Attending and Presenting at the European Conference in Precision Agriculture.

Dates: **29 June 2025 – 04 July 2025**

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Dr. Charles Whitfield was the recipient of the GCRI Trust grant.

The conference was held in **Barcelona, Spain**.

Executive Summary and highlights

- Yield forecasting models (from simple biomass sensors to advanced simulation and vision systems) are emerging as practical tools to help predict crop performance and optimise planning in protected edibles and ornamentals.
- Precision fertigation and irrigation systems linked to sensors and weather forecasts can reduce water and fertiliser use by up to 25% without yield loss, offering cost and sustainability benefits.
- Robotic platforms for scouting, spraying, and weeding are commercially available, while robotic harvesting continues to advance and could help address labour shortages.
- Policy and regulation are evolving: precision application technologies are being recognised by EU regulators as a route to meeting pesticide reduction targets, with clear implications for UK horticulture.
- Data ownership and trust frameworks (e.g. the EU's Common Agricultural Data Space) are being developed to overcome barriers to technology adoption — a theme highly relevant for UK growers considering digital platforms.

Conference summary

The European Conference on Precision Agriculture (2025) (ECPA), is at the forefront of agricultural innovation. Bringing together researchers, farmers, and industry leaders, the ECPA provides a unique platform for sharing the latest breakthroughs and discussing the challenges and opportunities of precision agriculture. By fostering collaboration and knowledge exchange, ECPA plays a crucial role in shaping the future of sustainable and efficient food production.

Over the four-day conference, there were four parallel running sessions on the following topics: Precision Crop Protection, Proximal and Remote Sensing of Soil and Crop, Economics of Precision Agriculture, On-Farm Experimentation and Site-Specific Agricultural Practices, Unmanned Aerial Systems and Satellite Technologies for Advanced Precision Agriculture Applications, Precision Pasture Management, Advances on Precision Agriculture, Adoption of Precision Agriculture, Robotics Guidance and Automation, Software Mobile Apps and Decision Support Systems for Precision Agriculture, Geostatistics Mapping and Spatial Data Analysis, and Data Mining for Precision Agriculture. In addition, there was a field visit to view a wide range of autonomous equipment, robots, and precision tools, from devices still in development and many commercially available systems.

Background

More than 400 delegates attended the European Conference on Precision Agriculture. The audience and speakers were highly international, with strong representation from across Europe and the UK, as well as North and South America, China, and other Asian nations. Attendees included postgraduates and professional researchers from universities and research organisations, alongside representatives from government and regulatory bodies, and industry stakeholders such as plant protection product manufacturers, data and software providers, and engineering companies.

The programme covered a wide range of crops, with a particular focus on the development and implementation of precision agriculture techniques. Many presentations and posters addressed protected edible crops, including case studies on tomatoes, peppers, lettuce, and salad leaves. Other topics, while not specifically focussed on these crops, were highly relevant to protected edibles and ornamentals—for example, advances in automated abiotic stress detection, precision nitrogen and fertigation management, robotic harvesting, and biotic stress detection.

The event highlighted the significant and ongoing benefits that precision farming technologies and digital services are bringing to food production systems. On a personal level, I gained valuable insights into areas beyond my usual research focus, particularly around the adoption of new technologies, barriers to wider uptake, and how regulators are responding to the major changes in crop protection and management practices.

Travel Findings

The purpose of this travel was to learn about the latest work in precision agriculture, to network with experts working in connected areas, and to present NIAB's work in precision agriculture. These objectives were successfully met.

Latest work in precision agriculture

<u>Yield prediction</u>

Many presentations focused on advances in yield forecasting. One researcher presented a digital simulation model to predict tomato yield, integrating genetics (variety), environmental variables (weather, soil properties), and management decisions (e.g. planting dates, crop protection). This approach captures the "genotype × environment × management" (G×E×M) interaction. The model was coupled with spectral reflectance data for ground-truthing over time, enabling accurate prediction of leaf area index and yield. Although developed for field-grown tomatoes, the approach would likely perform even better in controlled environments such as glasshouses.

Another forecasting model, tested in commercial South American farms, used a far simpler approach: plant biomass detection combined with manual fruit sampling. Despite its simplicity, the model achieved low prediction error in four of five tree crops. Using relatively inexpensive biomass sensors and early-season fruit counts, final yield could be reliably and cost-effectively estimated. While less precise than more complex models, this approach could be highly practical across many protected edible and ornamental crops due to its low cost and ease of implementation.

Machine-vision applications were also highlighted. A newly developed pipeline for oyster mushrooms successfully automated detection, localisation, and estimation of size and volume, trained on datasets of growth rates over time (Figure 1). Although currently reliant on 2D image data, performance could be enhanced using depth cameras or LiDAR. The aim is to provide accurate yield forecasts, predict harvest timing, and enable robotic harvesting. This development pathway is highly transferable to other high-value crops in controlled environments.

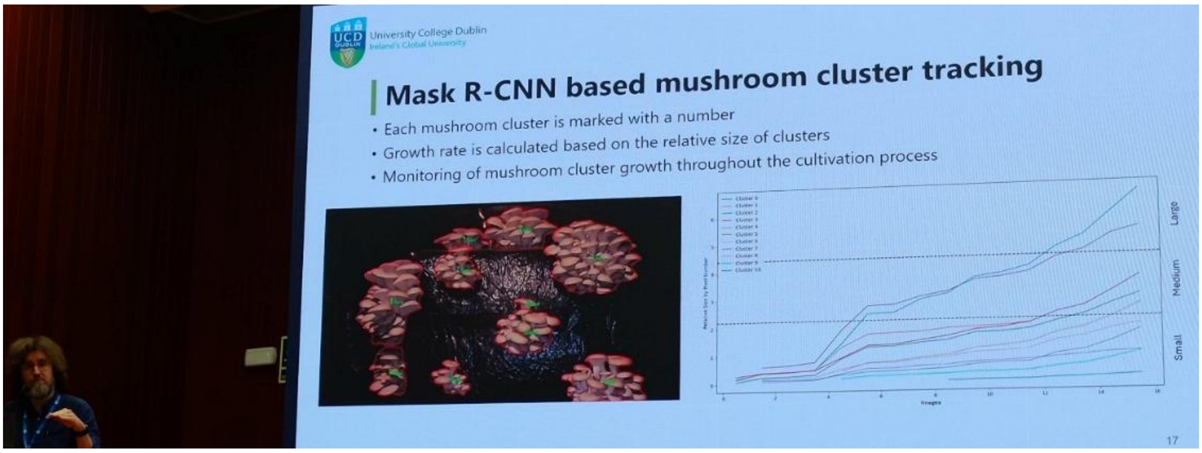

Figure 1: machine-vision based automated detection, sizing, and growth rate estimation of mushrooms to predict yield.

<u>Resource efficiency and input reduction</u>

Reducing inputs and improving efficiency remain major objectives of precision agriculture. Most work presented relied on sensing platforms (drones, satellites, ground-based sensors) combined with data analysis to tailor inputs such as fertiliser, irrigation, and pesticides to crop requirements.

One example was a Regulated Deficit Irrigation (RDI) system combined with a Digital Twin (DT) for field-grown tomatoes. By integrating soil-moisture monitoring and weather forecasting into a decision-support platform linked to automated irrigation, the system reduced water use by 26% compared with standard grower practices, while maintaining total commercial yield. Trials were carried out on commercial farms using growers' standard irrigation plans as controls. Such systems will become increasingly important in mitigating erratic weather patterns. With further development, abiotic stress detection and automated fertiliser control could be integrated, offering growers reduced input costs and environmental benefits.

<u>Robotics and automation</u>

Robotic and automated systems were presented in various stages of commercial readiness (Figure 2). Most operational platforms currently focus on crop monitoring, spraying, weeding, or harvesting.

- Weeding robots (mechanical, laser, or precision spraying) appear closest to full commercialisation.
- Harvesting robots, while advancing rapidly, still require further R&D to improve accuracy and speed.

Glasshouse systems, with their structured layouts, are particularly suited to robotic sprayers, which could greatly reduce operator exposure and alter the risk profile of pesticides. This in turn affects decisions around product approval and renewal.

Figure 2: Top left: HARVBOT, robotic harvesting in apples (still in R&D). Top right: Ecorobotix, precision automated smart spray machine for vegetable crops (commercialised). Middle left: Earth Rover, scouting and weeding (non-pesticide) robot (commercialised). Middle right: VineScout, scouting and mapping robot for vineyards (ready to commercialise). Bottom left: Oz naio technologies, soil preparation, seeding, weeding robot (commercialised). Bottom right: scouting and harvesting robot for dragon fruit (still in R&D).

Policy and regulation

The advancement and uptake of precision technologies has major implications for regulators of Plant Protection Products (PPPs). One keynote lecture and several presentations discussed how regulation is adapting.

The European Commission's *Farm to Fork* strategy aims to reduce pesticide use and risk by 50% by 2030. Precision agriculture is expected to contribute significantly to this reduction, for example by variable rate spray systems that can greatly reduce the overall volume of PPPs applied to cropping area (example systems in Figure 2, Figure 3, and Figure 4). Regulators recognise that the approval process must adapt to technological developments, and should focus on outcome-based requirements for example, reductions in drift, targeted application that only spray a proportion of the crop not the entire crop area, and minimising operator exposure, rather than prescribing specific equipment. The onus will be on the technology provider to show that their product achieves those outcomes. The end result may be that pesticide labels have different rules and rates depending on the equipment being used to apply them.

Figure 3: precision variable rate spray machine for vineyards. Capable for applying different water volumes to different zones/blocks of the vineyard following a prescription map. It has been extensively trialled on commercial vineyards, demonstrating that targeted application according to canopy density significantly reduces the quantity of PPPs required to manage the crop. It is ready to be commercialised.

Cross-cutting issues

To fully realise the benefits of precision technologies, several enabling factors must be addressed:

- **Farmer investment**: upfront costs remain a major barrier, requiring financial support mechanisms and clearer evidence of return on investment.
- **Knowledge exchange and training**: growers and agronomists/advisors need support to interpret data and integrate tools effectively.
- **Data ownership and privacy**: concerns over data use are among the biggest barriers to adoption. The EU's Common European Agricultural Data Space (CEADS) project is developing frameworks for transparency, access, and control of agricultural data.

Conclusions and implications for protected edibles and ornamentals

The research and technologies showcased at the conference demonstrate clear potential for application in protected edible and ornamental crops. Yield prediction models, sensor-driven fertigation and irrigation systems, robotic platforms, and evolving regulatory frameworks are directly relevant to these sectors. Adoption of such innovations offers opportunities for reducing inputs, improving resource efficiency, addressing labour challenges, and meeting regulatory and sustainability targets.

Personal Statement

Networking

Attending the European Conference on Precision Agriculture provided an excellent opportunity to expand my network across academia, industry, and regulatory organisations. I made valuable new connections with EU regulators, agri-tech companies, and researchers, leading to useful feedback on my work and early discussions about potential collaborations. Several of these contacts have already been introduced to colleagues in the UK, and initial conversations are underway on joint research proposals.

Presenting

I also presented NIAB's work in the Precision Orchard Management and Environment (POME) project, showcasing 2024 field trial results on precision variable-rate spraying in orchards (Figure 4). This work aims to improve productivity and reduce environmental impacts by applying crop protection products according to the needs of individual trees. The conference helped position this research within the wider European context and highlighted its relevance to UK horticulture.

Figure 4: presenting the work from the Precision Orchard Management and Environment (POME) project on the results of the field trials testing a prototype precision variable rate spray system for orchards. The presentation focussed on results from trials measuring spray deposition, insecticide efficacy, and in-field drift losses, comparing the variable rate spray system to a standard constant rate spray machine.

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