming and the need for urgent action. Perhaps with a digital farm there is the potential to run further forward and see the implications of different strategies?

Dr Marcelo Valadares Galdos is a Soil Carbon Specialist at Rothamsted Research. He agreed, stressing that modelling also offers an opportunity to compare economic benefits of different strategies.



Drawing from his work at the Rothamsted experimental station at North Wyke Farm, Marcelo described how a sensor network can measure multiple factors to create a digital model, which then enables managers to see in time and space the different interventions that can be made.

He explained that the next step is to model 'what if' strategies to explore the change, for example, in water use, soil health and GHG emissions.

However, he stressed this needs to be 'human-centric' to augment intelligence data from the sensors with AI that can help humans to understand the processes and the problems.

Matthew Smith, Head of Planetary Intelligence at Scientific Technologies, said that this support can be achieved through dashboards to refine and present the data with appropriate filters to enable humans to explore the information, given the right tools.

He said that the big challenge was to go from data to intelligence. But this doesn't depend on collating more data. Being overwhelmed by data was disempowering. Instead he advocated a position where there is sufficient information to diagnose the problem, predict the impacts and then develop a prescription that offers an evaluation with the costs and benefits of each option.



The challenge is then to know what strategy is the most beneficial.

Sarah Kendall, Associate Managing Director of the Soils, Crops and Water business at ADAS, commented that modelling can be used to identify the KPIs (key performance indicators). She said that ADAS has calculated that UK arable farmers face a quadrillion quadrillion different decision combinations* so there needs to be a smarter way of using digital technologies to identify which are most crucial to support decision-making.



For this, collaboration is key, and this is being achieved within the Yield Enhancement Network, where farmers submit their data and in so doing are able to benchmark their performance against others.

Marcelo concluded that a digital twin is an extension of the 'mind model' that farmers already have but has the power to increase the amount of interactions and empower end-users.



**ADAS report Supporting and Progressing Enhancement of Performance on-Farm: Farm-PEP*

FARMER BREAKFAST



Tim Mordan, a Deputy Director in Defra's Agri-Food Chain Directorate, presented at the REAP Farmer Breakfast and responded to questions from a room packed with farmers.

Ahead of the conference he commented: "Farming is an industry with long lead times and deep traditions. The development of agri-tech is relatively new and yet in recent years we have seen radical changes on progressive farms, particularly around the use of data and adoption of precision agriculture. The industry has shown that it is ready and able to embrace change.

"Over recent times Defra has been working closely with farmers on the development of initiatives that will help diversify the sources of income and there is growing evidence that it is possible to increase productivity in a way that is good for food security, good for the environment and good for business."

Tim highlighted the **Farming Investment Fund**, which aims to support the adoption of new technology and purchase of equipment. The next round in January 2023 is aimed at improving automation of the industry, with further rounds planned focussed on water and irrigation.

He also explained how the **Farming Innovation Programme** (managed by UKRI) has a focus on farm-led research. This is to ensure that new thinking is directed at solving on-farm challenges as well as enabling disruptive innovation.

Tim mentioned progress towards a **'What Works Centre'**, that would evaluate emerging technologies, and the need for more experimental farms.

Of particular interest to the room was discussion of a new body to support professional development called **The Institute for Agriculture and Horticulture (TIAH)**.

He stressed that he was looking to increase the amount of two-way communication in order to co-design calls and welcomed input from those who want to shape the direction of innovation. He commented that meetings like this provide a powerful insight into what policy should look like.



Discussion points:

Looming fresh produce crisis – farmers stressed the need to accelerate innovation and for early adopters to be paid upfront to de-risk investments. There were also calls for a whole value chain approach that included risk sharing with retailers to find solutions.

Commitment to increasing security – farmers commented that the UK has capacity to increase self-sufficiency in the food it can grow well. Tim responded by saying that a Food Security Report is being researched, with publication due in 2024.

Diversity – with the phasing out of the Basic Payments System, farmers are looking to make up the shortfall through diversification. Tim responded by saying the Agricultural Transition Plan includes scope for diversification but also encourages a focus on what the farm is good at.

De-risking on-farm trials – farmers asked if there would be more support to cover the opportunity cost of trials. Tim responded that farmer-led research was valued.

Boost for Controlled Environment Agriculture (CEA) – the cost of energy has an impact across the industry, but particularly in CEA where it makes up 40% of the cost. Would there be more support? Tim said that Defra was looking both at the opportunities for an 'energy for farmers' scheme and also working with BEIS on planning for renewable energy schemes.

Labour shortages – Tim was asked if there were plans to link immigration policies with innovation strategy. Tim responded that there had been a pilot this year to offer more visas for seasonal workers and investment in automation technologies that would help ease the problem in future.

*The Farmer Breakfast was sponsored by **Savills**.*

EMERGING AGRI-TECH: **Research Into Practice**

*Chaired by **Andrew Francis**, COO and Co-Founder of TEAM Ag UK*



Scientists at some of the UK's leading agricultural organisations use an object to illustrate how their research is heading for impact in the industry and provide insights into the research pipeline.

Development and findings of five years 'Hands Free Farming'

Smartphones offer new options for managing, monitoring and mitigating issues – will we soon be farming by phone?



Kit Franklin is a Senior Engagement Fellow in Engineering at Harper Adams University.

His research into 'future farming systems' led to the ground-breaking and headline-grabbing world first 'Hands-Free Hectare' project, which established and harvested a cereal crop autonomously and has now grown to become the Hands Free Farm.

Urban-integrated agriculture

Can the storage of liquids give insights into the production of food in space-efficient ways?



Ruchi Choudhary is a Professor of Architectural Engineering at University of Cambridge.

She specializes in use of simulation for predicting energy demand in the built environment, including the use of digital twins.

She is leading projects on modelling underground heat and city-scale geothermal systems, urban farming, and end-use energy demand modelling.

TraitSeq - AI to accelerate crop trait development

Crusty, seeded or soft? Machine learning tools are being used to help breeders improve the traits of the world's most important cereals.

Josh Colmer, a PhD student at Earlham Institute, is the lead developer behind TraitSeq, an AI-based technology platform for accelerated trait development. Josh has developed a collection of machine learning tools to predict complex traits in plants such as disease resistance using biomarkers discovered in gene expression data.

Josh is looking for new applications of his technology to improve the efficiency of crop development and prepare our crops for the climate of the future.







Portable phenotyping tools and their application to crop improvement

New visualisation tools enable unprecedented insights into how plants, soils, pests and diseases are progressing.



Charles Whitfield is a Senior Scientist at NIAB East Malling.

Charles was a co-developer of a handheld imaging fluorometer for detecting spray deposits, used to optimise sprayable crop protection products, and is the manager of several current agri-tech projects focusing on soil health, fruit ripeness, and precision variable rate spraying.

These projects utilise a range of technologies including semi-conducting polymers, spectral imaging, augmented reality, and LiDAR.

Plant feedback system to determine optimal lighting requirements

Can we tune in to plants' broadcasts to learn about different aspects of photosynthesis to provide optimal lighting requirements?

Pallavi Singh is Group Leader at the School of Life Sciences at University of Essex.

Photosynthesis varies during the day according to light levels. This knowledge can be used to create light recipes that reduce energy use in controlled environments, while boosting plant performance.

Pallavi is interested in using natural variation to improve our understanding of complex traits such as water use.

Pallavi has received Young Scientist Awards in 2017 and 2019 from the Indian National Science Academy on her pioneering work on flooding tolerance in rice.



How do we transfer disease resistance from wild relatives to our favourite potato varieties?

'Spec-tacular' research helps potatoes 'see' to tolerate pests more effectively.

Agnieszka Witek's background is in plant biochemistry and plant-microbe interactions. She is part of the Jonathan Jones group at the Sainsbury Laboratory, which has successfully developed a late blight resistant Maris Piper and Hermes potato, PiperPlus 1.0 and HermesPlus 1.0.



These disease-resistant varieties would require substantially less fungicides and are ready to be commercialized when the UK has put in place workable regulation of crops improved with the GM method. PiperPlus and HermesPlus have additional tuber quality traits that will make it easier to store the potatoes without losing product quality, thus reducing food waste in the supply chain.







A savoury solution to pest control (it's not just the smell that does the business)

From pharmacy to "Farma-ceutical" – harnessing nature's own medicine cabinet to find solutions to nematode, insect and fungal pests.

Chris Hamilton is Associate Professor in Medicinal Chemistry at the School of Pharmacy at University of East Anglia. His research interests are more 'farmaceutical' than pharmaceutical, with a particular focus on the application of garlic-derived pesticides in food crop protection.

Working in collaboration with biopesticide company Ecospray, Chris has been supervising several PhD studentships, exploring the effects of garlic extracts on nematode, insect and fungal pests. He is also involved in an Innovate UK Agritech Catalyst 'Side-Ridge Injection' project, developing methods for subsoil delivery of biopesticides for the timely targeting of nematode pests in potato crops.



A question of taste? Breeding resistance to CSFB

Do you love it or hate it? For one of the UK's most damaging insect pests, which plants to target could all be a matter of taste.



Rachel Wells is a Senior Scientist in the Department of Crop Genetics at John Innes Centre. Her current research involves the identification of genetic resistance to Brassica pests, with a strong focus on cabbage stem flea beetle (CSFB). The team uses controlled environment and field trials to study CSFB damage in Brassica and related species.

These experiments can be used to look at how the plant and pest interact and ultimately help determine genes associated with resistance for plant breeding. The aim is to use genetics as a non-chemical solution for pest control to reduce the pesticide reliance of UK agriculture.

What can agriculture learn from Major League baseball?

Researchers are using technology developed to improve baseball players' performance with crop science – integrating the many factors which influence yields.

David Clarke is a Soils and Farming Systems Technician at NIAB and a doctoral student at Cranfield University. He is assessing spatio-temporal yield stability within and across the rotation and the interaction with weather patterns.

David has been developing methods for collating and integrating data from different years and of different types, such as weather, satellite imagery, in-field observations and yield maps.

This data will then be used alongside crop models evaluated using long-term NIAB agronomic field trials and monitoring at Morley to support in-season and between-season rotational management decisions.









START-UP SHOWCASE

The 2022 Start-Up Showcase featured an exciting line-up of emerging and growing businesses looking to meet farmers, investors and future collaborators.

*The session was chaired by **Nicole Sadd**, Executive Director of Rothamsted Enterprises.*

*The Start-Up Showcase was sponsored by **Rothamsted Enterprises.***







Using AI to help decision-making on the vineyard

***Deep Planet** uses AI to help vineyard growers make the best decisions and manage yield, maturity and irrigation. The technology helps predict grape maturity and optimal harvesting dates, forecast yields for picking and vintage planning, optimising irrigation scheduling, and reducing variability across the vineyard, helping to identify problem areas.*

Using AI and satellite imagery, Deep Planet's VineSignal can reduce variability and disease by tracking daily, weekly and monthly changes in vegetation (NDVI). The unique two-week prediction delivers an accuracy of 93% to see the future impact of irrigation and fertiliser application on vineyards.

It can also help growers to understand vine moisture by monitoring daily, weekly and monthly vine moisture changes, and the two-week leaf moisture prediction allows irrigation impacts to be seen and necessary changes made proactively.

VineSignal can also forecast grape tonnage by block and variety with 90% accuracy, and map an entire vineyard to a depth of 1.5 meters to provide data to back up irrigation decisions.

Sushma Shankar, Co-Founder and COO of Deep Planet, says: "Our goal is to help agricultural businesses, supply chain companies and growers to gain new and unbiased insights from satellite data while supporting sustainability in their operations."

World's first organic bioresin seed coating provides biodegradable protection

*Frasscoat uses a bioresin impregnated with a biopesticide created from insect frass to provide powerful, biodegradable seed protection. It has been developed by **WASWARE** to create a seed treatment that increases seed sprouting and seedling survival, enhances growth and repels pests, whilst leaving no chemical residues.*

The idea emerged after a discussion between AgriGrub and Cambond in the Royal Norfolk Show Innovation Hub hosted by Agri-TechE.

This identified an opportunity to address a huge crop protection challenge facing agriculture following the withdrawal of many chemicals used for seed treatments.

AgriGrub is using chitosan, a natural stimulant for a plant's defence system, to create a potent active ingredient for crop protection. The chitin comes from insect frass produced by the larvae of black soldier flies feeding on waste fruit.

Cambond has created a bio-resin from dried distillers' grains, a by-product from whisky production that, when combined with plant waste, offers an alternative to oil-based plastics.

WASWARE, Cambond's product development arm, is to take it to market.

Prof Xiaobin Zhao explains: "Frasscoat has potential to be the first organically certified seed coating technology. Seed treatments typically use a polymer containing pesticide to provide protection to the crop during emergence. These chemicals leave residues in the soil and are unsuitable for organic crops.

"By combining a biopesticide that has been developed naturally by insects and a bio-resin created from plant materials and biological processes, the result is a plant protection product that is highly effective, bio-degradable and provides uses for materials that would otherwise have been wasted."





WASWARE has been conducting trials of Frasscoat with NIAB, the John Innes Centre and Rothamsted Research to verify the findings, which are very promising: seed germination is enhanced (>20%) and seedling growth is stimulated. There is also evidence of pest resistance properties.

Citizen scientists given access to first global platform for tree recording

***Tremap** has created the world's first global tree platform for recording and locating trees. The app is already in use by a number of botanic gardens to replace manual methods of tree surveying.*

As international governments propose ambitious tree planting programmes to reverse habitat degradation, one key challenge is being overlooked.

"We don't have a reliable way of knowing what trees we have," said Jonathon Jones, Founder and CEO of Tremap, an agri-tech start-up based in Cornwall.

"Tree surveys are incredibly time consuming and only conducted across small areas," said Jonathon. "The concept for Tremap worked so well that we have increased its scope."

Tremap combines existing tree databases with satellite imagery from earth observation to create a global map, which is being ground-truthed with a smartphone app for recording and visualisation.

"The Tremap platform makes contributing to and viewing the world's first global database of trees engaging and enjoyable. It puts tree mapping into the hands of everyone with a smartphone app."

Applications for Tremap include collating collections in arboretums and public spaces, evaluation of tree planting programmes, measurement of tree loss, and identification of particular species for conservation programmes.

The company is collaborating with the University of Exeter in the UK and the Smithsonian Institution in the USA to further develop the mapping, and has several early adopter development partners, including The Eden Project in Cornwall.





Solar-powered ActiveWater tech reduces salinity of water for agriculture

As further droughts are predicted worldwide there will be increasing demand for crop irrigation - but a lack of fresh water is causing extensive soil degradation.

To overcome this issue, **ALVÁTECH** has developed ActiveWater, a sustainable and affordable solar-powered treatment for water that reduces its salinity by up to 50% and improves soil health, enabling poorer quality water to be used without harm to the crop or the environment.

ALVÁTECH's devices can be incorporated into existing irrigation systems and are already being used in Africa, LATAM, MENA and North America with the support of NGOs such as the Red Cross.

ActiveWater disrupts the way water molecules move and interact with other molecules and minerals in the soil.

It increases water absorption by the soil, reducing the salinity around the plant roots while improving nutrient uptake by the plants.

This saves 20-50% of the water normally required for irrigation and reduces the need for fertilizers.

A UN report (2014) estimated that 62 million hectares, an area the size of France, of previous agricultural land has been salt-affected at an estimated global economic loss of US$27.3 billion per year.

IPBES suggests that approximately 190 million acres (76 m.ha) of irrigated land has already been permanently lost to salinisation.

ALVÁTECH is offering the system in the form of weatherproof devices, which easily slot into existing irrigation systems. The technology is affordable and available on a subscription basis to make it more accessible to farmers.



"20% of all irrigated land has been lost by salinisation and in many arid and semi-arid regions the only accessible water source is saline or brackish.

"We have developed an innovative grower-friendly technology that enables farmers to use available high salinity water while improving soil biodiversity with every irrigation cycle."

Zac Gazit, CEO and Managing Director of ALVÁTECH

Same parents, different outcomes

*"I have two racehorses with the same parents, but one has won €5M, the other €5K; why?" This was the question that fuelled the curiosity of Maria Jensen, founder and CEO of **Antler Bio**, to look at the impact of nurture on gene expression.*

The result is the EPIHERD Platform, a technology that bridges the massive data gap between an animal's potential and its performance.

The company is now focussed on the dairy industry, where more effective breeding and management would revolutionise productivity.

Maria explains: "A farmer can have two genetically similar cows on the same farm, but one might produce three times as much and is much healthier than the other. It's evident that genetics alone does not explain these differences.

"I considered that if we could better understand the data behind the best producing and healthiest individuals, then we would be able to more accurately identify the next generation of animals to meet these standards.

"The industry could be producing at least three times as much high-quality produce with the current number of animals and with even fewer resources, thereby reducing methane output by up to 40%."

Current genetic testing looks for the presence and absence of gene variants that can affect different traits, such as milk yield, conformation, and fertility.

These tests, however, do not quantify how much relevant genes are expressed and whether they are even active. It is also recognised that environmental factors such as nutrition, animal husbandry and stress can influence gene expression and directly impact the animal's performance.

Understanding these processes and their mechanisms is called epigenomics.

Maria continues: "Our innovative EPIHERD Platform focuses on the analysis of epigenomic data, looking at expression of key genes that impact health and performance, not just the presence or absence of a gene as with classical genetic testing.

"By understanding which events trigger desirable or undesirable gene expression we can give precision recommendations to unlock the herd's full potential and support herd health in a natural way."

Based in Dublin and Cambridge UK, the company has so far raised over £1M in equity and grants including from Innovate UK and is looking towards further fund raising.

"The Innovate UK project started in February 2022," says Maria. "We are currently generating proprietary epigenomic data from samples such as blood and milk from dairy cattle and building the EPIHERD platform.

"This will deliver results and insights to the farmer in an easy-to-understand and actionable format. This platform is scalable to plants in the future."







Making 'bad' bacteria self-destruct to create a healthy microbiome

Bacterial crop diseases cause devasting losses. Some are controlled by antibiotics, which results in damage to beneficial organisms in the microbiome and the risk of resistance. ***FLOURISH*** *offers an alternative plant protection strategy.*

Its Guided Biotics® technology disrupts the metabolism of the pathogen. This enables natural competition to create a healthy growing environment, boosting yield.

Over 12 million hectares of tomatoes are grown globally and they are at risk of bacterial canker which is caused by *Pseudomonas syringae*.

Canker is also a serious disease of stone fruits such as cherries and peaches, among other species.

In trials with tomatoes the use of Guided Biotics® was shown to reduce *Pseudomonas syringae* and Botrytis cinerea by more than 99.9% and double the weight of the tomato yield.

Ed Fuchs is a Co-founder of FLOURISH, a carve-out from FOLIUM Science.

FOLIUM developed a Guided Biotics® technology for animal health and now has a number of product candidates ready for commercialisation via multinational feed additives distributors, following successful safety assessments by regulators.

Ed comments: "Plants extract nutrition from their environment using complex interactions with microorganisms in the soil. The importance of this microbiome is increasingly recognised in human and animal health.

"Our technology uses either bacteria or phages (virus particles) that are highly selective for a particular type of bacteria, such as Pseudomonas. It shares a specific DNA sequence with the target that redirects its immune system, causing the pathogen to self-destruct.

"As the sequence is very specific and targeted to the particular bacteria it will not damage organisms that are vital for plant growth. This process therefore gives the beneficial organisms a competitive advantage."

The use of phage particles is already regarded as safe by major territories and is being increasingly used in diagnostics and medication.

"FOLIUM benefited greatly from the profile gained at the REAP 2018 Start-Up Showcase and I hope to repeat this success with FLOURISH."







New biostimulant protects wheat yields by up to 40% after drought

*As erratic weather events are becoming more common, and have a detrimental effect on crop yields, a biostimulant being developed by agri-tech start-up **SugaROx** is attracting significant interest.*

SugaROx is a spinout from Rothamsted Research and University of Oxford.

It was formed following collaborative work published in Nature that discovered that a modified version of a natural plant molecule, trehalose-6-phosphate (T6P), had the potential to significantly increase grain yield.

In addition, application to vegetative tissues pre-flowering was found to improve plant recovery after a drought event.

Dr Cara Griffiths, Chief Technology Officer and co-inventor of the SugaROx technology, explains that T6P plays a key role in controlling sucrose utilisation, which underpins plant growth, grain development and stress responses.

SugaROx has been found to prevent yield-loss in wheat by up to 40% when applied after a drought event and can boost yields by up to 18% under typical growing conditions. The product slots seamlessly into existing agricultural practices, offering ease-of-use for farmers.

Cara says: "The collaboration between plant biologists at Rothamsted Research and carbohydrate chemists at Oxford University resulted in the development of a modified version of T6P. This was so effective at boosting wheat yields that we decided to protect the invention, and form SugaROx to develop this technology commercially".

The potential for this biostimulant to contribute to a low-carbon economy is huge: a 15% yield boost to wheat grain yields could provide a 24% uplift in gross margin for UK farmers, while reducing CO2 emission by 11% per loaf of bread.

Further product development is occurring to cover additional broadacre crops: maize, barley, millet and sorghum with promising results.

"We are essentially making plants as productive as they can be at driving nutrients and carbon resources into grain yield, making every unit of agricultural land more efficient than ever before," says Cara.

Since 2020, SugaROx has attracted over £1.4M of funding from angel and VC investors, as well as receiving funding from Defra and Innovate UK through the Farming Innovation Programme for product development and market analysis for a wheat biostimulant.

Cara says that the company is keen to talk to potential investors, commercial partners, and end-users about applications to a range of crops and geographies – the product offers potential for worldwide application.

FARMER INSIGHTS PANEL



*Chaired by **Tina Barsby OBE**, farmers from across the spectrum of agriculture reviewed insights gained from the day and grounded the discussions of the day with examples of their real-world challenges on-farm: Peter Mason of Uphouse Farm, Ian Beecher Jones of Digital Vineyard, and Andrew Peal of Salle Farms.*

Poultry farmer **Peter Mason**, Farm Manager at Uphouse Farm, is passionate about sustainability and innovation in the agricultural sector, always striving for new efficiencies in the day-to-day and long-term farming practices.

He says: "Broiler farming is a high-input high-output business. Soaring input costs and ever-increasing pressure for environmental sustainability are two huge talking points in our industry.

"Feed is our largest input, making up around 70% of the cost of each flock, simultaneously being responsible for around 80% of greenhouse gas emissions in the poultry sector. That makes our Feed Conversion Ratio (FCR) one the biggest driver of both economic and environmental sustainability."

Peter is a big believer in precision farming, taking a data-driven approach to improving performance across the farm's broiler business.

"I am excited about the potential of data-led and data-driven decision-making for the poultry industry and think we can do more in terms of using the data available. We have access to a huge amount of data, and I would like to be able to analyse this in more depth to understand better what we need to change and then see that applied in practice."

Ian Beecher-Jones established JoJo's Vineyard in 2019 and has been developing a 'Digital Vineyard', which integrates precision viticulture techniques with the real-world vineyard using RTK level tools and techniques.

Ian explains: "My background is precision agriculture from a broadacre perspective, so when we started to plant up the vineyard about four years ago, I was keen to introduce automation, as a number of tasks, especially mowing and under-vine management, are very labour intensive.

"However, to enable this there is a need to digitise the vineyard accurately and correctly and make a representation that is shareable, so whoever we are working with – drone, robot or satellite providers – can have access to the digital infrastructure of the vineyard."

Andrew Peal has recently taken on the role of Farm and Estate Manager at Salle Farms in Norfolk.

Salle Farms, along with three other major Norfolk farming businesses – NE Salmon, the Holkham Estate and Raynham Estates – are part of the Catalyst Farming Programme, which aims to share data and best practice and benefit from the analytical insights revealed by information sharing.

Andrew, who describes himself as an 'irrigation nerd' has welcomed the introduction of smart water management on the estate. He explains that, while in a previous job he would drive 100 miles in an evening to check irrigation, he can now do this remotely with an app on his smartphone.

"If there is a problem I can drive straight there."

What is the biggest pain point for digital tools?

Ian: "We are time poor, so automation is key. However, with the introduction of new technology, there is a need to engage staff in any change to the way of working and this can be time-consuming in itself!"

Peter: "The biggest game changer would be in early disease detection, to identify if there are bacteria present. I am very interested in camera-tech that monitors the movement of the birds. With this it might be possible to get early warning of issues."

Andrew: "Providing actionable insights. The biggest challenge is aggregating data and information. You have to decide which are the most useful KPI (knowledge performance indicators) in data collection.

"Satellite imagery is interesting, but it is retrospective, we can't access the information quickly enough to be able to use it for interventions."

How can tech companies work with farmers?

Peter: "The introduction of new technology often needs justifying to the board, so you need information on the cost and pay back time to help that discussion. There also needs to be consideration of the farmer's time."

Andrew: "You need to be targeted and approach farmers that will benefit from the technology."

Ian: "We are welcoming to companies wanting to try something and can provide advice and guidance where we think there will be mutual benefit. But at some point, this can become a cost to the farming business."

Are you happy to share data?

Andrew: "If there is mutual benefit. A project with UEA identified that cover crops could reduce the amount of nitrogen being leached into the river – this is a good example of the benefits of sharing within a water catchment."

Peter: "It depends who you are sharing with. Happy to do this within a poultry group to improve efficiencies and to use it for benchmarking."

Ian: "Yes, if it increases sustainability and enables us to benchmark with the other vineyards. The four fundamentals are crop, farmer, field and boundary – you need to have consistency in the data and common names at the base level."









TECHNOLOGY EXHIBITION

A notable feature of REAP is the technology demonstrations and networking opportunities. By bringing together all elements of the agri-tech ecosystem the conference creates a collaborative environment for stimulating innovation.



ADAS

ADAS is a leading agricultural R&D and consultancy business, with over 60 specialisms including soil science, crop physiology, crop protection, nutrition, horticulture, modelling, informatics, GIS, and web/software development.

ADAS leads the Yield Enhancement Network to foster innovation in yield improvement with farmers, industry and researchers.



Trade and Invest British Columbia

"The province of British Columbia has an office in Europe to help British Columbia companies to export to Europe, and we work with UK companies to explore Canada as an option for their expansion plans.

"We met Belinda through events in the Netherlands and as a result decided to explore the market in the UK. We want to see if there is an appetite for expansion into Canada and opportunities for technologies to be applied on farms here in the UK."

Melissa Arsenault



AgRecruit

AgRecruit supports companies in the agri-tech sector, from early-stage start-ups to international household names, in securing talent across a variety of disciplines.



xarvio

"The aim of xarvio Digital Farming Solutions, the digital arm of BASF, is to equip growers with tools like xarvio FIELD MANAGER to help them use crop inputs only when and where they are needed.

"Targeted prescription maps, environmental data and crop modelling can assist decision-making on-farm - a key enabler to achieve a more sustainable agriculture."

Luke Pollard

AmbioTEK CIC with King's College London

"We are looking at how low-cost DIY environmental monitoring tools can be used by farmers to make their own environmental loggers.

"Our new model – Co$tingNature Local – looks at ecosystem services at farm scale by combining in-field monitoring, remote sensing data and AI."

Sophia Burke, AmbioTEK



First Base Solutions

First Base Solutions presented its innovative KYMINASI PLANTS Crop Booster technology, based on biophysics, which uses natural processes to give plants the necessary stimulation they need in order to grow stronger, faster, bigger, healthier, tastier and more nutritious.



Cambridge Consultants

Carbon sequestration – where carbon dioxide is taken out of the air and stored – could potentially be a new source of revenue for landowners if there are reliable ways of measuring carbon uptake.

Niall Mottram explained to delegates how improved traceability regarding regenerative agriculture practices, as well as combining modern techniques (for carbon measurement) and data science in an economically viable way is vital to realise the benefits.





Netword Agro

NetWord Agro is a start-up offering digital soil, crops and pasture monitoring technology.

Its technology aims to identify the agents that cause crop damage (pests, diseases, and weeds) to prevent loss. It monitors the crop autonomously with a maximum of 24 hours between sampling and the generation of maps.





Kroptek

Kroptek offers Controlled Environment Agriculture solutions and develops Sustainable Farming projects with the aim to drive the new farming revolution by empowering growers around the world to grow high quality crops locally, sustainably, and profitably all year round. Its range of high-performance LED grow lights for use in a variety of fruit and vegetable production, including strawberries, leafy greens, tomatoes and more.



Grant Instruments

"We are here today to show off our bi-directional gradient plate which is used in seed germination research.

"It demonstrates the optimum conditions for germination. Rapid establishment is a key factor in the performance of a crop."

Andrew Boyd



Gardin

"We are developing a system that will give farmers easily actionable insights by revealing how their crops are responding to the environment in real-time, before any visible changes to the canopy happen.

"The aim is to direct farm managers to the cause of growth issues, unlocking the potential for higher yield and better crop quality."

Fabrizio Ticchiarelli



Innovation AgriTech

"We have an aeroponic vertical farming solution where we can grow leafy greens and herbs and other crops in aeroponic farms, and are showing the model for the first time at REAP.

"We are looking to speak to farmers who are considering precision farming and alternative approaches to improve resilience and productivity."

Kate Brunswick



Pure Farming from Map of Ag

"Pure Farming – Map of Ag's data integration platform – connects data from multiple sources, standardises it to a common form, and then allows farms to control who accesses that data and for what purposes. We see ourselves as giving control to farmers and also powering up businesses that need to make sense of farm data.

"The insights also help supply chains demonstrate that farmers are genuinely acting on the sustainability and welfare concerns of consumers."

Andrew Cooke



Drone Ag

"With our Skippy Scout software, the whole field can be viewed quickly, with data collection repeated throughout the season to view comparisons and trends in near real-time.

"Moreover, the collected data can be viewed or sent anywhere by the farmer, so anyone who needs to see it can see it instantly.

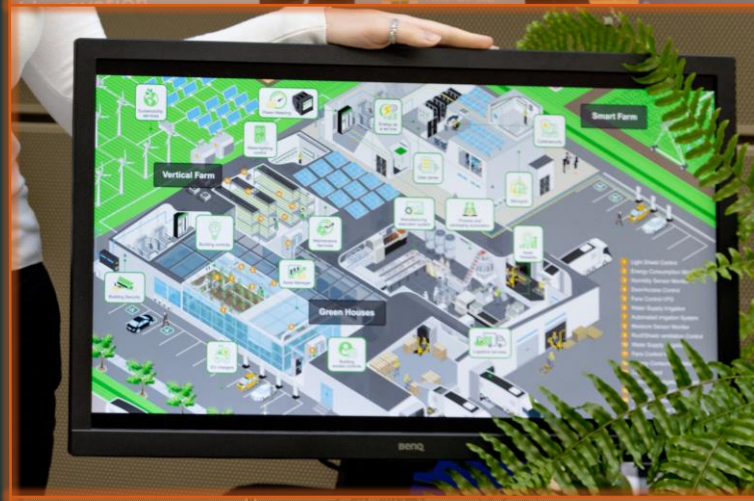
Alex Macdonald-Smith

Schneider Electric

"We are showcasing a mixture of our automation technologies: our Delta robots and our Cartesian robots, showing how they offer 'pick and place' for package fresh produce.

"We are also discussing automation of vertical farms, greenhouses and traditional farms to enable a transition to a smart farm."

Lara Ashford





Earlham Institute

Earlham Institute's new technology, Air-seq, identifies and analyses airborne pathogens in near-real-time using DNA/RNA sequencing. Air-seq could be implemented as an early warning system for pathogens to reduce crop and livestock losses due to disease outbreaks.

EI has also developed machine-learning-based technology, TraitSeq, to discover biomarkers for complex agricultural traits, such as water use efficiency, nitrogen use efficiency, taste and yield – potentially benefitting a range of agricultural sectors to enhance the sustainability and productivity of crops.



CASE STUDIES: **Introducing automation into a conventional farm**

Automation of farming operations offers promise but integrating robotics on-farm when there has already been a significant investment in equipment creates many challenges.

Jamie Lockhart is Managing Director of Frederick Hiam Limited, a diverse farming and fresh produce business with farms in Suffolk and Cambridgeshire growing a wide range of root vegetables, including parsnips, potatoes and onions, on light sandy and rich fen soils.

Jamie explains: "We are looking to increase the accuracy of our mechanised weeding to reduce the use of herbicides and move to a more preventative approach to weed control."

Jamie met Tom Beach *(pictured below right)* through his father at Mudwalls Farm in Warwickshire; Tom had recently co-founded **Autonomous Agri Solutions** to bring a farm-centric approach to automation.

"I was impressed by Tom's enthusiasm for all things autonomous and how we could use them in a practical and immediate way. It was at this first meeting that a trial with a **ROBOTTI** was suggested."



The ROBOTTI is like an autonomous tractor – it can navigate the field fitted with attachments for various operations, such as seeding, weeding, spraying etc. Autonomous Agri Solutions is using an N-Trip RTK system for navigation that offers sub-2cm accuracy. Sowing the crop with this level of precision allows a sequence of automated operations to be conducted with confidence.

Jamie continues: "We offered a 40-ha block as part of the trial. We were keen to learn the true costs of operation and how they compared with our existing conventional system.

"The ROBOTTI has drilled the parsnips on this block and weeded them on several passes. Initially it was about getting confidence in the accuracy and reliability of a fully autonomous system. In this regard the machine hasn't put a foot wrong and, on several occasions, we left the machine running all night whilst weeding and the accuracy was perfect.

"We don't see the ROBOTTI as a direct replacement for our manned equipment. Our biggest asset remains our highly skilled team, who are essential to ensure consistent results with these high input crops, but we absolutely see opportunities for the ROBOTTI to work alongside these teams going forward."

Tom Beach agrees; he sees automation as a complement to farm operations.

"It's about the systems integration. Our first customer in the UK, Home Farm Acton, based in Suffolk, wanted to use ROBOTTI from day one for weeding in potato ridges. Unfortunately, with the inaccuracy of their planting system and the way the beds were created, this was not possible. But this was something we could rectify and improve.



"We made sure that the level of guidance being used on the conventional agricultural equipment, the tractor, was of a high enough level of accuracy and precision. The management systems were in place to support that all the way through; the same guidance lines were used, making sure it all matched up and flowed together.

"This year they've had absolutely no issues weeding their organic potatoes with ROBOTTI – it's gone perfectly, because we were able to support them in putting this in place, and they are now able to introduce other forms of automation."

"It's all about understanding the needs of the farmers and the reasons for doing things. Next year we are planning to weed a greater area of crop than we've actually seeded; that is, to weed a crop that's been planted using a conventional tractor.

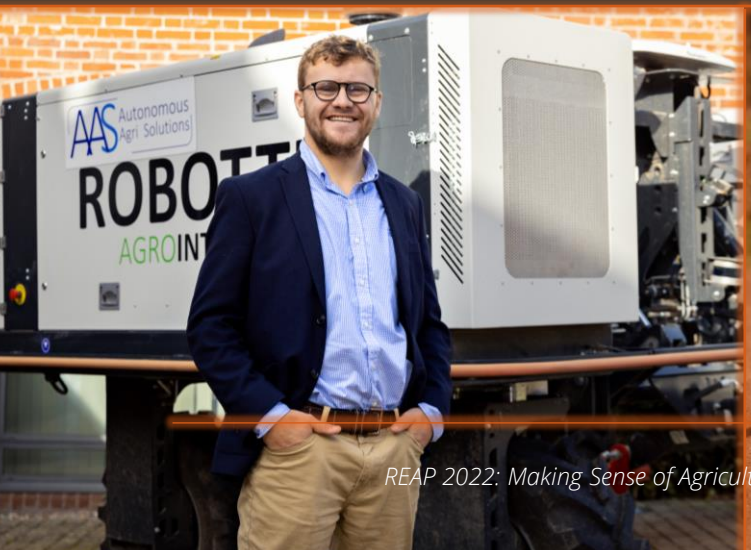
"As we can't guarantee the level of accuracy that the tractor's been able to achieve, we will be using a vision system to add a side-shift element to move the implement left and right within the constraints of the ROBOTTI, to adjust for that inaccuracy.

"We have a variety of technology that can work on-farm and this type of hybrid solution means that farmers can use their legacy equipment where most effective and we can help automate the elements that will be most beneficial.

"The volumes of data available in farming is enormous. What I'm interested in and what I'm looking for is actionable data – 'what data will make a difference to a real decision we're making on-farm?' If we have appropriate information, then we can really make changes in our farming practices."

Jamie shares Tom's sentiments: "One of the main uses we see going forward for the ROBOTTI is for crop monitoring throughout the growing season.

"The company is a developing a 'crop eye' system that will monitor crops and, through a series of algorithms, will decide on precision applications and actions. This will have a big impact on reduction of inputs and creating a more focussed management plan."







AI-directed mechanical weeder promises improved blackgrass control

A next generation weeding machine was launched at REAP.

ARWAC has been spun out of the Innovate UK funded project 'Autonomous Robotic Weeder (in) Arable Crops (ARWAC)', combining robotics expertise with industry expertise to provide a solution for blackgrass control. The objective is to optimise crop production and soil quality through the reduced use of herbicides.

ARWAC Managing Director Nick Webster says: "The weeding machine uses refined sensors and AI to distinguish between the cereal crop and blackgrass. This is a challenging task as the two have a grass-like appearance.

"The aim is to develop a mechanical solution that is diesel- and chemical-free and is also lightweight to avoid soil compaction.

"A low carbon mechanical approach to weed removal will reduce inputs and bring financial and environmental improvements to the UK farming economy."

Agri-TechE: AN INDEPENDENT MEMBERSHIP ORGANISATION

Agri-TechE is building a vibrant innovation ecosystem aimed at revolutionising that way that food and other organic materials are produced.

Its members are diverse and include farmers and farming businesses, technologists, researchers, investors and other business support providers.

Everyone with a passion for agriculture has an important role to play and the membership tiers are designed to enable participants to pick a level that is right for them and the requirements of their organisation.

All membership organisations benefit from:

- Entry in the online member directory
- Free access to online events
- Discounts on in-person events
- Members' newsletter
- Member-exclusive opportunities

The new membership tiers are:

- **Milli-Member** (£200): aims to enable a watching brief of industry insights and developments.
- **Hecto-Member** (£400): is for those looking to raise profile and expand their network in agriculture.
- **Mega-Member** (£1,200): is suited to established businesses looking to stay ahead of the competition.
- **Giga-Member** (£5,500): offers bespoke support, particularly for those looking to develop their business strategy.

Get in touch at **info@agri-tech-e.co.uk** to see how membership can benefit you.

Some highlights from 2023

Agriculture 101

At Agriculture 101, Rosie Begg, Farm Director at Gorgate Farms, blackcurrant growers for Ribena and others, joined fellow farmers and others in the agri-food value chain to provide an overview of the agricultural sector to newcomers to the industry.

The Missouri Delegation

Following on from a successful mission to Missouri, in March the Governor came in person to visit Agri-TechE and catch up with developments.

From left to right: Dr Nik Johnson (Mayor of Cambridgeshire and Peterborough), First Lady Teresa Parson, Governor Mike Parson, Sarra Mander (CMO of Small Robot Company), Dr Belinda Clarke (Director of Agri-TechE), Professor Mario Caccamo (CEO of NIAB) – with one of Small Robot Company's robots.

Innovation Hub at the Royal Norfolk Show

The President of the 2022 Show, Lord Cholmondley, supported 'Time for Tech', which was a focal point for a number of VIP visitors.

This included Karel van Oosterom (Ambassador of the Kingdom of the Netherlands to the UK) and his colleagues, who met Dr Belinda Clarke (Director of Agri-TechE), Jo Churchill MP and Andrew Wood (Honorary Dutch Consul for the East of England) in the Innovation Hub.







A BIG THANK YOU TO...

...the REAP 2022 sponsors ...

The Royal Norfolk Agricultural Association (RNAA) is a leading organisation for the promotion of Norfolk food production, farming and the countryside. Over 175 years it has supported the farming community and provided a connection with consumers through events such as the Royal Norfolk Show and the Norfolk Farming Conference.
Sponsor of the Bursary.

Innovate UK is one of the nine research councils within UK Research and Innovation. Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base.
Field Sponsor

Burleigh Dodds Science Publishing is an award-winning, "climate-smart" publisher in agricultural science; its work helps researchers in agricultural science address the challenge of feeding a growing population in the face of climate change and increasing competition for land, water and other resources.
Field Sponsor

Rothamsted Enterprises is located on the world-renowned Rothamsted Research campus, the heart of agricultural research. It offers a unique hub, focused on supporting start-up agri-tech companies, and facilitates introductions with Rothamsted Research colleagues.
Sponsor of the Start-Up Showcase

Savills was founded as a rural surveying business more than 150 years ago. It offers a broad range of specialist advisory, management and transactional services to global clients. The UK rural economy remains an integral part of its business and the rural teams are focused on the commercial needs of landowners, farmers and agricultural enterprises.
Sponsor of the Farmer Breakfast

...the Agri-TechE team...


Belinda


Becky


Laura


Diego


Kristina

...and everyone who attended as speakers, exhibitors or delegates. See you at REAP 2023!



Hauser Forum, 3 Charles Babbage Road, Cambridge, Cambs CB3 0GT

01223 760135 | info@agri-tech-e.co.uk | agri-tech-e.co.uk | reapconference.co.uk